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The Impact of Spending Cuts on Science and Scientific Research

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The Science and Technology Committee

The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Government Office for Science. Under arrangements agreed by the House on 25 June 2009 the Science and Technology Committee was established on 1 October 2009 with the same membership and Chairman as the former Innovation, Universities, Science and Skills Committee and its proceedings were deemed to have been in respect of the Science and Technology Committee.

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The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at http://www.parliament.uk/science
A list of reports from the Committee in this Parliament is included at the back of this volume.

Committee staff

The current staff of the Committee are: Glenn McKee (Clerk), Richard Ward (Second Clerk), Dr Christopher Tyler (Committee Specialist), Xameerah Malik (Committee Specialist), Andy Boyd (Senior Committee Assistant), Camilla Brace (Committee Assistant), Dilys Tonge (Committee Assistant), Melanie Lee (Committee Assistant), Jim Hudson (Committee Support Assistant) and Becky Jones (Media Officer).

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Taken before the Science and Technology Committee

(Science and Technology Sub-Committee)

on Wednesday 3 February 2010

Members present

Mr Phil Willis, in the Chair

Mr Tim Boswell	Dr Doug Naysmith
Dr Evan Harris	Ian Stewart
Dr Brian Iddon	Graham Stringer

Memorandum submitted by the Campaign for Science & Engineering (FC 62)

Introduction

1. The Campaign for Science & Engineering (CaSE) is a policy advocate for science and engineering in the UK. We are supported by individuals and organisations spanning all areas of science, technology, engineering and mathematics with representation from universities, industry, learned societies and charities.

Summary

2. Science and research funding needs stability through the forthcoming period of constrained public expenditure. In the short-term this should mean:

— the current Science Budget running until 2010–11, is protected; and

— that the next Science Budget spending settlement (2011–14) should at least match projected economic growth, consistent with the goal of the 10 year Science and Innovation Investment Framework.

3. The government should adopt a broader perspective on its support for R&D, which incorporates investment in the research base, government department R&D, and industrial support through the Technology Strategy Board, Regional Development Agencies and the R&D tax credit.

4. The next government should start the process of developing a new medium to long-term strategy for investment in science engineering. It will need to establish a cross-government research programme to develop a stronger evidence-base to inform decision-making in this area.

Science and Innovation Investment Framework

5. Science and engineering research needs to be supported by a clear and stable investment plan. The government developed the 10 year Science and Innovation Investment Framework in 2004 to give clarity and confidence to the research community, as well as corporate and charitable research funders. It is important that the Framework is seen through until 2014 no matter what party forms the next government.

6. The 2009 Annual Report of the Framework was disappointing as it was more of a summary of current activities in different areas rather than a measurement of progress against the goals set out in the Framework.

7. The 10 Year Framework had the goal of increasing the knowledge intensity of the UK economy, with the ambition of reaching 2.5% of GDP being spent on R&D by 2014. In 2007, 1.81% GDP was spent on R&D. CaSE has calculated that to achieve the target of 2.5% GDP invested in R&D, an additional £10 billion would have to be spent from all sources, if GDP remains constant. Alternatively, if R&D spending was held constant, UK GDP would have to shrink by 28%.

8. Constrained public spending will inevitably lead to tough choices about government investment across the board, including research funding. However, the government and the research community should consider how sustained investment can contribute to societal goals like rebalancing the economy and responding to global challenges, as well as advancing knowledge for its own sake. There are at least two strong precedents in South Korea and Finland for taking such a path. Both countries increased their investment in science and innovation to good effect during periods of severe public expenditure constraint.

9. The government used some stimulus funds to increase later stage R&D support through the Strategic Investment Fund and the Technology Strategy Board. However, there has not been increased support for the research base as part of stimulus spending, unlike many of our competitor countries.

Portfolio of Public Investment in Science and Innovation

10. The government has a broad portfolio of support for R&D. The main funding streams are through the Science Budget, research funding from the Higher Education Funding Councils, and government department investment in R&D. In addition, there is support for R&D through the tax system, the Technology Strategy Board, and Regional Development Agencies. Each funding streams is there to support different purposes.

11. The same process of evaluation and analysis should be applied when deciding whether and where to increase or decrease funding for science, engineering and technology research. The Treasury is responsible for the spending settlements across government, and thus it sets the highest level of prioritisation within the government's support for research. Therefore, CaSE has recommended that the Chancellor should appoint a Chief Scientific Adviser to develop the evidence-base to underpin those decisions.

Science Budget

12. This government and the next one need to see through the current spending commitment for the Science Budget until 2011. This would ensure the integrity of the Science Budget ring-fence. The Science Budget is ring-fenced as it is agreed separately from the government department budget that is responsible for its oversight, currently the Department for Business Innovation and Skills (BIS). The most recent example of the Science Budget ring-fence being breached is in 2007 when the Department for Trade and Industry took money out of the Science Budget for industrial support.

13. It is important that the next government sees through the 10 Year Framework, which is meant to run until 2014. In terms of the Science Budget this would mean that it would at least match projected economic growth for the period from 2011–14.

14. There needs to be clearer delineation of responsibility, as well as transparency, in setting research priorities between the department which allocates the Science Budget and the Research Councils. The Research Councils, through proper engagement with their research communities, should decide the research priorities in their area. There needs to be a sufficient amount of responsive mode funding to support emergent areas of research—it is also a highly competitive way of allocating funds.

Science and Technology Funding Council (STFC)

15. The implications of the STFC budget allocation and subsequent currency fluctuations mean that there will be fewer trained researchers and research across a number of areas within STFC's remit. Their re-prioritisation of funding will also have consequences for our international standing as a research partner due to questions over the UK's ability to honour its long-term commitments. It is important that the UK plays its part in international research collaborations. These benefit the UK not just through the discoveries made, but also in the training and networking of UK researchers.

16. The review of the STFC announced by Lord Drayson is welcome. However, it is very disappointing that there are no published terms of reference for the review, nor does it seem that there will be formal external involvement. BIS should have been much clearer in what the review would entail when it was announced. Because of the lack of clarity on its scope it is difficult to assess what the outcome of it might be.

HEFCE research budget

17. The most recent letter from the Secretary of State to HEFCE asked them to protect the research budget whilst making cost savings to the teaching side of the budget. In essence the research budget has been ring-fenced for the time being.

18. It is important to recognise the role that HEFCE research money provides in enabling a university department to win project funding from Research Councils and other external sources. The government is keen for universities to increase the amount of research funding from external sources. It is important that the Charity Research Support Fund is kept in place to cover some of the indirect costs of charity funded research. However, government departments, European, and industry funding do not always cover full economic costs and can therefore be a less attractive source of funding. It is important that government's efforts to correct historic underinvestment in the UK's research base, are not undermined by unsustainable research funding.

Government Departmental R&D

19. According to Government statistics, overall government departmental investment in R&D shrank by 24% between 2004 and 2007. So it is extremely important that departmental R&D budgets are protected from short terms raids and are saved from disproportionate cuts whilst public expenditure is being constrained.

20. The Department of Health is the only department to have a ring-fenced R&D budget. At the moment, the only protection for other departmental R&D budgets is that the Treasury and the Government Chief Scientific Adviser are meant to be consulted prior to a department taking funds from them. With fewer resources at their disposal, government departments will need to ensure that their policies and public services are effective—this will only be known through research and analysis. Departmental R&D budgets should therefore be published for the spending period and protected.

21. It may also be appropriate for some cross-departmental evidence needs to be serviced by a cross-departmental research budget, coordinated by the Government Office for Science.

STEM Education in Higher Education

22. There was an increased intake of STEM students in 2009 following the government's decision to allow 10,000 additional places in those subjects. There is considerable tension between expanding places in STEM subjects and the sustainable financing of them. Prior to this decision and cuts to higher education, CaSE was concerned about the funding ratio of 1.7 for science and engineering courses. Although it has been extremely difficult to determine the right ratio, 2 would provide for a more sustainable financing of those strategically important courses.

Impact and Evidence-based Science Policy

23. The government should separate out two different objectives that have become increasingly interwoven within its impact agenda. The first is what options there are for increasing the impact of the research the public funds. The second is how to assess the impact of research that the public has funded, in order to justify investment in it relative to other areas of public expenditure.

24. There have been many concerns about the Research Council examining impact statements as part of their funding process. There is a shortage or lack of evidence evaluating the ability to predict the future impacts of research yet to be conducted. However, the Research Councils are not actually asking researchers or grant assessors to do this. Research Councils have done a poor job of articulating what they want from researchers in terms of impact statements and what their purpose is.

25. It is sometimes possible, but extremely difficult, to assess the impact of research retrospectively. The development of the impact component of the proposed Research Excellence Framework should have been piloted and evaluated before there was a commitment to its inclusion within the assessment process.

26. Government departments, including BIS, the Treasury, Government Office for Science and major R&D spending departments, should fund research to inform debates about the impact of different investments in research. The US has developed a programme in this area called the science of science and innovation policy. A similar programme should be developed to inform the next long-term strategy for science and engineering in the UK.

Political Commitment

27. Cuts to science and engineering are not necessarily an inevitable consequence of the recession and the public expenditure constraint that will follow it. It is critical that all political parties recognise and develop long-term policies to strengthen the UK's capacity in science and engineering research and skills.

February 2010

Witnesses: **Lord Broers**, a Member of the House of Lords; **Professor Brian Cox**, School of Physics and Astronomy, University of Manchester; **Nick Dusic**, Director, Campaign for Science and Engineering; and **Sir Peter Williams**, Vice-President, The Royal Society, gave evidence.

Q1 Chairman: Could I welcome our distinguished witnesses to the first of our evidence sessions where the Committee is looking at science budgets ahead of the next General Election but in the light of the confusing scenario which currently surrounds where resources are being allocated or where they are not being allocated. We are very grateful indeed that we have with us Sir Peter Williams, one of the Vice-Presidents of the Royal Society and the Treasurer, and we are delighted that the Royal Society is with us this morning; Lord Broers, welcome again to you, Professor Brian Cox from Manchester University and, of course, Nick Dusic, the Director, Campaign for Science and Engineering. I wonder if I could start with you, Lord Broers. Could you say, briefly, why you feel that investment in science actually matters? Have we not spent enough on it over the last 10 years?

Lord Broers: We have spent quite a lot. We have a very strong science base, but, of course, science is important not only from a cultural standpoint but to support our science-based industry, and it is science-based industry that re-emerges as the mainstay of our economy. The problem I see at the moment is that we have not had a linked linear relationship between the science base and our science-based industry. While the science base has been strong and getting stronger our science-based industry has been

getting weaker and weaker. We have some very bright sparks, but it is not consistent, and that is a serious issue. In our hearings to the Lords Committee recently we heard from Anne Glover, who was telling us, of course, that this is a cyclical process and if science does not somehow trickle through into industry and come out the other end so it can be reinvested in the top, then we are going to have an issue, and at that is the issue that has arisen that we have to address.

Q2 Chairman: Surely, in that case, we should be concentrating our resources on pulling through that science into industry rather than, in fact, further investment in fundamental science.
Lord Broers: We have to be careful with that, because we must sustain our science base. What we do have to do is to find better mechanisms for involving industry. I think a lot of the fault has lain with industry, not necessarily with our university-based science. We have some industrial companies, Rolls Royce and BP, who know very well how to work with universities, perhaps British Aerospace, but across the board we are not particularly good and we are not particularly good at involving SMEs.

Q3 Chairman: Professor Cox, the physics community, particularly the nuclear physicist academics, are bombarding us at the moment with, yet again, claims that that area of science, which, quite frankly, industry will not fund in the same way in terms of that element of fundamental science, is, in fact, again losing out. Can we not do without it for a few years? We are in a recession.
Professor Cox: If you look at the amount we spend, first of all, on R&D in the UK, it is low by any international standards, even now. If you look at the league table, we are down below Iceland, Finland, Spain, Korea, Denmark, Portugal Germany, Switzerland, Sweden, and the Netherlands. We are down somewhere in between Luxembourg and Australia.

Q4 Chairman: But they are small nations, are they not?
Professor Cox: Italy, Japan, Norway, Sweden, Germany. We are low.

Q5 Mr Boswell: Do you mean public spending when you say that?
Professor Cox: Yes, public spend on R&D. It is also the same in private investment as well actually. We are low by all league tables. If you look at the STFC funding into universities, for example, particle physics is about £27/£28 million a year, if you discount the international subscriptions, astronomy is around £40 million a year. These are very small amounts of money, but as Lord Broers said, the people you educate who are the engines of innovation in the economy, it is well-known from any study that you look at that you need PhD students and graduates educated in cutting-edge research institutions in order to take knowledge from wherever it comes, be it generated abroad or in this country, and translate that into innovation, translate it into economic growth. You cannot just switch off the R&D and the research in universities for a few years while you come through a recession, because when you come out of that recession you will not have the people educated at the cutting-edge who are the engines of innovation.

Q6 Chairman: Professor Cox, there is an inbuilt assumption at the moment, both in Parliament and elsewhere, that because we have got this huge recession everybody needs to tighten their belts and nobody seems to be making the case strongly enough that we need to continue to invest and, indeed, invest more in terms of science, and Lord Broers is making the point, which I think is a very valid point, which, to be fair, he constantly makes, about this throughput, this continuum of pulling the stuff out of universities. My point to you is should we not be concentrating more on that side of things in this recession rather than in fact spending more on fundamental science?
Professor Cox: The thing is, you need to know how to do that. I agree that if you could do it, then it would be a wonderful thing to do, but if you look at all the social science research that has been done by the Treasury, Salter and Martin, for example, in a very famous social science review commissioned by the Treasury, say that it is essentially impossible to identify the areas you would like to invest in to translate basic research into economic growth. Look at the example from America. Yesterday, I think it was, the plan for science and innovation was announced by the President. It says they are going to double to science budget over the next 10 years, and it says, "These investments will expand the frontiers of human knowledge and create the foundations for the jobs and industries of the future", but, number one, it is accepted clearly in the Obama administration that the way to do it is to expand the frontiers of human knowledge and thereby we derive the benefits.

Q7 Chairman: The Royal Society is the custodian of science, arguably, in the United Kingdom and is respected throughout the world. Do you accept that we should be spending more on science and that we should dismiss this idea of reducing and cutting back?
Sir Peter Williams: In a word, Chairman, yes.

Q8 Chairman: So what are you doing about it?
Sir Peter Williams: Before I answer that question, can I give you an illustration, which I think goes to the heart of the matter, from purely personal experience. I spent 20 years running a university spin-out from Oxford, it was called Oxford Instruments. In 1911, that is nearly a century ago, a chap called Kamerlingh-Onnes discovered superconnectivity. In 1982, following Peter Mansfield's Nobel Prize winning science for Nottingham University, we wheeled the first scanner magnet into the Hammersmith Hospital. It is still scanning patients today. Today they are a five billion dollar worldwide industry and we have also, much more importantly, brought nothing less than a

revolution in diagnostic medicine. None of that could have been predicted by Kamerlingh-Onnes, and I put it to you that little of it could have been predicted in 1982 when we marched confidently into the Hammersmith hospital. The timescales for the process that Alec so accurately described are long, they are indeterminate and they are imponderable, and the idea, Chairman, that science has had a good run in the last decade so it is perhaps time to tighten the belt is a mistaken one, because what science needs, leading to engineering, leading to wealth creation, is continuity and delivery of programmes over very long periods of time. Therefore, now addressing your question, yes, the Society is (and I think you are well aware we are) coming out with what you might term our manifesto for science on the morning of 8 March, just prior to the three main parties' debate, I think, Evan, the following day, and you will have copies of that, which is very much a manifesto for science and engineering and wealth creation on top of that.

Q9 Chairman: Could you say on the record, without in fact giving us an insight into what you are going to say in terms of the manifesto, that it would be fundamentally wrong for UK Plc to roll back on its funding on science and that, indeed, we ought to be moving forward in terms of that agenda?
Sir Peter Williams: Funding for science is one of the best investments a nation can make.

Q10 Chairman: Is it the best investment?
Sir Peter Williams: It is one of the best investments, yes, along with perhaps education. I think that if you do not invest in your future at difficult times of recession, you will not prosper when the good times come. This is a lesson we have all learned in industry. I sit on a couple of major engineering boards, these remnants of our great past that Alec referred to: GKN, WS Atkins, and so on. We have had to invest during these difficult times so that when we emerge we hit the ground running and will be successful. The nation has to do likewise.

Q11 Chairman: Nick Dusic, do you accept that science has had a good run for its money over the last 10 years, particularly since 1999 and particularly since 2004 and the 10-year Science and Investment Framework and it is now the time to say we will put our energy elsewhere in tackling the deficit?
Nick Dusic: The 10-year framework is a very important document for science innovation in this country and it came out of a real need, pushed by Save British Science, the forerunner of the Campaign for Science and Engineering and others, that the country was under investing in its science base. The 10-year framework was funded in 2004 and it is supposed run until 2014, and we want to see that seen through. The continuity that Sir Peter was talking about is absolutely necessary in investing in science and engineering research, and if we were to roll back on that commitment to the 10-year framework that would be a travesty for this country, but it would also show our partners in the research community and industry that we do not have the follow-through to make those investments in the good times and in the bad, and I think that is what this country needs to do now.

Q12 Dr Iddon: Can I ask Nick, and, indeed, the other the panel members, in that framework, Nick, to which you have just referred, there was a promise that the science budget was ring-fenced.
Nick Dusic: Yes.

Q13 Dr Iddon: Has that promise now been broken?
Nick Dusic: As far as I am aware, the science budget ring-fence has not been broken yet, other than in the instance in 2007 when the DTI took money back from Rover. The science budget allocation is supposed to run to 2010/2011, and if there is any money taken out of the budget up to that period, then it would be breached; so that is the science budget ring-fence.
Mr Boswell: To pursue the logic of what has been said and to try and look at it through the eyes of the Treasury for a moment, is the implication of what Sir Peter and others have said, first of all, that nobody should ever consider any reductions in the science budget generally—the quantum—secondly, that they should never consider the allocation between the various components in the public science budget and, thirdly, that they should not consider any modulation of the timing? After all, if something is invented in 1911, for example, and it is now going to take a century to achieve commercial exploitation, I think at least the Treasury has to be convinced that a year or two's wait is not critical to this. I am deliberately setting that up because I would like a response to it.
Chairman: Who would you like a response from?

Q14 Mr Boswell: Let us start with Sir Peter and anyone else can join in.
Sir Peter Williams: That is a very good question. Having worked with the Treasury quite closely on a number of issues over the last decade, I can sense why you are trying to tease out the answer. Nobody is being as dogmatic as the terms in which your question is cast. The reality of our statements that science and engineering and research need continuity is a sensible one where allocations, as you put it, between particular subject headings could conceivably vary over the years—more properly, I think, a question for our colleagues in your next session this morning. If I take Singapore, for example, as an international comparator their prowess in the seventies and the eighties in the semi-conductor emerging revolution is well-known. What is less well-known is that their decision in the late eighties to devote a lot of intellectual resource into the biosciences, and biotechnology in particular, is now bearing fruit 20, 30 years later. Yes, there are sometimes some difficult choices to be made, but the fundamental point where I think this panel, as you have heard from us, is united is in that continuity, broadly speaking, of at least constant funding and, hopefully, as economies grow, growing funding for science and engineering and research is the thrust that we are trying to put before you today.

Professor Cox: The answer, I think, to the question, "Should reductions ever be considered?", is to look at the magnitude of the science budget overall. If you look at it from a Treasury perspective, total R&D investment in the UK next year is around eight billion, of which RCUK, the money into universities, is around three, three and a half billion, if that. If you cut that to zero, it would not make much difference to the bottom line of the UK. That is the first thing to note. The second thing to note is that physics, according to the Institute of Physics' figures which were quoted in the Wakeham Review, contributes 6.4% to UK GDP. That three and a half billion in RCUK is the whole science budget, MRC and everything, but just physics, 6.4% of UK GDP. In my view, it is a rather dangerous and high stakes experiment to consider cutting physics funding, let us say, which is below a billion to RCUK, and see what happens. I do not know why you would take that gamble. The second thing about moving between disciplines, of course, is that you have to constantly reassess the public spend on science. What has happened, what you have to avoid, I think, from a university perspective, is radical and steep step-function changes. That is what has happened with the STFC issue. What we have seen in about two years is a reduction by, let us say, between 40–50% in grant income into universities, this is the projected drop in astronomy and particle physics, nuclear physics astro-particle physics, which are the most populous areas in terms of academics in university physics departments. As a business what are universities to do if you make such radical and abrupt decisions?

Nick Dusic: Can I follow up on a point about the portfolio of investment? The science budget makes up one part of the Government's investment in science and engineering research, a very important part, and the foundation for the rest, but we have seen a decrease in government department R&D around 25% between 2004–07, which is during the 10-year framework period when the science budget was supposed to be increased in line with economic growth.

Q15 Chairman: Can I stop you there, because there is some doubt about those figures. In fact, we are in conversation with the Science Minister at the moment to try to examine that shift, and there is a claim that, in fact, it is a different accounting system rather than a direct cut of 25%.

Nick Dusic: Okay; so this is from the Government stats. There has been a shift of some money between the departmental budgets and the research science budget due to accounting, changes to DIUS, machinery of government, but I do not think that accounts for all of it and I hope the Committee will pursue that line of inquiry with the Science Minister.

Q16 Chairman: We certainly will.

Nick Dusic: Very quickly, the Technology Strategy Board and the Strategic Investment Fund have provided some additional money for these late stage investments, and so that does happen, and, also, there have been two countries, Korea and Finland, who have had to cut public expenditure quite significantly at different periods but increase investment in science innovation because they saw that as a way out for their country.

Q17 Graham Stringer: Lord Broers, there is nothing new here, is there? During your time as a professional engineer this is the fourth recession we have arrived at. What has been the impact of cuts in science and engineering during the previous recessions? What was your experience of that?

Lord Broers: I did not have direct experience in this country; I was in the United States. What used to happen, for example, in IBM research when there was a recession and times became difficult was that the work did become more applied for a while: there were no cuts. I think to cut your science and engineering is very damaging. I think that happened in this country and that is probably what was very damaging. One does have to be realistic at times and change one's priorities slightly. If I look very parochially, declaring my interest as Chairman of the Diamond Light Source Board, we have been cut in the phase of building the actual device, which is a great shame because it means that certain things we could do even if we could change the emphasis a bit we cannot do any more. If you look at the Japanese Light Source, which is perhaps the biggest one in the world, they have eight people full-time working with industry to make sure that their industry is quite up to speed in using these marvellous resources. We do not have that capability. We would like to have it but, of course, it costs money. At the moment we are desperate not to cut our science resource to sustain the user part of our programme, but we are unable to do some of those things that would be hugely beneficial. I think my bottom line on this is, no, of course one should not cut one's science and engineering budget, but one may need to change priorities during very difficult times.

Dr Harris: Can I follow up that Diamond Light Source thing. We had a session with Alan Thorpe, who I think we will be hearing from in a minute, and I asked whether there was a concern that we could meet the Government's side of the funding for Diamond Light Source to keep all the stations running that were planned to run for the time that they could maximally be used. Despite Wellcome having put in all that capital, we were not actually deriving what we could because of funding cuts. What is the position? We were told there was no problem.

Q18 Chairman: Before you answer that, Lord Broers, in addition to that we have had the Chief Executive of STFC make a clear statement in terms of their new proposals that the funding for the Diamond Light Source and ISIS too would be protected.

Lord Broers: They have not been protected to the original five-year plan that we were living on. We have taken a 10% or 11% cut against that five-year plan. Fortunately, unlike some other light sources in the world, Gerhard Materlik and his team run a very, very tight operation, it is very well managed and, by

going to the extremes, we have been able to sustain what we are doing for this year, and next year looks uncertain, as, of course, does the full programme look completely uncertain at this stage, because the ring has about 15 beam lines running at the moment. There will be another seven coming online in the next two or three years and then the plan was to proceed on to phase III another 10 beam lines, which would take us up to 32, or similar to the European Synchroton Light Source—by the way, we would be running at about two-thirds the cost of that source—but our funding is only adequate for the next year. So 10, 11 is already uncertain and beyond that it is extremely uncertain.

Q19 Chairman: Okay.
Professor Cox: Could I make a comment on that.

Q20 Chairman: I do not want to get bogged down in the various kinds of light sources.
Professor Cox: I am agreeing completely. If you look at the documents that were released on the freedom of information about the exchanges at CSR 07 between STFC, DIUS, RCUK, you see that STFC map out what would happen if they got a flat cash settlement, and they say that would mean running Diamond and ISIS at 50 per cent capacity and 50% cuts to university grants. It is in the documentation. It is not a surprise. It is actually surprising that Diamond is managing to run at slightly above 50%, I think that is a tribute to management in a sense, but that is the implication of the CSR 07 settlement that STFC forced.

Q21 Graham Stringer: The panel is making a compelling case for there not to be cuts in science. It is not unexpected but that case is being made. Are there any lessons of process that can be learnt from previous cuts exercises if the Government goes ahead and makes cuts?
Lord Broers: I do not think I would be able to comment on process. There is debate about where the decisions are made. We are probing that, of course, in the Lords' Science and Technology Select Committee and it is obscure to somebody like me. There is an evidence session with the ministers on Thursday that may clarify that and with Adrian Smith. It is obscure to me where these decisions are finally made.

Q22 Graham Stringer: I would guess that the panel would also be united in welcoming President Obama's decision to go for 3% of GDP investment in science and engineering. It is a very big question, but what impact do you think that will have both in the United States but on science internationally and, in particular, in this country, if any?
Lord Broers: I would like to make a quick comment on that. I think it will have a very positive impact. What we have to learn to do, though, is to take up some of our advances and do more with them than we do, and that is an insoluble problem and I know this Committee has been working on that, just as a lot of us have. Peter Williams brought up the case of scanners. Oxford Instruments has done very well in that area, particularly under Peter's leadership and others, but the big business is owned by GE and people in America. We have lost our ability in many areas to get the big part of an operation. We do well in certain sectors, as we all say, but it would obviously be a good thing if we could do well in more sectors.
Sir Peter Williams: May I add a comment in that context that the dog that has not barked in this session is not things that you would do to the science base to ensure that it pushed out, or came out with ideas, but the receptor, the world of industry, and what the world of industry is doing to match what goes on in the science base and to exploit it better. Alec's point about Oxford Instruments being a relative minnow compared to General Electric and Toshiba, who have made the bulk of the revenues out of the scanner, is a particular case in point. The best companies, the great exemplars, the Rolls Royces of this world, as you are well aware, work very actively with UK universities. Their UK technology centres are legendary, they attract the best scientists and engineers and they produce some of the best commercial ideas. I think we have to look again at government's role in ensuring that the world of industry is more receptive to taking up the ideas that come out of the science base and taking the risks that go with it, and the recent annual evidence from the R&D score board, was it 21 billion in the most recent reported year of business enterprise R&D, most of which, as we know, is D rather than anywhere near R&D. That is the equation we have to look at, that is where you get the momentum in the economy, not from penny-pinching in the science budget, which, as colleagues have already pointed out, is a comparatively trivial part of the economy in total cost terms. We have to look at the industry state of the nation and see how receptive they are to taking up the cutting-edge ideas, cutting-edge people, best trained PhDs and scientists and moving forward.

Q23 Chairman: We have been saying this for 10 years.
Sir Peter Williams: Yes, we keep saying it.

Q24 Chairman: Lord Sainsbury's report *Race to the Top* was stuffed full of exactly that and the same for the TSB.
Sir Peter Williams: We have not done it yet convincingly.

Q25 Mr Boswell: Does it need more public money to do it?
Sir Peter Williams: I think it probably does, yes.

Q26 Dr Iddon: Can I come in on the back of Graham Stringer's question about President Obama's recent commitment to science and what appears to be a pretty significant investment in the United States? Yesterday the Chairman of this Committee raised with the Prime Minister at the Liaison Group this particular question, and I am sorry if I paraphrase it, but the Prime Minister said something to the effect that the United States are only really catching up from a lack of investment during the Bush era and

that our investment was significantly more than that under this Government in relative terms. Do any of the members of the panel have any comment on make on the Prime Minister's statement yesterday?
Nick Dusic: According to OECD stats, between 2004-2007 the US and the UK had the same increased government investment in science and technology, so during our 10-year framework and during the Bush administration we were just holding equal, and that was the OECD average, so there is no room for letting other people catch up. Science is a global endeavour, so competition and collaboration is absolutely necessary, but we cannot rely on the fruits of other people's research if we do not invest in it ourselves, because in order to absorb the research that is done abroad you have to invest in research and skills here.

Q27 Dr Iddon: What is the percentage of GDP that the US spends now? Can you remember that, Nick, off the top of your head?
Professor Cox: Publicly funded R&D in 2009 was about .41% of GDP and the UK was slightly ahead, .45, or something like that.
Dr Iddon: There must be something wrong with those figures because I have got the percentage of GDP for Britain at 2001 at 1.8 and, of course, the target is 2.5.
Chairman: It includes the private sector.

Q28 Dr Iddon: Yes, two-thirds of that is private sector. It dipped slightly between 2001 and 2007 but it has only climbed back to 1.79 in 2007, so it appears that we have not made a lot of progress in science expenditure, public and private, in those years from 2001 to 2007, and we will be looking at international comparisons, of course, during this inquiry.
Lord Broers: Can I make a comment, please? The US economy is six, seven, eight times larger than ours. I would argue that the US is the only country that anymore can pursue all branches of science and technology. The countries that have succeeded: Peter Williams already mentioned Singapore. If you look at the emergence of Taiwan as the major semi-conductor force now, South Korea, even if it has troubles, is emerging; Finland was mentioned. All these countries specialise. They bit the bullet and focused. I think we have got to bite the bullet and focus a bit more than we do. We still think that we can cover the entire base, but I do not think we can.

Q29 Chairman: That means they are going to be losers, Alec.
Lord Broers: They are going to be losers. That is what we are particularly bad at.

Q30 Chairman: Picking losers?
Lord Broers: Chairman, I lived through that in the semi-conductor business. When I came back from the States we wanted to start a large institute such as they founded in Belgium, where they did specialise, but we could not do it because Southampton wanted it, Edinburgh wanted it, Cambridge wanted it, Manchester wanted it and we took the AlBi Programme and divided it five ways and now we have nothing and Belgium has the number one research semi-conductor laboratory in the world.
Professor Cox: This is a contentious thing to say, because if you look at the research—let us look at the social science research, let us just look at the research that has been done by the experts—there is a recommendation here, and I can read it out: "Since a single piece of basic research may contribute to many different technological and product developments, nations need a portfolio based approach to the public funding of basic research."

Q31 Chairman: Where is that quote from?
Professor Cox: That is from Salter and Martin again, this Treasury commissioned document. It is a contentious issue, but the point is that it is considered by many people to be so difficult to pick the area that will generate the paradigm shift that will generate the wealth, but a nation such as Britain, which is a world leading scientific nation, must maintain investment in across the whole portfolio in order to take advantage of developments from wherever they come.

Q32 Chairman: Sir Peter, I know you cannot speak for the Royal Society, but as the Vice President you can come near to it. Which side of the argument do you fall on?
Sir Peter Williams: Can I be greedy, Chairman, and say, all of the above. From an industrial perspective, I am with Alec. It is fatuous to think that this country will excel at everything in the twenty-first century. It will not. There will have to be certain areas of technology where we win and others where we accept that we cannot. In terms of science, because of the unpredictability of this pull-through process, as my example illustrated, I am nearer to Professor Cox, in the sense that I think it would be ill-judged of a science minister and, indeed, of your good selves to try to start picking winners round this table. It is a dangerous game.
Nick Dusic: There are different ways for funding investment in science and technology. We have the Research Councils and we also have the Technology Strategy Board, the Strategic Investment Fund. The funding through the Research Councils needs to be a broad portfolio of research because of that necessary need to have an absorptive capacity, but the Strategic Investment Fund and the Technology Strategy Board are there to pick areas where emerging technologies are coming through, and I think that is why you can have both arguments, and there are two different funding mechanisms to make that happen.

Q33 Dr Harris: Before we leave science funding I have a couple of quick questions for you, Nick, because this is important. The 10-year framework was to cover science spending as a whole, not just the science budget. Is that correct?
Nick Dusic: The 10-year framework covers the whole.

Q34 Dr Harris: The science budget is just part of the science funding overall, as you made clear, and so when the Prime Minister said in February 2009, "We will meet our 10-year commitment to maintain science spending", he was not just talking about the science budget, he was talking about the whole thing, presumably—the 10-year commitment?
Nick Dusic: It must be to maintain the commitments within the 10-year framework, but within that it is to increase investment in the science budget above, or at least matching, economic growth.

Q35 Dr Harris: In 1986 when Save British Science was created by Denis Noble and John Mulvey in Oxford and Abingdon, is this right, we spent 2.17% of GDP on R&D, and in 2007, according to figures that are on your blog, we spent 1.81% of GDP on R&D in terms of the whole budget. Is that correct?
Nick Dusic: I cannot recall the 1986 figure off the top of my head, but I assume that is correct if it is from the blog.
Professor Cox: I will tell you what it is in real terms: it was 9.4 billion in 1986 and it is predicted to be eight billion.

Q36 Dr Harris: Given that Save British Science was set up when the funding was higher in real terms, as Professor Cox has just said, you are not saving British science any more. Do you think John Mulvey and Denis Noble will be turning in their solenoids, or whatever they will turn in, given that is where we are?
Nick Dusic: There are two things. There has been a huge shift in funding between defence to civil spending. The Research Council's funding has gone up between 1997 and now. There was a dip between 1986 and 2007, but we are not making any ground on total government expenditure on science since that period.

Q37 Dr Harris: Professor Cox, have things only got better!
Professor Cox: As you said, as Nick said, the figures are difficult to interpret. I will just give you one example. The science budget is true, RCUK's budget has doubled since 1997 roughly—that is true—but if you look at a particular STFC area, let us take the ESA subscription, that appears to have doubled in 10 years. What actually has happened is when we began 10 years ago about a quarter of the ESA subscription was paid out of the science budget, the RCUK budget. Now it is a half, so it has not actually doubled, money has moved around, and that makes it very difficult to interpret what the rise actually was.
Chairman: I do not really want to go over the last 10 years in great detail; I would like to move on to review the effect of these cuts.

Q38 Dr Harris: Let us have a look at the impact, because we have touched on this basically. The Research Excellence Framework has the significant bit now about impact, and so do grant applications, that one has to look forward and scientists have to say what the impact will be. Can we have a view, whoever wants to start, maybe Professor Cox, on whether you think this is the right approach and, if not, what you think they should do instead?
Professor Cox: In preparing an argument you like to see the other side, and so I have looked through the literature for any evidence that it is possible to judge impact under virtually any criteria and I honestly cannot find it. What I find everywhere I look from the academic peer review research that has been done on measuring impact is that it is extremely difficult to do so. Broadly you can say that science has impact in the economy and you can pin it down and you can say that it is the graduate students, the PhD students, you can follow impact to some extent, but it is very, very difficult, if not impossible, to measure impact. I have been on peer review panels and I am being asked at the moment, if the present proposals go through, to sit there and take a view on the impact of a particular research proposal. I have no idea how to do it. That is what you hear from each one of my colleagues who has sat on panels: "I do not know how to do it."

Q39 Dr Harris: Guidance on the HEFCE website about the proposals recommended that as part of the REF units of researchers should submit a statement setting out demonstrable benefits' to the economy, society, public policy, culture or quality of life during the REF period and, indeed, previously.
Professor Cox: It is two different bits. That gives retrospective and RCUK is forward looking.

Q40 Dr Harris: Indeed, but either of those, are they just a waste of time or are they positively damaging given that you do not think it is a sensible thing to do?
Professor Cox: If I were to take a view on a peer review panel, if I was forced to guess what the impact would be, then it would be random from my perspective, so it would be damaging. Retrospective looks from HEFCE, that is more difficult to judge. I do not know; maybe you can provide evidence of the impact you had. I know the studies say that that is no guide to the impact you are going to have in the future.

Q41 Dr Harris: Sir Peter, do you have anything to add to your further point about this because, unless it is just politicians saying something that sounds good, presumably someone has called for this in industry?
Sir Peter Williams: The Royal Society in its REF consultation response has already in writing welcomed these broad measures of impact which you have just quoted, not one, and it is usually the economic impact factors which are singled out, and not a narrow interpretation and not over metricated simplification of the structure into some peer review processes. Broadly speaking, if we are looking at the impact that science and engineering have on society, on the quality of life, on the culture, which is a sign of a civilised society, and on the economic growth of that society, yes, the Royal Society welcomes that as a broad set of concepts.

Q42 Dr Harris: When I said "you" I meant industry, but let us come back to the Royal Society. The Royal Society can provide, and will provide evidence that doing something like this will be a benefit, in other words, it can identify, for example, bits of research that do not have any of those impacts that we should defunct: because in order to propose something to get more something has got to lose out. Help us out by naming or identifying the bits that should be cut.
Sir Peter Williams: You presuppose, and, indeed, the whole nature of our invitation today was to come and debate cuts. That is not the Royal Society's position and the manifesto you will receive from us on 8 March is not a manifesto for cuts, it is a manifesto for investment.

Q43 Dr Harris: I was talking about reprioritisation.
Sir Peter Williams: You will see within the recommendations that we are making all of these broad impact indicators feature in the nature of the specific recommendations we make.

Q44 Chairman: Why is Professor Cox wrong then, in your view, because clearly you take a contrary view?
Sir Peter Williams: No, I do not. Chairman, with respect, I think what we are saying is complementary to each other. I sympathise entirely with Professor Cox, I have seen the stacks of papers that these peer review committees get, it is an invidious task, and to have superimposed on that an overly simplified and narrow interpretation of these impact patterns, which is all too often what happens, makes his job far more difficult and far less effective.

Q45 Dr Harris: I think there was a difference, and you will both have a chance to clarify this, because I asked, is it just a waste of time but it does not actually affect funding going to the best project, or is it actively damaging to the idea of funding the best because there is this distraction and, if you act on it, it is not a relevant consideration, it is not quite random, but it is not directed in a directive way against potentially the best research which does not have anything obvious? If the scientist just has not been able to identify in grant applications future impact, they might lose out. I thought he was saying it was a bad thing, however it is done, if there is no good evidence to suggest that it helps you fund what you need to fund, and you were saying that you could probably welcome it; that it is overall a good thing. I think that is quite a big difference.
Sir Peter Williams: I am saying that I can understand how it makes Professor Cox's and other peer reviewers' jobs far more challenging and difficult. As all too often happens, Evan, as you well know, the fine rhetoric is reduced to narrow tables and spread sheets and tick-box mentality, and that is what corrupts and makes the peer review process more difficult.

Q46 Dr Harris: Do you have a response, Brian, and then if I may ask Lord Broers to come in?
Professor Cox: Briefly, if you applied an impact assessment across government departments, so you said, "What is the impact of scientific advance relative to some other areas of spending of government?", I think it works in those broad terms. All research shows that scientific advance has impact, but I agree entirely—you interpreted my point correctly—that it is next to impossible, I would contend, to draw a series of guidelines for a peer review panel to take into account to make them pick winners more often than they pick losers. I do not see how that judgment can be made by a peer review panel.
Lord Broers: I would take a slightly different tack on this. I start from support for very broad ranging curiosity-driven research. However, if you do look at the great advances that came out of Pure Science, you find they came out through people who were very interested in impact. Townes, when he took his understanding of science to create the maser, was trying to solve a problem. He wanted a very high frequency amplifier and did not how to do that with vacuum valves, et cetera. He came out with the maser. Then people thought, "Goodness me, we could do that at light frequencies", and then came the laser, and from then on there were people trying to use the laser intensely to see if they could not get it more reliable and at the right frequencies, et cetera, to do the things they wanted to do with it that then exploded completely so that in the end we have applications we could never have dreamt of, but they all came about as a result of people who were trying to get impact out of the science. If you look at the transistor, Bardeen, Brattain and Shockley at Bell Labs were trying to get rid of having to have a glass bottle out of which they sucked the air so they could have an electron beam in there; they we are trying to make a solid state vacuum valve and they came up with the transistor. What were they trying to do? They were trying to get impact out of science, and you find this again, and again, and again. It is not so much that you can judge what that impact will be down the road, but the motivation is very important.

Q47 Chairman: All scientists, surely, are motivated to do that.
Lord Broers: Exactly, all scientists are motivated. There is not a single scientists that I have ever met, if you said, "My gosh, if we took your ideas we could save half the world", that would not drop everything and start doing that. We should be interested in impact. I do not know why we have got quite so hung about this.

Q48 Chairman: Because 25% of the REF is going to go on impact. That is why we are hung up.
Professor Cox: This a list of anecdotes, so I can give another list.
Lord Broers: Pretty good ones.
Professor Cox: Okay. What about the Worldwide Web then? Tim Berners-Lee is on record, I have seen the papers that he presented at CERN. His manager wrote, "Vague but interesting" on it, threw it back at him but he didn't say, "You can carry on anyway because this is certain to revolutionise the global information system."

Chairman: I am going to stop you all here, because I do not want you falling out. Nick is going to have a word.

Q49 Dr Harris: Can you come back on the question?
Nick Dusic: I will. I am going to say something first though. The evidence base for science policy decision-making needs to be improved, and I think BIS, Treasury, the Government Office for Science need to invest to build up the evidence base to have more informed discussions around the impact of investment in these areas, because if we would have done that when we developed the 10-year framework with these sort of discussions around the Research Council impact, grant assessment processes including REF having impact, we might have had bit more informed, thought-through discussion about how investment in our research base leads to impact in the wider world, which we all want to see. Coming back to the Research Councils and the REF on the HEFCE proposals to include impact, I think there has been a lot of confusion, mainly some by the Research Councils, about what it is that they are looking for in terms of these impact statements. Are they part of the grant assessment process and they will be judged? I have heard different things from Research Councils on this, but if there is a good way that a researcher can see how a little bit of extra money can help them get more impact out of the research that they are conducting, then that is different thing.
Dr Harris: Maybe there is a way forward. Let me see if the panel would agree with this, all of you. Rather than trying to identify impact at the beginning, the key thing is to identify it once the work has been done, drive it and fund it better than we do. Would that be something we could all get to?

Q50 Mr Boswell: A sort of second stage.
Nick Dusic: Absolutely

Q51 Dr Harris: Spot it, drive it, fund it rather than try and predict it; putting the energy into that instead.
Nick Dusic: Yes, that is the way to go. It would also be a better use of resources. Why spend money, when we are not quite sure what the impact is going to be, to help increase that impact rather than spending money when we know there is a potential impact and additional money would help it out.

Q52 Chairman: I think we are in reasonable agreement.
Lord Broers: I have a slight reservation in that a very large percentage of human innovation comes about as a result of solving problems, and you do want to make sure that you have got people who are trying to solve big problems. We have got enough, like climate and other things, and you should have people thinking about how we solve the problems in health and the environment and all these things. It is very important to start from that end of it. The human being is amazingly ingenious when it comes to solving problems, and if everybody is just working out in the blue without doing that in the hope that they will come up with something that somebody will suddenly identify, I do not think you get the same rate of creativity.
Sir Peter Williams: Could I add briefly, I think you should not make choices when you do not need to. Can I commend to you the words of the Gillette shaving advertisement as far as the scientific peer review process is concerned, we should do it before, during and after. The projected impact, the likely course towards impact and the retrospective view of impact is all part of the process; it is ongoing from the very beginning.
Dr Harris: You are saying that is "the best a man can get"!
Chairman: I am going to move on at this point. Thank you very much.

Q53 Ian Stewart: On the issue of prioritisation, Professor Alan Thorpe, we are told, told this Committee that beyond 2010/2011 planning was based on the flat cash allocation that you mentioned before, future budget allocations not taking into consideration inflation. He said that flat cash would be very challenging to manage, and then when STFC recently reprioritised its programme it held a consultation exercise amongst its members and the STFC said that it was satisfied that the prioritisation was a transparent and accountable exercise. My questions are going to be about the prioritisation process. If cuts have to be made—this is to the whole panel—on what basis should the decisions be made?
Professor Cox: I think it is correct to say that the prioritisation process the STFC has embarked on is transparent. It has been done this time through transparent peer review, it has been published, the ranking order was published of the experiment, and we go along from there. The problem, of course, is that that prioritisation exercise was not the result of some kind of considered plan for UK science, it was the result of a crisis. The STFC did not have enough money to fund its programmes, and so it was a reaction to that. It is not true to characterise it as the settled will of the community on how to proceed, it is essentially saying, "You have a budget that has been slashed by 50%. What are you going to do with it?", which is a very different thing. So, yes, transparent, but the direction of it not community driven, certainly.
Nick Dusic: Briefly, not on the specifics of the STFC but because of the short-term decision-making and the constant reprioritisation that STFC has gone through, it has created a lot of uncertainty within the research community to say the least, and I think that what we need to make sure of is that uncertainty around reprioritisation, whatever happens going forward, there is a bit of consistency about levels of investment for the science budget so people can plan ahead. Otherwise there will be constant reprioritisation processes which will just instil instability and, when other countries are investing and showing commitment, if we are not doing that people go to where there is a safer home. The same processes should be made about the decisions about

investment, and this Committee has looked at the science budget allocations and those questions and the same sort of principles should apply.

Q54 Mr Boswell: This is prompted by something Professor Cox said, but you might both wish to comment. You were arguing that there is a qualitative difference between, as it were, a settled will of the scientific community, as you described it, and a situation in the context of cuts which trigger changes. If we can take my hypothetical role as the voice of the Treasury for the moment again, would they not be entitled to say it is only in the context of "cuts" that these sort of tough decisions on priority will be taken; otherwise there will be an attempt to share it out, or (can I be a little more helpful and put a little more of a gloss on it) are you implying that some programmes which are of higher risk but possibly greater benefit are more easily available within a more generous funding envelope than they would be when you are having rigorously to stick to the basics?

Professor Cox: What I would say is when you impose such financial constraints so rapidly on an organisation, then the outcome is unpredictable. It is irresponsible to do it, in my view. For example, you will have seen in the Science Board evidence that was submitted to this Committee the Science Board said that any investment in future facilities should be withdrawn because of the low likelihood of additional operating costs being made available. The *raison d'être* of setting up STFC was to provide a more coherent and successful approach to providing facilities, both national and international, for UK science. The outcome of the budget squeeze has been for the Science Board at least to say that they wish to have no more investment because they cannot see how it can be important. That is precisely the opposite of what we would like to do. You cannot squeeze organisations and hope that a good outcome, an outcome that you wish to happen, comes out of that process. It does not.

Lord Broers: I wish to make a point, which is an obvious one but I think it is worth making. The science that Professor Cox is talking about that I am involved with in Diamond is totally international. I have been amazed at the unity. I was in Australia visiting the Light Source there and I am familiar with the ones in Brookhaven, and this is one community and everybody knows who is good and which is the good place to be. At the moment Diamond is that good place, but if things really turned down and expectations are not fulfilled, these people have an easy road to somewhere else, it is a very competitive business, and so it is very dangerous to perturb funding. Of course, it would be my view point, but once you have got a success one should cling to it; one can lose it very easily.

Q55 Ian Stewart: As to this prioritisation stuff, was the STFC consultation robust and, secondly, what use is the sort of beauty contest approach to prioritisation? Is it any use at all?

Professor Cox: I would say that the structural problem with STFC, which is well-known, is that what has happened is that you have tensioned the operating costs of the UK facilities that are provided for the whole of science, world leaders like Diamond, with a small subset of the science base, for historical reasons, accidentally—part of it because it is astronomy, those areas—so that tensioning has demonstrably failed. The prioritisation process in STFC is quite odd because you have got a set of people who are experts, who have to make decisions between two areas of science that have no link and you have got to tension them. I would say that the outcome of the STFC prioritisation is about as reasonable as it could be, given the financial constraints. I do not think anyone in the community has any complaints about that, but to be asked to tension the needs of the Diamond Light Source, a world leading facility, against astronomy, for no reason other than historic reasons, is ridiculous.

Q56 Ian Stewart: If nobody else jumps up I will take it that you agree with Professor Cox. We as a Committee have visited different countries and we have had discussions on the impact of the decisions made by the UK Government in terms of partnering relationships, and I have to say that my own view, may be others on the Committee too, is that it certainly has been implied that it can diminish the status of UK science and scientists because of these cuts, because of the restrictions that it places on UK partners. Is that your view?

Professor Cox: Absolutely. This Committee said that there has been severe reputational damage to the UK from the last round of cuts, not this round, and I agree with that, but also we are now in a position—and PPAN have said this (the advisory board in STFC)—where there is no future in the programme. The peer review process, the outcome has been to protect what we have to protect; so exploitation of CERN, exploitation of Diamond, exploitation of ISIS—and once you have done that there is no money left. It is widely recognised—it is on the record—that there is no future in the STFC programme. That is, of course, immensely damaging because UK physicists, like myself, who are in the middle of their careers cannot commit to any future research; we cannot take part in it. It is the same facilities—XFEL, the next generation, we can list them all. There is no money to participate.

Q57 Chairman: Can I interject here because, clearly, we are rerunning an inquiry we did some time ago.

Professor Cox: It has got worse.

Q58 Chairman: It is exactly the same issues that are arising. We ought, as a Committee, to be able to actually produce, as part of this report at the end of this Parliament, at least, a way of moving forward. What is the way forward? Is it to go back to PPARC and CCLRC? What is it? One of you give me an idea that we can write down.

Sir Peter Williams: As a former Chairman of PPARC could I say that I think you should start by addressing those questions to Professor Sterling, who I think is coming before you fairly shortly.

Q59 Chairman: We will do, but do you have a view?
Sir Peter Williams: I do, but I think I would prefer you to hear it from the current—
Ian Stewart: Come on!

Q60 Chairman: The Royal Society has no view.
Professor Cox: There is one settled view from the community, is there not? I think everyone I spoke to agreed with this, that you have got to find a way of tensioning the—

Q61 Chairman: We know what the problem is.
Professor Cox: So the answer will be to find a way of tensioning the exploitation of facilities against the science budget and not against a small fraction of it that cannot bear that tensioning; it is not big enough to bear the tensioning. This is making no value judgment about the relative—

Q62 Graham Stringer: Are you saying there are too many funding councils—that you need to simplify the whole funding structure of science? Is that what you are really saying?
Professor Cox: The key problem with, let us say, anything that uses a big international subscription like CERN, is that once you commit to be in CERN then you have to have some kind of ring fence for the exploitation budget; it does not have to be solid ring-fenced (that would be silly) but you have got to commit with the subscription some sort of ring fence. That is what PPARC was the solution to, as far as I can see; it was that problem of how you ring-fence the exploitation of international subscriptions. Also, you have got to ring-fence exploitation of facilities like Diamond. You cannot build a facility and not run it optimally.

Q63 Graham Stringer: What you are really saying is that STFC is not big enough to prioritise.
Professor Cox: Yes.
Lord Broers: Can I introduce another confusion, and that is that we have got space in there too, and I do not think space should be in there. If you look at the budget that has grown largest it is the ESA budget, and I think that is something that we should have as a space agency (?) because space looks very commercial these days, and I think it is not a happy partner; it is even worse than what Professor Cox is talking about. Tensioning things against space is very difficult because space, largely, is supporting the communications industry and things like this.
Chairman: We are very tight on time. I know, Ian, you have one question and then Tim.

Q64 Ian Stewart: It is one question in two parts. First, have you already all explained what you think the costs of UK science have been in relation to the reduction of the projects that we have already covered? Do you object to the outcome of the prioritisation or do you object to the process of prioritisation having taken place in the first place?
Professor Cox: I object to neither of those things; my objection is to the fact that a research council was set up with a very difficult structure in 2007 and then under-funded to the point where these issues would arise and problems would occur. That is the objection. The objection is not to what has been done—well, in recent times. The recent prioritisation at STFC has been transparent; it would be difficult to object to that.
Sir Peter Williams: I would just respond that I think in attempting to draw generalisations out of this rather specific issue of STFC you might be straying into dangerous territory. There are no other parallels that I am aware of.

Q65 Mr Boswell: Given that this has already been commented on, we are used to international subscription, which implies collaboration because we have not got the resources to do some at CERN on our own, is there scope for greater collaboration in terms of the exploitation of the outcomes from that scale of major experiment, maybe internationally? Maybe one of our solutions, in effect, would be looking at some burden-sharing in terms of taking the work forward, rather than sitting there saying: "We have not got any money, we can't do it, so we'll have to switch off the essential hardware"?
Professor Cox: If you look at particle physics, for example, then CERN's subscription is £80 million a year, let us say, and the UK domestic spend is of the order, at the moment, of about £27/28 million, or something like that. So already there is a very small exploitation budget and that is not just for CERN; that is for the whole programme, which incidentally has gone, apart from CERN, effectively, and it is the same in astronomy. So you have had to cut the future to exploit the present.

Q66 Dr Harris: Is not the sensible thing when a merger has not worked to just de-merge it; you do not have to call it PPARC, you can call it New PPARC, or People's PPARC?
Professor Cox: Is the answer not "You may say that but I could not possibly comment"?
Chairman: On that note, we will finish this session. Can I just thank you all enormously for being such an interesting and courteous group of witnesses this morning, Sir Peter Williams, Nick Dusic, Professor Brian Cox and Lord Broers. Thank you very much indeed.

Memorandum submitted by Research Councils UK (FC 31)

This response aims to set out the views of Research Councils UK (RCUK) by responding to some of the issues raised by questions in this inquiry. Due to the short time period available for submitting a response, we have focused on the questions which we feel we are best placed to answer. In this response, answers are set out below specific inquiry topics.

In this response 'science' and 'scientific research' has been interpreted to include all aspects of research, including the physical, biological, engineering, biomedical, natural and social science disciplines, and the arts and humanities. RCUK considers that the whole research spectrum, including the arts and humanities, is relevant to this inquiry.

The process for deciding where to make cuts in SET spending

1. Under the Haldane principle, once Spending Review allocations have been made, Research Councils develop their own strategies and priorities and make individual funding decisions based on thorough and detailed peer review. The Research Councils discuss priorities to ensure effective co-ordination of funding.

2. All Research Councils have scientific advisory boards comprising members of the research community. Therefore, the vast majority of prioritisation processes involve the research community. Members from key stakeholder communities also sit on the advisory boards, providing opportunities to reflect the views of stakeholders on priorities. Individual Councils of each Research Council take a strategic role in deciding on prioritisation after consultation with stakeholders and advice from the advisory boards. As well as programmes, grants and studentships, any discussion of priorities would also take into account institutes, facilities and international subscriptions.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

3. RCUK is committed to excellence with impact. This means continuing to invest in the best research, people and infrastructure, whilst aiming to enhance the impact of that research on society. The primary criterion for funding decisions continues to be the excellence of the proposal.

4. The demonstrable contribution that excellent research makes to society and the economy includes:

— fostering global economic performance, and specifically the economic competitiveness of the UK;

— increasing the effectiveness of public services and policy; and

— enhancing quality of life, health and creative output.

5. RCUK recognises that the research we fund has academic, and economic and societal impacts. All Research Councils provide evidence of actual economic impact and of performance of the processes by which it is enabled and sustained through their Economic Impact Reporting Framework (EIRF). Annual EIRF reports are a useful source of evidence of progress against the objectives of the 10-year investment framework. Achieving impact is not a linear process and Research Councils do not have direct control over the impacts of the research they fund. Impacts occur over a period of time and as the result of multiple interactions. RCUK increases impact from our investments by developing an impact culture through improving support mechanisms, evaluations, sharing best practice and communicating the benefits and impact of our continued support of research, training and the provision of facilities. For example, RCUK is:

— developing impact assessment methodologies;

— demonstrating the impact and value of sustained investment;

— identifying and addressing the barriers and drivers for maximising impact;

— optimising schemes for knowledge transfer funding, user partnerships and exchanges; and

— embedding impact considerations.

6. As part of our broad portfolio of evaluation studies, RCUK has commissioned over 35 impact studies over the last 10 years, demonstrating the impact from previous investments. These studies have used a variety of different impact methodologies. The most suitable methodology to use is determined by the area of impact being considered and can be quantitative or qualitative. As a result of developing and undertaking impact studies the Research Councils have found:

— diversity of impacts across the research portfolio;

— multiplicity of processes to achieve impact;

— both expected impacts and serendipity;

— impacts manifest at many scales: project, person, organisation etc;

— time lags and multiplier effects; and

— researchers and research are enriched by impact.

7. The studies undertaken include an econometric analysis of the rate of return for investment in health research, an investigation into the career paths and impact of physics PhDs, and the influence of environmental research on policy. Examples of impacts can be found on the RCUK website (http://framework.rcuk.ac.uk/default.htm).

8. RCUK is not trying to assess or predict the future impact of proposed research as part of the application process. Recent changes to the application process were designed to help assess the appropriateness of the activities planned in research proposals to enhance impact for a particular piece of research, in order to ensure that potential impact is maximised. Within the application process applicants have the opportunity to add to their case for support by describing the potential impact of their work, and pathways towards realising that, under the following headings:

- *academic beneficiaries:* this should cover potential academic impact and pathways towards realising that;
- *impact summary:* this should cover potential economic and societal impact and pathways towards realising that by addressing two questions:
  (i) Who might benefit from this research?
  (ii) How might they benefit from this research?
- *impact plans:* these should detail the activities which will help develop potential economic and societal impact, answering the question: "What will be done to give potential beneficiaries the opportunity to benefit from this research?"

It is expected that having reviewed the guidance, applicants will be able to answer these questions, however where activities aimed at enhancing impact are not applicable for a research proposal, applicants are invited to explain their reasoning and this will be reviewed with the rest of the proposal.

The operation and definition of the science budget ring-fence

9. RCUK welcomes the Government's commitment to sustain planned spending on research in 2010–11 and considers that the science budget ring-fence has provided vital stability for the research base, enabling the UK to build upon its research investments and maintain its leading position internationally. In recent years the Government has made a strong commitment to the UK research base supporting research excellence, building capacity and infrastructure. Long-term funding has allowed the Research Councils to build sustainable partnerships with key stakeholders across the spectrum, including business, industry, Government and third sector, and align strategy and research priorities with other funders in the UK and internationally to maximise the impact of the public funding committed to research.

10. The operation of the ring-fence is linked closely with the partnerships that it has helped to develop and maintain. Research has a major role to play in the economic recovery and cuts in UK research funding would have far reaching consequences impacting on funding plans for key stakeholders and as well as the UK's competitive position internationally. The global standing of the UK in almost all areas of research is first or second, and by most measures first in terms of global productivity per pound invested. RCUK considers the science budget ring-fence has been essential to achieving global excellence. If funding is cut from research, especially in the context of recent science stimuli in other countries, the UK risks falling behind international competitors, both in terms of research excellence and productivity, and ability to attract high value inward investment.

Witnesses: **Dr Tony Peatfield**, Director of Corporate Affairs, Medical Research Council, **Mr Iain Gray**, Chief Executive, Technology Strategy Board, **Professor Michael Sterling**, Chair, Science and Technology Facilities Council, and **Professor Alan Thorpe**, Chair, Research Councils UK, gave evidence.

Q67 Chairman: Can we welcome our second panel and thank you very much indeed for joining us today, Professor Alan Thorpe, from RCUK, Professor Michael Sterling—very nice to see you again in your new role—Dr Tony Peatfield, and Iain Gray from the Technology Strategy Board. Welcome to you all. If I could start with you, Iain Gray, when you are—as I am sure you are—having discussions all the time with the hard-hearted men and women at BIS and the even more hard-hearted men and women at the Treasury about future budgets, how do you persuade them, particularly given the comments of our previous panel, that investing in science and research is absolutely crucial to the future and that the tap should not be turned off?

Mr Gray: Firstly, thanks for the opportunity to be here. The Technology Strategy Board is still a relatively young organisation and has made, I think, very big inroads in the last two, two-and-a-half years—some real results. We are doing a heck of a lot of work at the moment looking at the economic impact we are making. What we have done, particularly last year, is we chose four key priority areas that we invested in, and those sort of challenges rely on underpinning capability—a much broader science base. The key thing, from a Technology Strategy Board point of view, when we look back down the pipeline, is science, research, the work of the universities, the research councils, is our technology pipeline; it is our pipeline for the future.

The Technology Strategy Board is about pull; it is about UK business benefit, economic benefit, but it depends upon an underpinning capability and a very broad base underpinning capability.

Q68 Chairman: If we turned the tap off for a few years while the recession is dealt with and get our finances and our deficit back on track, will it matter?
Mr Gray: I think it will make an absolutely huge difference. I say that in two different regards: one is that one of the roles that we have got, and it is in our mission statement, is to be a magnet for investment today, whether it be inward investment—companies looking to invest in the UK—whether it be about retaining companies here in the UK, whether it be about investors investing in small businesses today. They are all saying to us that one of the key reasons for investing in the UK is the strength of the science base. So the decisions we make about the science base today are not just impacting the research of tomorrow, they are impacting the investment decisions of today. So from my perspective that is one really solid reason why it is very important to keep that investment going in science and research today. The second key thing (and it will not be lost on people in this Committee) is we debate now the lost opportunity of topics in the past: plastic electronics, I know, has been a subject that this Committee has spent a lot of time reviewing and debating. What we need to be doing is making sure that we are investing for those technologies, emerging industries of tomorrow, and a gap—whether it be a six, 12, 18-month, two or three year gap—is absolutely crucial. Regenerative medicine is a very, very clear example; if we stop investing in regenerative medicine today then we will lose that industry forever. So the decisions are not about a five-year gap; they are about decisions that actually are discrete points in time that will change the landscape forever.

Q69 Mr Boswell: I am not asking you to name them because I think that would be inappropriate, but are you aware of any potential international investors who have looked at the profile of science cuts and the projections for science funding and said: "In the light of that, I think I need to reconsider my decision to come here"? Is that just a fear you anticipate in the future or have you got actual data that this has already been happening?
Mr Gray: I will answer the question slightly differently. I have very strong evidence that overseas companies are making decisions today based on their knowledge of what the investment is. I am 100% convinced that a change in our investment strategy in science will impact on those decisions, and I do have evidence in that regard.
Mr Boswell: Anything you could tell us (I realise, obviously, there are some commercial constraints) it would, I think, be helpful.

Q70 Chairman: Professor Thorpe, obviously, the research councils are absolutely key to what Iain Gray has been talking about in terms of actually providing the fuel to come through that pipeline, but given the talk about cuts and, also, given the talk about prioritisation, is the Haldane principle now dead, as far as you are concerned? Are you now going to be directed into these areas by officials in the Treasury or in BIS?
Professor Thorpe: Absolutely not. The Haldane principle is certainly not dead and I see no evidence for imagining it will be in the future. I suppose the first point is that I am not yet in a place to say that we are looking at cuts. We have had investment in research and we have got another year of this spending review, when the research councils achieved overall about a 15% increase over that spending review. Obviously, the public purse is very tight going forward but, as Iain has said, many others have said and we say, now is the time to hold our nerve on this and to continue that investment. So I do not see why, in any case, if there were changes to the amount, that the Haldane principle should be attacked. We benefited hugely from, overall, the investment from government being aligned with research and then for the individual researchers to decide on the areas of high priority. That has served us well in getting us to the quality position of research that we have got; that is our unique selling point in the UK. We are the place that people in the world come to because of the high quality of the research, and it has been because of that ability to prioritise. So prioritisation, for me, is key.

Q71 Chairman: Professor Thorpe, we heard it from the previous panel (we had divided views) that increasingly impact plays a role, not only with the HEFCE side but particularly with the research councils too; somehow your research community has to predict the future and that impact is becoming a more integral part in terms of actually getting the grants which are becoming in very, very short supply, particularly from STFC, that we will come on to in a minute.
Professor Thorpe: Two comments on that. There is no question that the research councils and RCUK is much more explicit now than it has been about the hugely great record that the UK has had in achieving impact from the research base. So it is not for nothing that our strap line is excellence with impact, because that has actually characterised the last 20 years up to now. We are certainly getting smarter at being able to capture that investment and understand that the impact has arisen. Your question, though, asks about the additional part of the proposal form that we have introduced, which is really for researchers to think about, at the earliest stage in the research, what the pathways to impact will be, so that they open up the possibility, where that is appropriate, for impact—whether it be in the public sector, whether it be in companies or whether it be with the public itself. We are just inviting now researchers to put that into their proposals because we think there is a lot to benefit from researchers thinking about that up front rather than at the end of the research.

Q72 Dr Harris: They are not judged.
Professor Thorpe: They are because it is part of our secondary criteria. We have a number of secondary criteria on research grants: value for money, the management of the project, etc. This is one of those secondary criteria, but our primary criterion is research excellence. The secondary criteria become important, of course, as you would imagine, at the very border lines of funding or not funding.

Q73 Chairman: Can I move on to Professor Sterling? I hear what Professor Thorpe said. I know he says it with great sincerity. However, when you come to STFC, all bets are off, are they not? You have cut your grants by 50%, half the research is not going to be funded anywhere else. Surely, you are now looking at impact as being the way out of that predicament.
Professor Sterling: No, I agree with Professor Thorpe that we treat it in the same way. Of course, if we look at the margin, when we have judged the science to be excellent we would look at whether there is an impact difference between the two proposals that were otherwise the same. If the impact were greater for one we would fund that rather the other, if there were no money to fund both.

Q74 Chairman: So the most fundamental of science, particularly in the particle physics community, where, quite frankly, it is incredibly difficult to understand where impact will come, that could be just thrown to one side in favour of another proposal which simply can satisfy that tick-box of impact. Is that what you are saying?
Professor Sterling: No, I was not saying that. We are looking for scientific excellence in all the proposals that we fund, and if there is insufficient funds to fund all of those proposals that are scientifically excellent one comes down to another set of criteria, which are, quite reasonably, impact.

Q75 Mr Boswell: So the tighter the funding envelope the greater the impact—
Professor Thorpe: Do not forget that in recent years and up to now we were only able to fund on responsive mode something like 20% to 25% of proposals, so these criteria—whether they are value for money or how the project is being managed—have always been there to enable us to discriminate. So that is not new.

Q76 Dr Iddon: What do you say to a Nobel Prize winner, like Harry Kroto, who reckons that his research was purely curiosity driven with no obvious immediate impact? What would you say to a person who is doing research like that?
Professor Thorpe: We are absolutely not asking researchers to predict what specific impacts their research is going to produce; what we are asking for researchers to do is to think about how to open up the pathways to enable impact to happen. That can be in lots of different ways; it can be in terms of getting the message out about that research, involving public and others in that. Just take, for example, the Large Hadron Collider and the Higgs Boson. Those are (to some of us, anyway) rather theoretical concepts in research but that triggered a huge inspiration in the public about science and about the importance of research. Actually, STFC and colleagues were really great at getting that message out early on when that research was being conceived of. It fired the imagination of the nation. I think that is another example of where we need to think about impact widely; it is not just a narrow concept of predicting particular commercialisations. It is not that, it is a much wider concept. We are not asking them to predict the particular impact but to think about where impact could flow.

Q77 Chairman: What we are trying to get at here is this issue of how do you, in constrained budgets or flat budgets, differentiate in order to be able to spend your money as appropriately as possible?
Professor Thorpe: The primary differentiator is the excellence of the research. That is the primary criterion, always has been and, as far as I am concerned, always will be.

Q78 Chairman: Okay, and Professor Sterling agrees.
Professor Sterling: Yes, absolutely.

Q79 Chairman: Dr Peatfield, the Medical Research Council has, in many ways, benefited enormously from the last two Comprehensive Spending Reviews and, certainly, the current Comprehensive Spending Review. What is your argument then, in terms of the Treasury coming along and saying: "You have had, arguably, six exceptionally good years; we now need to put resources elsewhere"?
Dr Peatfield: I think there are several. We have had good years, that is certainly true, and we are very pleased about that. I think there are several arguments. One is that we have shown that investment in medical research gives a very good return to the nation economically, and there are at least two quite recent studies that show that. For example, for cardiovascular and mental health research, it has been shown that for every pound you put in you get 37/38p per year back, so although there is a time lag it only requires three years worth of return before you have recouped your investment. So I think there is very good evidence from economists to demonstrate that. So why would you not invest in medical research? Another answer to that is in terms of our partnerships, particularly with industry and with NIHR where we have spent the past three years developing these, following the Cooksey report, and we have invested a lot with them. So to cut back on that now would jeopardise not just research but those partnerships, and mean that things would not happen for patient benefit and, also, in our links with industry, both large industry and SMEs. To step back now would jeopardise that.

Q80 Chairman: So your argument is we should continue to be funding upwards.

Dr Peatfield: Definitely. I recognise the financial situation of the nation, but, yes, we would put in a very clear case that we could spend additional money very wisely.

Q81 Chairman: Before I pass on to Doug Naysmith, one of our frustrations is that everybody has that phrase "We recognise the difficulties", yet, over in the United States Obama has not recognised the difficulties; he has actually said: "This is the solution". Are we singing that song loud enough?
Dr Peatfield: We certainly think it is part of the solution. We do sing it quite loudly and we sing it both within government and outside to the public. The Academy of Medical Science has produced a very recent report "Reaping the rewards: a vision for UK medical science", saying it. So I think there are lots of independent voices as well as, if you like, the interested parties saying it.

Q82 Dr Naysmith: I am going to move on to making the assumption that if there are spending reductions what do we do? We have got to wait and see what happens. There seems to be a consensus that if we are going to cut projects it is much better to cut specific projects rather than top-slicing everything that is considered to be worth funding. How do we go about picking winners? Iain, I am going to start with you. How do we go about picking winners, and can you give some examples of the kind of projects at risk if current levels of spending are reduced or not maintained in the next CSR period? Maybe you could pay particular attention to this question of impact again, because in the previous session people, highly qualified individuals, who were reviewing grants said they did not know how to assess impact.
Mr Gray: Just to be clear, I believe it is a continuum. We need a very broad science research base. I believe the role of the Technology Strategy Board is very much about identifying, about making choices, about prioritising those areas that will maximise UK economic return. Just a couple of examples: there are the obvious sector examples of aerospace and pharmaceuticals where for investments in new materials, carbon composites—we have just recently seen the announcement of a national composite centre of excellence—it is hugely important to get the underlying science and research behind that. Two important sectors. Last year, we made four priority calls. One was around low carbon, which we essentially split into two. One was around carbon abatement technologies, for which I think there is a great opportunity in the UK. The other was more around the demand side—low-carbon vehicles, low-impact buildings, and the impact that those programmes have had have already been hugely significant, and they all rely on underpinning science, photonics, new lighting. It is quite interesting how many of the small businesses have stemmed out of university spin-out, how many of them have come out of the centres of excellence, the clusters, in the UK. So low carbon, regenerative medicine (as I said earlier), for me there is a one-off opportunity here in this country to maximise the capability we have in the science and research base. It is a new industry that is evolving; a huge global market opportunity. If we do not invest in that now we will lose that opportunity forever. The other key priority area that we have really homed in on last year was around the whole digital economy; the intersection that the UK has of bringing the ICT capability together with the creative industries capability together with the sort of digital economy—huge opportunities. The Technology Strategy Board is about making choices, building on and underpinning a broad, underpinning capability, and both are important.

Q83 Dr Naysmith: So what kinds of projects do you think are most at risk if the current levels are reduced?
Mr Gray: Coming back to the point about making cuts, I believe very strongly that now is the time to further invest, not to make cuts, and I believe the opportunity actually exists, much, much more, rather than looking at a rebalancing of the science or exploitation of science base, it is about looking further downstream; it is about looking at the £200 billion plus that the Government invests through procurement and through projects. I believe we can support those vital sectors, industries and choices through looking at the smarter use of other government money. Procurement, I think, is a very, very important driver in innovation. So I am not an advocate of reducing the budget in any way whatsoever; there is a large, unmet demand.

Q84 Dr Naysmith: I am going to ask you a slightly different question, partly because I know your background very well. In the previous session it emerged that there was a feeling that industry itself was not doing enough basic research. Do you think that is true?
Mr Gray: I think it is maybe different in different sectors, but what I have seen in the last 12 months, in a very difficult economic climate, is companies recognising that now is the time to invest for the future, because the shape of the business sector they are in, coming out of this economic crisis, will be very different to the shape going into it. So I am actually seeing in some sectors a real appetite, an increased desire to invest. However, they can only go it against what they see as some form of market certainty. So the support that organisations like the Technology Strategy Board give, the underpinning support, to science and research is a key catalyst to their investment; they want to invest. There are other sectors who are really finding it quite hard at the moment, and again it is for us to identify who they are, what they are and what we can do to support them.

Q85 Dr Naysmith: Professor Thorpe, do you think it is easy to pick winners at the basic science level, in terms of impact and so on? Maybe I could just throw one more thing in: does prioritisation inevitably mean that a comprehensive strategy to support a strong national science base suffers?
Professor Thorpe: A lot of questions wrapped into one there.

Q86 Dr Naysmith: We are getting short on time.
Professor Thorpe: I think in the prioritisation of research, first of all, it is important to realise that the research councils have had to prioritise research for a long time, and that starts, if you like, by each of the councils in their areas having an overarching strategy, which is composed of advice from the scientific community about the high-priority scientific areas to be supported at any time. So we have a considerable process of consultation with the science community to find what is the highest priority, top-quality science that we can do. We have been doing that for some time, and of course we will have to fully do that if we have a cut, but I do not want you to have the impression that somehow this would be a new thing; we are used to this. Where the challenge comes is that we run a research-to-innovation system in the UK, so it is not just about grants, it is about training our next generation of researchers, it is about training a skilled workforce via our studentships, etc; it is about having excellent universities; it is about having excellent facilities and infrastructure, and it is about having research grants. All of those are linked together. The difficulty of prioritisation in cuts is that if we make cuts in particular areas it has knock-on consequences right through that system. The job of the research councils and, in particular, the governing bodies of the research councils, is to look at all of those consequences through the research base of making particular decisions. So often the particular science priorities are at one end of that discussion but perhaps even more serious is the discussion about how to balance infrastructure investment, facilities investment and research grants and training, because all of those components have to be there to be able to have the full pipeline that Iain has talked about.

Q87 Dr Naysmith: Presumably, you do not think that the right attitude would be to reduce everything just a little bit.
Professor Thorpe: Of course not, which is why I emphasised that we already have a strong advisory and consultation process to flush out the top-priority science areas. Of course there are areas that we are not supporting nearly as highly as other areas, but it is driven by the research community's advice on the major research questions of the day. The final point I would like to make is that the research councils have focused on the grand challenge problems. As you know, we have got several (six, at the moment) cross-council programmes (we have one on energy, one on living with environmental change and on ageing and lifelong health and wellbeing) on the grand challenges that society faces at the moment. Those are where we are focusing our investment. They involve, actually, many of the research disciplines in the UK to be able to really address those questions, which is why it is really important for the UK to maintain the breadth of that research capability across the disciplines because we will not be able to attack those grand challenge problems by just having one part of the research community able to contribute; you actually need almost all parts to contribute to those grand challenge problems, which is why we are spending around a third of our money at the moment on those areas, in very round terms.

Q88 Mr Boswell: Just a brief comment on what you have just said, Professor Thorpe. If one is looking at the potential impact across the various factors you have described, including for example training and workforce, of potential cuts, are you satisfied that you have got a satisfactory standardised evaluation matrix which would enable you, at least, to convince yourselves and, hopefully, the science community and the public that you were apportioning those cuts taking into account all the factors in a rational way?
Professor Thorpe: I am not quite sure how to answer that, other than to say yes.

Q89 Mr Boswell: I hoped you would say yes.
Professor Thorpe: Because we have very significant advisory boards, not only on the science but, also, on things like training and infrastructure and facilities, a lot of that advice is transparent, how it is coming in, and how the councils are balancing that advice. So I believe it is clear how we deal with that.

Q90 Mr Boswell: At least (a small follow-up) you will have been giving some thought to the lessons learned from previous exercises in cuts.
Professor Thorpe: Indeed, although there has been investment for a significant amount of time. I think the Government is clear on that, from that point of view. The economic circumstances and the research areas that the nation needs—the grand challenge problems—are distinctive now. I think the extent to which one can look back at, historically, 15, 20 years ago, myself, I feel is a bit limited. I think we have to address the problem now the nation faces, because it is rather distinctive.

Q91 Dr Naysmith: I think, Professor Sterling, you are on record as suggesting that any savings to be made are in the short term, but astronomy is quite a long-term subject. Why should it not be immune from the current financial difficulties?
Professor Sterling: STFC, as you will know, has been through a major reprioritisation and selectivity exercise that started over a year ago, the results of which we published just before Christmas. That has been looking at the major areas of our activity and deciding which projects within those, at a high level, are important and are judged to be good science, and which ones are less so. That exercise is not yet complete because we are going through the implementation phase now, based on that prioritisation of the overall projects. So the difference between astronomy and particle physics, and so on, is now determined in terms of that priority, but the detailed impact on how that plays out to a particular research group or a university is the subject of ongoing discussion, which we should complete by about Easter time.

Q92 Dr Naysmith: Dr Peatfield, do you have anything to add in this area?

Dr Peatfield: Not really, I would just support Alan Thorpe's comments about prioritisation and the fact that all councils have a strategy. Ours is quite recent—we reviewed it last year—and that is the basis on which we would make the prioritisation. So we have a mechanism. I think the question is how deep the cuts would be. That is where the difficulty comes. If it is relatively small it is workable within the strategy we have got; if there are much bigger cuts then we would have to look at much larger chunks of work that we would stop supporting.

Q93 Dr Harris: Professor Sterling, prioritisation—that is cuts? Dr Peatfield used the word "cuts"; you managed to have a whole answer to Dr Naysmith in STFC without saying the word "cuts".
Professor Sterling: STFC did suffer the worst of the research councils in the present CSR period, so effectively funds have been reduced in real terms for STFC, and that has led to projects that we would have liked to have done not being able to be funded. Yes, "cuts", if you want to use the word.

Q94 Dr Harris: Professor Thorpe, just to come back to this impact thing, because you very helpfully said that this research council grant impact issue is used as a secondary factor when things are close, in order to choose which to fund between two projects that look good.
Professor Thorpe: It is one of several criteria.

Q95 Dr Harris: What evidence do you have that that aspect of the second set of criteria is useful, given we heard someone (Professor Cox) say that it could be damaging? There was an opportunity cost, at least. What evidence do you have that you can point to, tell us or send us, to say that this is actually a good way of choosing the right way forward?
Professor Thorpe: This is a new scheme, so I do not have the evidence of it operating.

Q96 Dr Harris: Fingers crossed.
Professor Thorpe: It is not a case of fingers crossed; it is a case of seeing many opportunities and virtues in researchers, up front, thinking about the pathways to impact. So, for example, particularly in terms of involving potential users in that research, it is much easier to have that discussion up front when you are proposing the research rather than when it is finished, in my experience. So in many fields, and it does not necessary apply to all, that conversation, if we encourage it to happen, which is what we are trying to do—we are encouraging researchers to think about how they can open up those pathways to impact.

Q97 Dr Harris: You gave an example, and we are grateful because it was very helpful for you to say that it is not just about economic impact, it was exciting the public—as one example. Does that not run the risk that those people who employ (because they are big enough) people who are very good at writing stuff about how this is exciting—spin merchants, basically—are going to excite your peer review panel when they are thinking about that criteria, and they are just very good at writing stuff about—I do not know—CERN, and all that sort of thing?
Professor Thorpe: I think I can just summarise it that whoever gets funded by a research council is, clearly, already very good at writing proposals, because it is extremely hard to get them funded. So in every part of the proposal they are going to have to write a really good proposal.
Chairman: Evan, Ian just wanted to come in as a rider to that.

Q98 Ian Stewart: I do not know if you were in the room, Professor Thorpe, when the previous panel were in.
Professor Thorpe: For part of it only, I am afraid.

Q99 Ian Stewart: Peter Williams, at the end of the questions about impact, said that his view was that there should be a return on investment approach to impact that you assess before, during and after. Is that what you would say?
Professor Thorpe: No. I think we have to distinguish two actions that we are talking about with impact at the moment. With the funding councils, they are, as you know, contemplating its consultation at the moment in assessing impact as part of the research assessment, the research excellence framework. I think that is one distinctive activity. What the research councils are doing is very different in terms of the proposals. We are not using quantitative information about potential return on investment etc—

Q100 Ian Stewart: Is that because you cannot?
Professor Thorpe: No, because we want researchers to think and open up the possibility for enabling pathways to happen. So, for example, it is often quoted at me: "Well, the Nobel Prize that was ultimately awarded took 30 years and the person who did the research originally would never have thought . . ." Maybe if there was a pathways to impact thought at the beginning and a conversation with a relevant sector of the economy, maybe that 30 years could have been shortened to, say, 20 years, or whatever it might be. It is a mechanism that we are using to encourage researchers to think about opening up pathways to impact—impact very broadly. We are not making it into a quantitative measurable part of the proposal.
Chairman: Professor Thorpe, I am not trying to be rude but I think we have got the point, you have made that clearly, and we are terribly short of time.

Q101 Dr Harris: My final question on that is that in every other part of the science application you can look at the previous literature, there is quantifiable stuff, but some of this stuff about impact, about who it will excite, whether it has got public interest—Andrew Wakefield would do very well in a funding application, if people were to say: "This could have real implications"—with the MMR stuff. I wonder, are you confident that this is not just rewarding stuff that is sexy, when it comes down to it, rather that something that might be better.

Professor Thorpe: It is not sufficient to say that it could be interesting to somebody; in the proposal we are looking for people to say how they are going to go about enabling people to get involved and to be aware of the research. One final comment is that research councils in the last few years have done, I think, at the last count, 35 separate studies on evaluating the impact of research. So to say that we are unaware of how to capture impact and measure it, qualitatively and quantitatively, is wrong; we have done a lot of studies on this and a lot of information is emerging, so it is not a blank sheet of paper.
Chairman: We have to move on.

Q102 Dr Harris: Professor Sterling, you are very well-placed to answer questions at this inquiry, given your background in universities and so forth. I just want to ask you, given that, as I understand it, University College found that 90% of physics students coming in were inspired by particle physics, nuclear physics and astronomy, how do you think this is going to impact on physics undergraduates deciding to have research careers when they can see all around them grant application success rates falling by half, from low to lower, and all these projects—this bonfire of the acronyms—that you have set out? It is going to have an impact, is it not?
Professor Sterling: There will be an impact—of course there will be—because students are intelligent customers; they look at the future, they look beyond the degree that they are planning to apply for to employment beyond it. So, yes, there will be an impact on that. What we are trying to do in the implementation phase that I described of STFC's prioritisation, is to look at the impact on a particular department and to see, within the funding envelope that that particular area of science has been allocated, whether there is any scope to ease the impact in one area (and, of course, because it is a fixed envelope, at the expense of another area); to be intelligent in the way in which we do the cuts, as you describe them.

Q103 Dr Harris: So you are trying to be intelligent, and doing the best you can (you have been dealt a bad hand—I understand that), but you would understand that objectively someone coming in and looking at the future health of physics could see real risks from the current situation.
Professor Sterling: I hope they would judge it in the medium to longer term rather than the short term, because science has had quite a good deal over the last 10 years, and we are, in any of the cuts even that STFC is having to implement, not in any way returning to the point that we were 10 years ago. So we would not like the cuts but, on the other hand, it is not a crisis. For example, particle physics is going to receive £690 million over the next five years. That is a very substantial investment.

Q104 Dr Harris: You are picking up the pieces. I want to ask you who you think, given that you are the new guy in trying to solve this problem (we have sympathy with you), made the decision to essentially shift UK investment away from astronomy, space exploration, nuclear and particle physics? You have to do the cuts. I am asking you who you think made that decision. Was it RCUK? Was it Ministers? Was it civil servants? Was it the Almighty?
Professor Sterling: Ultimately, I think, responsibility rests with the Minister, but, of course, BIS, as it is now called, are the ones who are the primary determinants of the allocation between the research councils, in response to bids from each of the research councils and, also, an RCUK overall bid. So, ultimately, it is the department advising the Minister?

Q105 Dr Harris: So it should be the Minister who has to take responsibility for it, even if it is the civil servants, if I can use that broad term to describe—
Professor Sterling: That would be my understanding.

Q106 Dr Harris: In terms of where we are with STFC, a suggestion has been made—you have heard it very clearly and I think very well put—that it is wrong to tension this pure physics spend against things that are not their responsibility: exchange rates (maybe that will be solved for the future), but also some of these big items, because the gearing is all wrong. Do you think, therefore, that there should be a demerging so that the CCLRC issues can be dealt with in isolation without pure physics research having to pay for that?
Professor Sterling: As you know, the Minister is conducting a review at the moment as to how we might put STFC on a better financing footing going forward. You will well know the three areas that we have to spend within STFC. One is on subscriptions, another one is on facilities and the other is on grants. As far as the subscriptions are concerned, those are international treaties where there is very little flexibility for changing the budget going forward. So we cannot, of our own volition, change the amount of money we spend in CERN, for example—it is an international treaty and it is a long-term financing arrangement.

Q107 Dr Harris: Unless we pull out.
Professor Sterling: It is a binary decision; essentially, if we want to exploit anything of the capital moneys that we put into CERN we have to be a member, and then it is a majority decision on the CERN council as to how much the spend is.

Q108 Chairman: Professor Sterling, we know what the problem is. What do you think is the solution?
Professor Sterling: The solution, in my view, as far as subscriptions are concerned is to carry the risk of exchange rate variations and GDP fluctuations, which drive some of the subscriptions, at the highest possible level.

Q109 Dr Harris: What is the solution to the bigger problem?
Professor Sterling: The next part is the facilities. A large component of facilities, effectively, is staffing, and it is not efficient to be changing the rate at which we fund those in the short term; it simply puts up

costs rather than puts them down, so we need a long-term view of the funding of that, and we are in discussion with RCUK, at the moment, about an arrangement where there is a three-year fixed and a three-year indicative budget going forward for the facilities. The facilities, remember, are used not just by STFC-funded people—in fact, minimally by STFC-funded scientists—they are used by all the research councils. So putting that, effectively, on to a medium-term footing—

Q110 Dr Harris: That is like creating CCLRC again, notionally. If the Minister were to suggest let us have a separation, a de-merger, you could live with that.
Professor Sterling: No. Well, we would have to live with that if that was the decision, but I do not think that would be the optimal decision. I think, actually, if the subscriptions are, as I say, insured, if you like, at a higher level and there is a long-term view taken of the national facilities, by planning forward with RCUK, then the grants, which is the area, of course, that creates the annoyance as far as the scientists are concerned, because that is the only bit that is left that you can cut in the short term—if you solve those first two parts the second part goes away, or at least puts us on the same footing as any other research council. To quantify this for you, our subscriptions are 49% of our near-cash funding—49%. So if we cannot change those—because we cannot because they are international treaties—then all of the cuts fall on the other two areas. Then add to that the fact that facilities are about a half of what remains—so a quarter of the overall near-cash funding—then all, effectively, falls on the quarter that you can actually do, which is why the community is vocal in complaining. However, unless we can actually take those other two parts, the subscriptions and the facilities, and treat them differently, the problem will remain.

Q111 Dr Iddon: Professor Thorpe, you were sat on that table a week before the Pre-Budget Report, if you remember.
Professor Thorpe: Yes.

Q112 Dr Iddon: We were talking to you about your budget at that time. Although you had been discussing with Treasury officials a short time before that certain aspects of the research base, you told us that you had not discussed your budget in any detail. So when the £600 million worth of cuts were announced did that come as a bolt out of the blue or had you been given some indication by the Treasury at the meeting?
Professor Thorpe: We had no indication of that ahead of time.

Q113 Dr Iddon: No indication at all?
Professor Thorpe: No.

Q114 Dr Harris: Where do you think that that figure of £600 million comes from?
Professor Thorpe: Of course, the £600 million, as you know, is across a number of budgets in this area: higher education, research and training, etc, so I have no idea where the number comes from. All I can say is that I think it is approximately 4% of the total budget in those areas that it affects. So from that point of view if there were cuts associated with that at the 4% level, then that is what we would be looking at.

Q115 Dr Iddon: Does it surprise you that the figure was announced in the Pre-Budget Report but no indications were given as to the areas that were likely to "cop it" the most?
Professor Thorpe: It is certainly because of that that there is some uncertainty. I think the Government has said subsequently that they are waiting for Lord Browne's review of fees, etc, to finalise those issues, but I agree with you; at the moment, we are uncertain exactly how they will fall.
Dr Iddon: Did any other members of the Committee have any inkling before the Pre-Budget Report that substantial cuts were going to be made in the science base budget?
Chairman: All answered no.

Q116 Ian Stewart: I am just intrigued. The questions that you have been asked have been about the Pre-Budget Report, and so on and so forth, but has anybody been in touch with you from either the Treasury or BIS to talk about the situation after 2011? Have there been any smoke signals or mood music (my draft question tells me to say)?
Professor Thorpe: I think we rather take a more, if you like, proactive view, that, clearly, first of all, research councils, like any organisation, are trying to plan for various scenarios into the future—you would expect us to—and all the research councils are doing that. Where we feel we are active is by making the case by talking to Treasury, by talking to Ministers, by talking to prospective future governments about the importance of research and how we think it is important to invest in. So those two aspects we are doing.

Q117 Ian Stewart: Please just let us get this clear: what you have answered is that you have deemed it sensible to be proactive.
Professor Thorpe: Yes.

Q118 Ian Stewart: However, what is the answer to the question: has anybody from either the Treasury or BIS contacted you to discuss this?
Professor Sterling: I can answer from an STFC point of view, because in the planning exercise we have been going through we have told to plan on the basis of "flat cash" going forward.

Q119 Ian Stewart: We know that, but is there nothing else—no discussion, other than you taking the proactive stance you have taken?
Professor Thorpe: There has been discussion with Adrian Smith and his team about gathering evidence about the impact of various parts of the research base—what impact it has on the economy, etc. So gathering evidence to show if there were cuts in various areas what impact that would have on the economy. So we are looking at developing an

evidence base. Again, we have had the opportunity to expose that directly to the Treasury to show where the investment is—if it was changed. So we have had explicit and open discussions about that to show what evidence we have of the impact on the research base. However, if you are asking have we been given guidance about the size of that, etc, the answer is no.

Q120 Dr Harris: You have just said "plan on flat cash".
Professor Thorpe: That is the standard assumption research councils make.

Q121 Dr Harris: So that is a real terms cut. Where does that leave the 10-year framework for research council money? Flat cash?
Professor Thorpe: Just to be clear, the standard government situation that is not particular for the moment is that research councils and, probably, other organisations are allowed to base their forward planning, because we have to make investments long term, beyond the current spending review, on the basis of flat cash. That is a standard process.

Q122 Dr Harris: Are you saying we should not panic, or is this the party line?
Professor Thorpe: I am saying that is the way we always plan our future investment because otherwise we would be committing ourselves potentially to commitments that we could not support.
Chairman: We do understand that.

Q123 Graham Stringer: Can I ask Iain Gray: sometimes in the past, when there have been cuts in different areas of the public sector, the Government has claimed the private sector would step in and sort of fill that funding vacuum. Do you think this will happen if there are cuts in the science budget?
Mr Gray: Just to be clear, to reiterate what I said before, I think the public sector investment in science, in research, has been key to catalysing private sector investment. I think if you cut the science base that takes away one of the key attractions for private sector investing in the UK, whether it be inward investment or whether it be companies that are here. I do not believe that they would necessarily fill that gap. Having said that, I think the other thing that businesses really do look for is market certainty, and I do believe it is not just about the science base, it is about creating the future market certainty, and that is the other key ingredient for future investment in the UK.
Professor Thorpe: There is one study in particular, but others as well, which look at the historical record of the correlation between public investment in R&D and private. Over the last 15 to 20 years they have tracked upwards very much in correlation together. So there is not a substitution effect; it is not as though they are anti-correlated, so that if the public goes down the private goes up, and vice-versa; they both go up together, which means that, basically, the basic research from the public part is feeding through into and stimulating the private investment.

Q124 Mr Boswell: So, logically, cuts to public investment are likely to trigger cuts to private investment.
Professor Thorpe: Absolutely, and there is good econometric evidence for that.

Q125 Graham Stringer: Dr Peatfield, when do you think we will notice the impact of any cuts in spending on the science budget, and how will we notice it?
Dr Peatfield: It depends how big they are. If they are large you will notice them, potentially, very quickly because, as I said before, there might be areas of particular programmes which we would not be able to fund. So that evidence would come very quickly. Similarly, if we found we had to cut some of our training programmes that would come quite quickly. So I think it is a question very much of how big the cuts are how quickly you would notice the impact—and where you are looking. If you are looking at the research community it would be quite quick; if you are looking beyond that at higher levels of impact then it will, obviously, take longer.

Q126 Graham Stringer: Would we notice any impact in the economy? How would we notice things were worse than they would otherwise would have been?
Dr Peatfield: I think that there would be less feed-through from the basic research into clinical practice, for example, so clinical trials and things would not be happening that would otherwise have happened. It is looking for something that is not happening, perhaps, rather than something that has been happening and stopped happening. It could be quite quick; I would have thought within a year or two, certainly, you would notice fairly significant changes—again, depending on the size of the cuts we are talking about.
Professor Thorpe: I quote three things straightaway: the training we would see straightaway, the number of people who were being training into the workforce would drop straightaway; the inward investment that we talked about that is attracted because of the research quality here will go down because of that straightaway, and we will not be addressing the critical, grand challenge problems as effectively as we are doing. So these are urgent issues, environmental issues, etc, that we have got to attack. So in those three areas we would see an effect straightaway.

Q127 Graham Stringer: On the critical, grand challenge issues, I have just been through Professor Phil Jones' emails which were, at the very least, bad science, if not worse. Do you think the impact of what has happened at the University of East Anglia will have any impact on funding of science, either generally or in the particular area of climate change?
Professor Thorpe: I believe that you are having an inquiry into that issue, so I am sure we will have another opportunity to discuss it.

Q128 Graham Stringer: We are not actually; we are looking at how the University of East Anglia are going about looking at it, and what is happening to

the different databases on climate temperature. Today we are looking at the impact on science funding. This is potentially a major scandal. Given your background in physics and meteorology, I just wondered whether you thought this would have any impact in investment in that area.

Professor Thorpe: I sincerely hope not. I think not as well, because—you say it is a scandal—I think the fact that the UK has been world-leading in generating evidence about climate change is solid and is there and, actually, the research on the global temperature record, which is the particular UEA speciality, along with other groups round the world, has not been challenged in this latest discussion. That evidence about the warming over the last 150 years has been reproduced using the same data by many groups around the world, so the basic science is solid there, and actually the investment that this country has made in the research in that area has put the UK at the forefront of not only the science but arguing the case for international policy. So I think it has been a challenge to public confidence in the science of climate change—I would accept that—but I am encouraging the scientific community to get out there to demonstrate how broad and deep the evidence on climate change is, and I think that is still solid and there.

Q129 Graham Stringer: So you do not think it will have an impact on funding.

Professor Thorpe: I do not think so, no.

Q130 Chairman: Could I ask Iain Gray and Dr Peatfield, you mentioned this issue of bioengineering earlier and that we, basically, had the opportunity to develop not only world-leading science, which has basically been coming out of MRC and other research councils and the scientists you fund, but, also, has this wonderful application to make it a multi-billion dollar global business. If, in fact, we start pulling or having flat cash settlements, or however you want to describe future cuts, is that whole area at risk?

Mr Gray: As I said, I think it is a huge potential market opportunity. I was up in Yorkshire and Humberside yesterday; I was visiting the IKC who are investing in regenerative medicine—some great stuff going on—and I met a number of small businesses. The message they were giving is commitment now is what is going to secure the future—commitment to the science base. So if we are not committed to the science and research base, and we are not putting the mechanisms in place to pull that through, yes, then that market is at risk. That market will develop; the question is: will the UK businesses be part of it or not?

Dr Peatfield: I think, following the Cooksey review and our settlement last time, in conjunction with the budget for NIHR, we have taken the translation agenda very, very seriously and I think we would want to protect that as much as possible in a "flat cash" or even "small cuts" scenario. Part of that programme has involved working closely with industry and with TSB to try and bridge the gap between what the MRC funds and what industry funds. So industry is becoming (this is a big generalisation) a bit less risk-averse and what we are trying to do through these schemes is to fill that gap so that industry can see that they are funding "marketable" research at a much earlier stage than, perhaps, filling that gap themselves. So I think that is something we would want to protect in any eventuality, as far as possible.

Chairman: On that note, could we thank you very much indeed, Iain Gray, Dr Peatfield, Professor Michael Sterling and Professor Alan Thorpe very much indeed for being our witnesses this morning.

Wednesday 10 February 2010

Members present

Mr Phil Willis, in the Chair

Mr Tim Boswell	Dr Doug Naysmith
Dr Evan Harris	Graham Stringer

Memorandum submitted by million + (FC 66)

1. Introduction

The university think-tank million + is pleased to submit evidence to the Committee's Inquiry into the impact of spending cuts on science, engineering and technology and scientific research. In particular, this submission:

- assesses the overall implications of the Pre-Budget Report;
- identifies issues with policies of concentration adopted by the Research Councils;
- outlines the threat to postgraduate provision throughout the sector if budget reductions are used to concentrate the funding of postgraduate doctoral students;
- outlines the implications of the 2008 RAE, associated QR settlement and the Secretary of State's annual grant letters to the Higher Education Funding Council for England for STEM, other science programmes and the future funding of excellent research;
- comments on proposals to apply economic impact assessments in future Research Council decisions and in the Research Excellence Framework;
- assesses increases in applications and enrolments for STEM students and invites the Committee to consider further the reasons why some STEM graduates do not progress to STEM focused careers;
- analyses the impact of the decision to provide an additional 10,000 STEM student places in 2009 and the issues arising in respect of the hefce unit of resource; and
- identifies the disadvantages of the switch of £14 million from other Research Councils to support the Science and Technology Facilities Council's re-prioritised budget and the consequences of the STFC's own proposals to reduce by 25% the number of funded scholarships and fellowships.

million + would be pleased to appear before the Committee as part of its Inquiry.

2. Impact of Pre-Budget Report on Universities

In the Pre-Budget Report, the Chancellor of the Exchequer announced:

- a 10p rate of corporation tax on income derived from British patents as incentive for companies to exploit British scientific discoveries;
- £200 million for new innovative industrial projects; and
- a reduction of £600 million by 2012–13 "from higher education and science and research budgets from a combination of changes to student support within existing arrangements; efficiency savings and prioritisation across universities, science and research; some switching of modes of study in higher education; and reductions in budgets that do not support student participation".

Unlike teaching funding, the science and innovation budget has been ring-fenced by Government. The long-term security of this ring-fence has been guaranteed by the Government under the framework to improve research funding and is supposed to last until 2014 although the future of this ring-fence after the general election remains uncertain.

However, the pressures and reductions in Hefce grant will affect those universities which have less access to research funding but whose research is relevant to the economy and society, making a significant contribution to the capacity of the university to earn additional income from external research contracts and creating significant value for the institution in terms of capacity to compete in the UK and the international market (including the postgraduate market.

In respect of the latter it should be noted that modern universities have a 30% share in the postgraduate international market and access to research infrastructure funding through quality related research funding is a crucial element of maintaining and expanding that market and the numbers of UK-domiciled postgraduate taught and doctoral students.

3. Research Council Funding

Research Council funding is highly valued by universities throughout the sector. The most significant threat to modern universities will arise if the trend towards concentration, funding regional centres and funding by critical mass is accelerated.

As the 2008 Research Assessment Exercise (RAE) demonstrated there is no evidence that critical mass is a criterion of quality and concentration of Research Council funding and studentships can only restrict rather than expand the number and diversity of UK postgraduate students and the UK's research base.

4. Postgraduate Provision

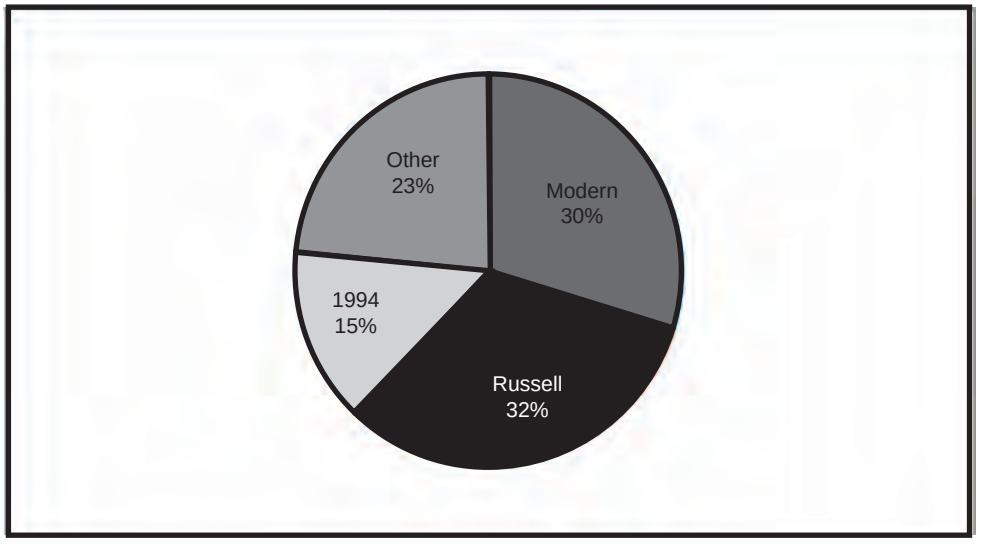
Notwithstanding the outcome of 2008 RAE, the reductions in the higher education budget and the BIS review of postgraduate provision have led to a lobby by some universities to concentrate postgraduate doctoral provision. There is no sound evidence basis for the Government to pursue such a policy which would undermine university title and the contribution to UK higher education and the international market of universities which were awarded teaching and research-degree awarding powers almost two decades ago. Moreover, there is no academic rationale for further concentration—particularly in a digital world where researchers are just as likely to collaborate with their counterparts internationally.

As evidenced by the RAE, critical mass is not a pre-requisite for excellent research and critical mass of excellent research is not a pre-requisite for doctoral students. The quality of supervision is a much more important factor and quality supervision is not restricted to a handful of universities. It is also worth noting that some of the largest science departments are in modern universities and that some of the latter have expanded their STEM facilities eg the University of Central Lancashire (UCLan) has opened a chemistry department and further concentration would undermine the investments in STEM provision that are being made across the sector.

Modern universities teach 30% of all international postgraduate taught and doctoral students in addition to the majority of postgraduate taught UK domiciled students as illustrated in Figure 1.[1] This is a very high rate of productivity bearing in mind the lower levels of research funding received by these universities. Cconcentration of doctoral provision would only serve to undermine this market.

Figure 1

DISTRIBUTION OF INTERNATIONAL POSTGRADUATE STUDENTS



Crucially, further concentration will damage the prospect of enhancing the number and diversity of UK-domiciled postgraduate students—both of which are in urgent need of improvement. The number of UK postgraduate students has platueaued for five years. The social profile of postgraduate students in modern universities to a greater extent reflects the diversity of their undergraduate student profiles and the more

[1] million+ submission to BIS PG Review (Jan 2010).

flexible options to study which are available in these universities. The postgraduate students of these universities are more likely to be mature, to study part-time and there are greater numbers of UK ethnic minority students. It is highly likely that these students would be disadvantaged by concentration which would also inevitably mean geographic concentration and favour London and the South-East and particular urban areas.

5. Quality-related Research (Hefce) Funding

Significant and important Government funding to universities for research (from the Science and Innovation Budget) is allocated by the Higher Education Funding Councils as Quality Related (QR) funding. In the year 2007–08, QR funding was over £1.5 billion and will increase to almost £1.9 billion by 2010–11.

Universities have received QR funding in the form of a block grant to spend on whatever research they wish. This money, and the security previously provided by a five year settlement has allowed universities to take strategic decisions to invest in building and support a strong research infrastructure (eg facilities, salaries and equipment).

Universities also bid for other forms of funding from public and private sector sources to support specific projects. However, relying on this form of ad hoc funding does not allow a university to establish and maintain a long term research infrastructure. At the time of the QR funding decision in 2002, the Government supported greater selectivity and concentration of funding on research of international significance even though the volume and quality of research had increased significantly since 1990.

This resulted in a small number of universities receiving the vast majority of QR funding over a five year period ie from 2003. Bearing in mind the increase in the budget, the majority of universities received little QR funding even though the quality of their research had improved. After the 2002 decision, 76% of all QR funding was allocated to just 19 universities (representing at the time only 15% of the 120 universities in the UK). This disproportionate allocation of QR funding and the exclusion of the majority of universities has major detrimental implications for the UK's research base and its ability to meet the demands of industry—including SMEs—and the public and not-for-profit sectors.

Concentrating funding on a few universities wastes the huge wealth of practical experience in other universities and limits opportunities for students who will be the innovators and the postgraduate students of the future. This concentration of QR on a very specific level of research risks creating a research base that is narrow in its scope and its geographic spread. It has also resulted in the closure of some departments eg chemistry and there is no evidence that this level of concentration has provided better returns in terms of Government investment.

It is unlikely that excellence in a range of subjects, including in STEM areas, can be nurtured in a handful of UK universities. An expanded and more competitive research base would benefit UK plc and create greater accessibility to research, including for businesses as they restructure to meet new economic and global challenges.

The outcome of the 2008 Research Assessment Exercise (RAE) confirmed that there was world-leading excellence and high quality research widely spread across the UK's universities. 150 institutions had at least 5% of their research activity in one of their submissions classed as "world-leading". RAE 2008 demonstrated beyond doubt that universities which had received very modest amounts of QR funding in the past could compete with others which had historically benefitted from much higher levels of funding. It is now even more obvious that no one university or group of universities can claim to lead all of the research agenda, including in STEM areas.

The Secretary of State's grant letter for 2009–10 confirmed that the Government would maintain its commitment to fund world-leading research wherever it had been found by RAE 2008. However, in spite of the fact that QR funding has previously been settled for five years, the hefce QR settlement was restricted to 2009–10 and additional protection was provided to STEM. As a result the one year Hefce QR funding settlement has remained highly selective but has at least recognised the need to fund world-leading research at all institutions.

Overall, the changes arising from the 2009-10 QR settlement have been marginal eg 74% (rather than 75%) of QR funding still goes to 19 universities—and QR funding overall has increased. It is therefore disappointing that Lord Mandelson's grant letter for 2010–11 required Hefce to provide higher levels of funding for high level STEM—potentially placing at risk the continued funding of excellence research wherever it was identified.

Large STEM facilities of strategic significance are funded strategically through the Research Councils and other initiatives. The ring-fence around STEM will have the obvious consequence of protecting those pre-92 institutions which have been historically well-funded. It will also divert funds away from excellent research in other areas of significance to the economy including social science, public policy but also other science programmes eg those associated with the UK's creative industries.

The overall increase in the science and innovation budget would allow hefce to achieve the higher levels of STEM concentration identified by Lord Mandelson and to continue to fund excellence wherever it was found. This would undoubtedly be a preferable (and fairer) outcome since (as previously outlined), there is absolutely no evidence to support funding by critical mass. Indeed, such evidence as there is suggests that smaller research units are more productive and the results of RAE 2008 provide further confirmation of this.

6. Assessing Economic Impact

million+ has welcomed the inclusion of the assessment (as opposed to the measurement) of impact in the future assessment of quality-related hefce research. A wide definition of impact has been identified in the current Research Excellence Framework (REF) consultation. It is important that a "hierarchy of impacts" is avoided. In this respect economic/commercial impact should not necessarily receive privileged status compared to other forms of impact. The hefce pilot project which will run into 2010 is expected to provide clarity to support the "impact" agenda.

However, the tracking and linkage of impact over a 10 year time-frame is fraught with problems. Academics move institutions across many countries and it will be exceptionally difficult to define a necessary and convincing audit trail to impacts evidenced in the REF assessment period. In any case, few businesses work on such long-time scales and excellent research including in STEM, areas does not necessarily take a decade and can be associated with a near-to-market approach.

Essentially, it is the quality of the impact assessment that is important irrespective of the time taken for that impact to be realised. Arguably, near-to-market impact cases are the only real undisputed examples of evidence of the direct link between research undertaken and any clear resultant impact engagement.

7. Intellectual Impact

There is a strong case to broaden the definition of research impact to include a clear assessment strategy for disseminating research through teaching and including students (at all levels) in the development of the research culture ie a specific type of intellectual impact.

Research can have a considerable impact on society and the economy through the curriculum and this activity should be promoted and rewarded. In many disciplines, the first "users" of research are students. Currently, the move to include impact assessments appears to take for granted that high quality research has a naturally occurring, positive impact on teaching.

Research-informed teaching does not happen spontaneously and there have been public concern about the potentially negative effect of external funding systems which encourage universities to take key researchers out of teaching. The current REF definition of research impact will only exacerbate this research-teaching divide when the assessment of impact applied by the REF and the Research Council could be used to strengthen the integration of teaching and research.

8. STEM Graduates

There was an 11.7% increase in STEM applications recorded by UCAS from 2002–07. Between 2004–05 and 2008–09 there was a 3% increase in the enrolment of STEM full-time students and a 4% increase in part-time enrolments. Table 1 outlines the total number of HE students by subject area from 2003–04 to 2007–08.

Table 1

ALL STUDENTS AT UK HE INSTITUTIONS BY SUBJECT AREA 2003–04 to 2007–08

Subject area	*2003–04**	*2004–05**	*2005–06**	*2006–07**	*2007–08*	*Percentage change over five years*
Medicine and dentistry	50,760	53,695	57,140	60,375	61,810	21.8
Subjects allied to medicine	285,600	296,870	305,550	297,205	287,125	0.5
Biological sciences	143,660	145,570	151,255	159,450	161,600	12.5
Veterinary science	3,935	4,210	4,335	4,735	4,850	23.2
Agriculture and related subjects	14,830	14,735	16,865	15,685	17,680	19.2
Physical sciences	70,265	75,080	79,170	80,000	82,130	16.9
Mathematical sciences	30,105	30,560	31,570	32,950	34,120	13.3
Computer science	135,235	128,360	117,035	103,880	95,575	−29.3
Engineering and technology	129,305	132,025	130,950	134,445	139,435	7.8
Architecture, building and planning	47,000	48,770	55,440	59,340	63,085	34.2
Social studies	187,290	189,425	195,460	195,920	198,875	6.2
Law	82,175	84,610	87,560	88,780	89,245	8.6
Business and administrative studies	292,340	290,455	294,775	300,445	310,455	6.2
Mass communications and documentation	44,710	45,720	46,640	46,770	47,965	7.3

Subject area	*2003–04**	*2004–05**	*2005–06**	*2006–07**	*2007–08*	*Percentage change over five years*
Languages	132,625	131,725	136,130	136,460	136,050	2.6
Historical and philosophical studies	99,055	96,045	98,095	99,420	96,620	−2.5
Creative arts and design	139,130	147,215	154,920	158,890	158,890	14.2
Education	189,625	198,120	204,210	212,860	202,300	6.7
Combined	122,530	123,070	114,140	117,085	118,300	−3.5
Total	**2,200,180**	**2,236,270**	**2,281,240**	**2,304,705**	**2,306,105**	**4.8**

Source: HESA Higher Education Statistics for the United Kingdom 2003–04 to 2007–08.

Universities across the sector have been involved in programmes and partnerships with schools and colleges to promote interest in STEM and to promote attainment.

However, the progression links between a STEM degree and a career in STEM areas are weak. The Committee may wish to consider the extent to which the STEM courses on offer in some traditional universities encourage employment in STEM focused employment.

9. Additional Student Places

Individual universities agreed to take additional STEM student numbers made available by the Department of Businesses, Innovation and Skills in 2009 with student support but not teaching grant provided by BIS for 10,000 additional places.

It should be noted that the focus on STEM and the exclusion of some practice-based STEM subjects limited the offers which universities could make and restricted opportunities for students who would have made their pre-entry subject choices several years earlier. Institutional enrolments for 2009–10 are being confirmed but there is no evidence that these places remained unfilled.

10. Hefce Unit of Funding for STEM

STEM programmes fall into the higher hefce price bands. In current circumstances the allocation of additional funding for some STEM subjects would have considerable disadvantages since reductions would have to be made in the unit of resource in other price bands (some of which cover some science programmes eg in the creative industries).

However, universities receive teaching funds from hefce as a block grant and under the 1992 FE&HE Act, the Secretary of State has no powers to direct funding by subject. Accordingly even if it was considered desirable to move funds from other price bands to the higher priced STEM subject bands or if additional funding became available, in practice there could be no guarantee that universities would spend their teaching allocation in a way which increased the institutional unit of resource for STEM.

11. Science and Technology Facilities Council

The Science and Technology Facilities Council has announced amendments to its five-year investment strategy in multi-disciplinary science and technology. The STFC argues that this new investment strategy, which will amount to £2.4 billion, will deliver and maximise scientific, societal, international and economic benefit for the UK in the current more difficult financial environment. Essentially this is a reorganisation of the STFC's programme to focus on "top priority" items deemed to be critically important to allow UK scientists to access to the world class facilities provided by international consortia.This decision has primarily been taken as a result of the current lower value of sterling but it is also indicative of the consequences of a highly concentrated funding model.

The STFC will still have a budget of £461 million near-cash (plus £73 million additional capital grants) in 2010–11. However, £14 million has been transferred from other Research Councils to support this budget and this will impact on the availability of funds in other areas.

In addition, the STFC proposal to reduce by 25% the number of new studentships and fellowships is particularly ill-advised and will affect funding for studentships in modern universities as well as pre–92 institutions. This reduction will damage rather than enhance the prospects of an increase in UK-domiciled doctoral students.

Pam Tatlow
Chief Executive
million +

February 2010

Memorandum submitted by The Russell Group (FC 67)

INTRODUCTION

The Russell Group is an association of 20 major UK research-intensive universities. Collectively Russell Group universities represent 12% of the higher education sector by number and account for a significant proportion of the UK's research base, employing 40% of academic staff and educating 56% of PhD students. Russell Group universities are successful in winning the majority of the competitively available funding for research from a wide range of sources. Approximately two thirds of research funding going into the university sector is won by Russell Group institutions including 63% of research grants and contracts from UK industry and commerce.[2]

The UK's leading universities are one of the country's success stories. The UK is second only to the US in terms of research productivity and punches well above its weight although the UK public and private expenditure on R&D still lags behind many other G7 nations. Leading research-intensive universities provide a concentration of talent, state-of-the-art facilities teaching and research, and offer a stimulating, competitive and progressive environment to enable them to:

— Generate a significant volume of excellent research.

— Provide first-class research-informed teaching at undergraduate level.

— Deliver high-quality postgraduate training, enabling PhD students to work together alongside researchers of an internationally defined calibre.

— Act as a focal point for clusters of knowledge intensive business activity.

— Stimulate inward investment.

— Offer international leadership and access to international research networks.

— Promote and facilitate international research.

Russell Group universities are international institutions, whose research and teaching has a major impact on the UK economy. Russell Group universities:[3]

— Have an estimated total economic output of £25.3 billion per annum.

— Are responsible for supporting 237,000 jobs UK-wide.

— Are a successful UK export industry, with overseas earnings of £3 billion per annum.

Maintaining an environment within the UK which is conducive to science, research and innovation is essential not only for the success of the economy but also to enabling the UK's world-class universities to compete for academic talent, the brightest students and R&D investment from the private sector, charitable and other sources. This is recognised in Government's framework for higher education, "*Higher Ambitions*" which states "A key asset in attracting researchers and maintaining the critical mass of our research activity is our clear public commitment to science and research. Stable government funding and support provides an essential foundation for science and research base to plan and grow".

The Russell Group agrees, and welcomes the Government's commitment in "*Higher Ambitions*" to the dual support system for research and to the public funding of teaching via independent Funding Councils. These are fundamental components of the UK HE funding framework and are necessary to enable universities (and other funders and collaborators) to plan, invest, and develop sustainable partnerships over appropriate timescales. They are also critical to maintaining UK and international stakeholder confidence in the HE sector.

Whilst this inquiry focuses on the impact of government spending cuts to science, engineering and technology, the Russell Group would like to emphasise that the cuts announced by the government to universities, science and research budgets will inevitably have a significant impact on teaching and research across the academic spectrum. The points raised below about the impact of these funding cuts and the importance of concentrating limited public funds on the very best UK research and teaching in order to maintain the UK's world-class research base are as applicable to the arts, humanities and social sciences as they are to STEM subjects.

1. *The process for deciding where to make cuts in SET spending*

1.1 We recognise that the Government has made major increases in investment in higher education and research since 1997. This increased provision has included substantial uplifts to the STEM-focused Research Councils, preferential weighting of STEM subjects in the Research Assessment Exercise (RAE), and an additional £75 million in funding from HEFCE over the years 2007–08 to 2009–10 to support the provision of very high cost laboratory subjects (chemistry, physics, chemical engineering and mineral, metallurgy and materials engineering). This additional funding has helped Russell Group universities to maintain high quality research and research-led teaching in these critically important subjects.

[2] 2007–08 HESA data show that 68% of Research Council funding going into the HE sector was won by Russell Group universities, with Russell Group universities also securing 62% of Funding Council investment.

[3] Data derived from the Universities UK report "The Economic Impact of HEIs".

1.2 The cuts in public spending for HE and research announced in October 2008, in the 2009 budget, and in the pre-budget report, and the annual grant letter to HEFCE in December 2009 amount to some £915 million. In December the STFC also announced cuts of around £28 million per annum to its programmes in order to balance its books. These cuts, which follow cuts to some departmental R&D budgets and other reductions such as the loss of funding for the Overseas Research Students Awards Scheme in England and Wales, are cumulatively eroding the sustainability of the UK's leading universities. This is damaging their ability to compete for resources and talent on the world stage and will in time undermine UK competitiveness. Public finances are likely to be squeezed substantially after the general election and the outlook for universities is grim.

1.3 It is worth emphasising that whilst the UK is cutting its public investment in universities, many competitor countries are substantially increasing public investment in HE and research and concentrating this funding on centres of excellence. Countries such as the US and France are investing in higher education as a means to prompt a swift, but sustainable, recovery from recession, recognising that research underpins innovation and long-term economic growth. Other countries, such as China, Korea, Taiwan, Canada, Denmark, and Germany, are investing selectively to create or strengthen world-class universities with the aim of challenging the existing world leaders for academic talent, students and resources, ultimately boosting their nation's economic productivity.

1.4 In this climate, where resources are under pressure and international competition is intensifying, public investment must be prioritised on strengthening research centres with world-class capability. "*Higher Ambitions*" states that this approach is necessary to protect the UK's international reputation for research excellence and to enable the UK to compete successfully to attract the world's best researchers, brightest students, and inward R&D investment. The framework emphasises the need to support and protect the UK's "strongest, world-leading centres of research" and that this should mean more concentration of research and resources.

1.5 The Russell Group supports this view and believes that it is important that SET policy and funding models reflect this approach. This includes the REF assessment methodology, as well as in the methods subsequently used to allocate QR funding in England, Scotland, Wales and Northern Ireland.

1.6 We believe that discussions about strategic priorities for public investment in higher education, science and research should continue to be based on solid evidence and analysis, and discussed in partnership between government, research funders, business, and universities via Funding Council boards, Research Councils' governing bodies, and national entities such as the Funders Forum and the Council for Science and Technology. This model has, on the whole, worked well over the last 10 years. If further cuts in HE and research budgets cannot be avoided, robust strategic thinking and re-prioritisation must be applied across the UK research base. Early dialogue and debate will help universities and other stakeholders to manage the risks more effectively and to assess impacts, revise strategies, and re-prioritise objectives.

2. *Evidence on the feasibility or effectiveness of estimating the economic impact of research both from a historical perspective (for QR funding) and looking to the future (for Research Councils grants)*

2.1 Government support for basic research is an essential part of the UK innovation system. Public investment in research generates a huge range of beneficial outputs and impacts which underpin and contribute to the UK's long-term economic growth, well-being and quality of life. Government also has a vital role in creating a policy and regulatory environment and providing signals and incentives to enable excellent research and innovation to flourish. The introduction of measures to evaluate economic impact more systematically and to use this information to inform the distribution of public funding is a significant policy development in this context.

2.2 As successful competitors for a substantial volume of public funding, Russell Group universities share a commitment to ensuring that the outputs from their research are disseminated widely across the academic sector and beyond, and that efforts are made to ensure that this research ultimately has an impact—whether this be on teaching, society, culture or the economy. Further information about these impacts is available in our forthcoming publication "*The economic impact of research conducted in Russell Group universities*".

2.3 Whilst it is appropriate that future public investment in research recognises and rewards these efforts, the quality of research must remain the paramount criterion used to determine how funding is distributed if the UK is to maintain its world-class research base. It is essential that both sides of the dual support system continue to stimulate, incentivise, and fund excellent, novel, high-risk fundamental research. It is important that the introduction of impact assessment does not result in a shift in funding to more conservative or more applied research or give this perception. This matters because evidence suggests that the highest quality research, particularly basic research, is likely to have the most significant social and economic impact over time. For example, from the Russell Group's recent analysis of a number of commercialisation case studies, it is clear that the majority of highly successful licences and spin-out companies from Russell Group institutions have emerged from long-term curiosity-driven research.

Impact assessment in the REF

2.4 The only realistic way to evaluate the impacts of research is post-hoc, after the research has been completed; outputs have been peer reviewed and disseminated; and intermediaries or potential users have utilised, transformed, or integrated the knowledge arising from the research into product or policy development or some other kind of development activity. The timescale and nature of this process is unpredictable, lengthy and often convoluted.

2.5 A variety of methods for evaluating the impacts of research have been developed including econometric or statistical analysis, bibliometric and citation analysis, use of indicators, expert review, network analysis and/or case studies. In selecting a method it is important to consider when impact should be evaluated (how long after the research was conducted) and at what level of aggregation (eg at the level of a programme, research organisation or subject area). The answers to these questions will depend on the purpose of the impact evaluation, for example the need to demonstrate the overall benefits of public investment in research; to review the effectiveness of an area of research, programme or institute; and/or to inform future investment decisions.

2.6 In the US, assessment of the wider economic and societal benefits of research is a common feature of post-programme or periodic subject reviews undertaken by federal research funding agencies or learned societies. Such reviews nearly always use a case study approach to track and estimate the economic impacts of technologies or areas of research over time and are primarily used for STEM research eg

— National Institutes of Health economic studies program (http://ospp.od.nih.gov/ecostudies/)

— American Council for Chemical Research study "*Measuring Up: R&D Counts for the Chemical Industry*" (http://www.ccrhq.org/publications)

— Department of Energy study of the economic impact of fossil fuel and energy efficiency R&D (http://www.nap.edu/catalog.php?record_id = 10165)

— National Institute of Standards and Technology "*Toolkit for Evaluating Public R&D Investment*" (http://www.atp.nist.gov/eao/gcr03-857/contents.htm)

2.7 In the UK similar approaches are utilised by the Research Councils, learned societies and universities to evaluate and demonstrate the economic impacts of programmes, institutes and areas of research eg

— Wellcome, AMRC, MRC study "*Medical Research: What's it worth*?" (http://www.wellcome.ac.uk/About-us/Publications/Reports/Biomedical-science/WTX052113.htm)

— University of Cambridge study "*A tale of two innovations—making an impact*" (http://www.research-horizons.cam.ac.uk/researchnews/-p-a-tale-of-two-innovations--p-.aspx)

— NERC study "*The economic benefits of environmental science*" (http://www.nerc.ac.uk/publications/corporate/economic.asp)

— AHRC study "*Leading the world—the economic impact of UK arts and humanities research*" http://www.ahrc.ac.uk/About/Policy/Documents/leadingtheworld.pdf

2.8 These kinds of studies are primarily a means to demonstrate the long-term benefits of public investment in broad areas of research, although the methodologies employed can also be used to evaluate the long-term impacts of an institution or a large research programme. These approaches are not well suited to use in the REF because they tend to be tailored specifically to the research being evaluated; are time consuming and expensive to undertake, requiring the development of in-depth case studies and the application of specialist economic or statistical analysis; and tend not to be concerned about the attribution of research impacts to university research groups—a key requirement of REF impact assessment.

2.9 The Russell Group response to the Funding Councils consultation on the REF, states that "it is important that the REF encourages researchers to consider and pursue effective means for exploiting their research whilst avoiding perverse incentives which could discourage novel, unorthodox, or high-risk research"—including the establishment of new research groups or collaborations. We support the inclusion of an element of impact assessment in the REF in principle, provided that a robust methodology can be developed, which commands the confidence of the HE sector, research users and other stakeholders. The Russell Group has specific concerns about:

— *Defining "impact"*: the Funding Councils need to define what constitutes "impact" and how this differs from the assessment of "significance" under the research outputs component of the REF. Based on the experience of the impact pilot projects, the Funding Councils should develop and issue clear advice to the sector about the definition of "impact" and give a range of examples.

— *Linking impacts to excellent research*: because the purpose of the REF is to evaluate research excellence and facilitate the allocation of QR (rather than to evaluate and fund knowledge transfer or public engagement) it is essential that impact assessment is explicitly linked to research activity and research excellence. The impact pilot projects need to explore ways to enable the panels to verify that the impact statements and case studies submitted are based on excellent research.

— *Attribution of impacts*: the exploitation of research is non-linear, often happens over a long period of time, and involves multiple organisations and individuals, many of whom are beyond the influence of the original researchers or their institutions. The Russell Group believes that it is essential that impacts are rooted in the research portfolio of the submitting unit ie it is not acceptable for a third-party institution to able to take someone else's excellent research, carry out non-research activity to exploit this (eg collation of research findings) and then be able to claim the impact as part of its REF submission. The Funding Councils will need to address this issue and that of attributing impacts from collaborative research and consortia as part of the impact pilot projects

— *Assessment period*: a number of studies (such as the Wellcome, AMRC and MRC study) show that the period from research to impact is often in excess of 20 years. As such we believe that the period of 10–15 years proposed in the consultation is too short and would prefer each panel to be given the flexibility to determine what is appropriate in each discipline, subject to guidance about minimum timescales. If a standard period is to be set then this should extend to 20 years after the original research was conducted.

— *The burden of impact assessment*: The Russell Group has concerns about the volume of work likely to be involved in the development and assessment of impact submissions. For example, if HEIs provide one case study for every five FTE submitted this would equate to around 890 impact statements and case studies in the engineering unit of assessment (UoA). Given that impact assessment is being introduced for the first time it will be important to evaluate the bulk of the evidence submitted, and to demonstrate that a sufficiently broad group of expert users have been consulted to enable realistic judgements to be formed about the reach and significance of the impacts.

2.10 Eleven Russell Group universities are participating in the REF impact pilot projects and are working with the Funding Councils to address these challenges and develop a credible and practical impact assessment methodology. Although these pilots should go a considerable way to exploring and addressing the theoretical and practical challenges of developing and using impact assessment, these cover only 5 UoAs and outputs from this exercise are by no means certain. Since impact assessment is a new and untested component of the REF with no pre-existing methodology we believe that we believe that impact should be introduced at a maximum level of no more than 15% in the first REF. This should be accompanied by a commitment to review the relative weighting of impact in subsequent REF exercises in the light of practical experience. This will help to manage the risks associated with introducing a new and potentially destabilising element into the REF and to help build the community's confidence in impact assessment. More detail is provided in the Russell Group's response to the Funding Councils on the development of the REF at: http://www.russellgroup.ac.uk/russell-groups-policies/

Research Councils' impact assessment

2.11 Funding research and postgraduate training, and promoting and supporting the exploitation of research outcomes to contribute to the economic competitiveness of the UK are core parts of Research Councils' missions. As such it is both reasonable and necessary that the Research Councils should seek to evaluate the economic impact of their investments at a suitable point in time after the research has been completed, reviewed and disseminated. However, as indicated above, we do not believe that it is always possible to predict the future impacts of basic research before that research has been undertaken—if this were the case the proposed research would fail to meet the peer review criteria for excellent, innovative research.

2.12 Research Councils UK has published a statement entitled "*Expectations for Societal and Economic Impact*" which states that Research Councils expect award holders to "identify potential benefits and beneficiaries from the outset, and through the full life cycle of the project(s)". In April 2009, Research Councils introduced a new peer review requirement asking applicants for funding to predict who is likely to benefit from the proposed research, how they might benefit, and the kinds of steps which might be taken to increase the likelihood of the benefits being realised. Applicants are also required to produce an impact plan describing how the potential impacts of research will be realised. Writing in THE, Professor Alan Thorpe, the chair of RCUK, said that "Impact plans are not designed to ask peer reviewers or applicants to predict future benefits; they are intended to ensure that applicants consider potential pathways to impact".

2.13 Whilst the Russell Group agrees with the RCUK chair that it is vital that the sector and funders work together "to make a strong and persuasive case for continued investment in research by the taxpayer", it is evident that the only reliable and effective way to demonstrate the economic impact of research investments is to evaluate this after that research has taken place. It is reasonable to encourage recipients of Research Council funding to consider who the eventual beneficiaries of their research might be, and where appropriate, to take steps to engage potential users and beneficiaries during the lifetime of the research. However, given the long-term and unpredictable pathways of research exploitation and substantial differences in exploitation patterns in different subject areas, predicting who these beneficiaries might be will not be feasible in every case and applicants should not be encouraged to provide spurious information.

2.14 The Russell Group is continuing to follow closely the changes introduced by the Research Councils. We are reassured that the guidance issued by Research Councils to applicants and reviewers makes it clear that research excellence remains the primary criterion for the peer review of proposals. We are also reassured that some Research Councils (eg ESRC) have given clear statements that excellent research proposals with

no obvious or immediate societal or economic impact will not be disadvantaged in the peer review process and would like to see this message reinforced by all of the Research Councils. We would like to see greater clarity and consistency from Research Councils in their communications about impact and expect them to monitor closely and report how the introduction of impact statements affects both applications submitted and peer review decision making to ensure that it does not stifle funding for novel, unorthodox or highly innovative research.

3. *The differential effect of cuts on demand-led and research institutions*

3.1 Many of the funding cuts summarised in paragraph 1.2 are very recent and their full impact on individual universities and programmes may not be known for some time. For example, it remains to be seen how HEFCE will choose to operationalise the cuts announced in the December grant letter, and the impacts of this will not be clear to individual English universities until they receive their annual grant letters in March. However, HEFCE has already announced that it will achieve some of the necessary savings through the withdrawal of targeted allocations within its teaching funding. This funding currently provides additional support for the costs of old and historic buildings and some postgraduate taught courses. Russell Group institutions stand to lose to £30 million per year from the withdrawal of these allocations.

3.2 Research-intensive Russell Group universities already have diversified income streams and continue to perform extremely well in the international sphere despite the disparity in resources compared to competitor institutions in the US and elsewhere. The potential impacts of the announced cuts in public funding will fall across all elements of university activity and individual universities will choose how best to manage these impacts in light of their mission objectives. In the current climate it will be increasingly difficult to secure additional funding from private or charitable sources and cuts could potentially impact on ability of Russell Group universities to compete internationally for researchers, students and resources at a time when international competition is increasing as a result of very substantial increases in investment in research and postgraduate funding across the US, Europe and in Asia. Potential impacts are summarised below:

Impact on research and collaboration

3.3 It is too soon to determine what the impact of £915 million of funding cuts to HE and research might have on Russell Group universities. Although the Secretary of State's letter to HEFCE indicated a desire to protect research funding, HEFCE has already agreed a reduction of £16 million in QR in 2010–11. This could impact on charity support or business research (both of which have a strong STEM focus). Cuts to the HEFCE capital investment programme for research are likely to mean that some Russell Group universities will have to reschedule infrastructure renewal and development unless alternative funding can be accessed eg the planned new biological and life sciences building for the University of Bristol.

3.4 Russell Group universities use their competitively won public funding to lever substantial income from commercial, charitable and other funders for collaborative research and for teaching. As well as the obvious impact of being able to support less research and invest less in research infrastructure, reductions in the public funding available for research creates uncertainty amongst researchers and their collaborators, making it more difficult to build the trust and relationships on which successful collaboration and co-funding is based. Ultimately this could deter companies, charities and others investing in research in the UK. Uncertainties about future levels of funding and potential cuts also influence the mobility choices of researchers, increasing the likelihood that the best researchers currently in the UK may look to move elsewhere. It will also be more difficult for research-intensive universities to recruit and retain new talent from the UK and overseas. Attracting and retaining these individuals is crucial to the international competitiveness of research-intensive universities, and their continuing ability to win income for research from a diverse range of organisations.

Impact on recruiting postgraduates

3.5 The ability to attract the brightest postgraduate research students from the UK and across the world is important for Russell Group universities because it adds to an institution's research productivity, brings in new perspectives, builds foundations for future collaboration, and contributes towards creating an international environment which benefits all students. Overseas students also generate significant benefits in terms of fees income. Russell Group universities are competing for postgraduate talent in a global market place. Their competitiveness is based upon offering high quality programmes which demonstrate high levels of student satisfaction and lead to students acquiring knowledge, competences and skills which they and employers value. Competition is fierce and many other countries are offering an education in English and financial incentives to attract talented postgraduates. The anticipated loss of £16 million from QR funding could result in less funding for postgraduate support, and the cuts to capital funding for research will curtail investments in modernising laboratory facilities and equipment. This will compound the losses already being sustained by universities on some laboratory-based doctoral programmes and the loss of the Overseas Research Students Awards Scheme in England and Wales.

Impact on teaching

3.6 At the present time the major cost pressure on universities is the funding for teaching and student support. Research-intensive universities face specific cost pressures on teaching. Russell Group universities seek to provide research-informed teaching delivered by leading academics, providing access to top quality equipment and resources whilst maintaining a low student:staff ratio. This kind of educational experience is costly, particularly for laboratory-based subjects. The case study at section 9 gives an indication of the funding gaps involved. The additional funding from HEFCE to support high cost science subjects outside the mainstream teaching grant is currently due to end in 2009–10. The withdrawal of this funding will have very serious consequences for Russell Group universities, because in many cases the mainstream teaching funding fails to adequately recognise the full cost incurred in teaching laboratory-based science subjects.

3.7 Whilst BIS has sought to minimise the reduction in teaching grant funding, the reductions in the capital budget for teaching will impact on universities' abilities to renew and upgrade laboratory facilities and equipment, libraries, collections, and other teaching and learning facilities which underpin high-quality undergraduate provision. Capital projects are likely to be scaled back or postponed. This is likely to disproportionately impact upon STEM subjects which are more dependent upon access to expensive laboratory facilities and equipment.

3.8 Russell Group universities have a strong track record in increasing cost effectiveness and are focused on pursing new and innovative ways in which to deliver greater cost efficiency and higher levels of productivity. For example, by leading or participating in a number of HEFCE's feasibility studies to investigate innovative uses of shared services and resources. Russell Group universities recognise that their administrations will need to continue to respond flexibility to these challenging and changing circumstances, with a renewed emphasis on sustainability and drive for efficiencies across all parts of their business. As noted by Price Waterhouse Coopers in their report "*Weathering the Storm: Coping with financial challenge in the HE sector*", many of the "easy" savings have already been realised. The extent to which further efficiency savings can be made without a negative impact on the teaching quality or the international research competitiveness of the UK's leading universities is questionable. The continued drive for improved efficiency has the potential to be counter-productive, if, for example, it results in the loss of ability to attract and retain leading academic staff and the brightest students.

4. *The implications and effects of the announced STFC budget cuts*

4.1 Russell Group universities competitively win around 70% of STFC's annual research grant funding to the university sector (£96 million in 2007–08) and host many of the UK's leading particle physics and astronomy research groups (66% of research active physicists in UK universities are at Russell Group institutions). Russell Group universities are also major players in the provision of postgraduate education in the areas supported by STFC eg 11 out of the 19 UK HEIs offering postgraduate provision in astronomy and space science are Russell Group institutions, as are 5 out of 6 UK HEIs offering postgraduate nuclear physics, and 9 out of the 16 HEIs offering particle physics at masters or doctoral level. 69% of postgraduate research students studying physics or astronomy are at Russell Group universities.

4.2. We commend the efforts of STFC to consult widely with the academic community as part of its latest prioritisation exercise and welcome the clear statement given by the Council about its future priorities. The budget cuts however are substantial and the loss of excellent research that would have been supported is regrettable. These cuts and the continuing uncertainty about the future funding of the particle physics and astronomy research in the UK have a number of implications for Russell Group universities.

Impact on research, collaboration and the UK's reputation as a partner in international particle physics and astronomy projects

4.3 The withdrawal of funding from a number of international projects will have a major impact on the UK research groups working on these projects (eg researchers at the Universities of Glasgow and Edinburgh contributing to the anti-Proton ANnihilation at DArmstadt (PANDA) project, and the researchers at the University of Birmingham who are the only UK group involved in Accelerators and Lasers Combined Experiments ALICE, one of the major experiments at the Large Hadron Collider). Withdrawal from these projects hampers the ability of UK research groups to lever new funds for collaboration and also raises questions about the reliability of the UK as an international partner, which will inevitably colour negotiations for future international research projects.

Ability to attract and retain leading physicists and astronomer

4.4 The Russell Group was critical of STFC's decision to cut 25% of its funding for postgraduate students and fellowships from 2010–11 because of the adverse impact on students and early career researchers. The decision by STFC's Education, Training and Careers Committee to preserve as far as possible funding for PhD students and funding for advanced fellowships (for outstanding researchers) is welcome. However, this comes at the expense of support for early career researchers, with no postdoctoral fellowships being awarded in 2010, a move which could well drive UK talent abroad. Researchers in the particle physics and astronomy fields are highly mobile and a high proportion of those working in the UK are foreign nationals (the Institute of Physics estimates between 32%–40% of physics researchers in UK and Ireland are from the EU and

16%–20% are other overseas nationals). As the University of Leeds has indicated in its evidence, some astronomers and solar system physicists may leave the UK to pursue their research in countries where funding is more secure and where they will be able to work in research groups which continue to participate in international projects. Attracting high calibre replacements will be challenging in the current climate and some institutions may choose to withdraw from areas of research if the excellence cannot be maintained.

Ability to attract the brightest postdoctoral students

4.5 Paragraph 3.5 above outlines the importance of attracting overseas postgraduate students to Russell Group universities. Whilst STFC's recent decision to limit the reduction in PhD studentships from 25% to 15% goes some way to alleviating immediate concerns, sustainable, long-term investment in research, university infrastructure, and postgraduate education remains fundamental to maintaining the UK's reputation and market position.

Ability to attract students to study physics and astronomy at undergraduate level

4.6 Loss of researchers and expertise could curtail the breadth of undergraduate physics degrees in Russell Group universities, which are dependent upon research-informed teaching. The funding cuts and their coverage may also deter students from pursuing courses in these areas. Russell Group universities report comments from parents and potential students about whether it is "worth studying physics or astronomy".

5. *The scope of the STFC review announced on 16 December and currently underway*

5.1 The Russell Group welcomed the announcement by the Science Minister of a review of the STFC. Academics from Russell Group universities are actively participating in the on-going debate. We would like the review to explore how best to determine the UK's strategic priorities for participation in major international research programmes and facilities and to look at alternative ways of funding UK participation to tension these priorities more effectively against support for the UK's research base. As indicated above, a solution needs to be found which enables priorities to be tensioned against each other strategically and does not simply result in the brunt of any currency fluctuations or cost overruns falling on university research funding simply because making cuts to university budgets is the simplest short-term solution for funding agencies.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the HEFCE research budget and departmental research budgets*

6.1 The science budget is a unique, UK-wide source of public funding for fundamental, curiosity-driven research. Via competitive peer review it provides the UK's very best researchers with the funding, postgraduate research students, equipment and facilities to pursue cutting-edge research across the full range of academic disciplines. The public investment in the science budget is also a powerful lever helping to attract £1,540 million of research investment into the UK HEI sector each year from business, charities, the EU and other overseas funders. The research undertaken with this funding generates new ideas and knowledge that will ultimately drive forward human understanding, deliver new products, goods and services, and inform public policy contributing to economic prosperity, quality of life and well-being. International comparisons show that UK universities are highly efficient centres of research, with the UK generating more citations per unit of R&D spend and more citations per researcher than any other G8 country. Maintaining investment in the science budget at a time when the private sector is scaling back investment in R&D and charitable funders are slowing or deferring research funding is essential to maintain the international competitiveness of research-intensive universities and their contribution to productivity and growth.

6.2 Research of this kind is by its very nature a long-term and incremental investment, which operates on a timescale beyond an annual budgeting cycle, a three year spending review or five year Parliament. The ring-fence around the Science Budget (and that around the single health research fund) provides a clear commitment of the Government's strategic intent to invest in basic research and enables Ministers, Government and academia to work together to define and commit to long-term overarching research priorities. This national commitment and broad predictability of funding (protected from short-term political pressures) gives academics, universities and potential research funding partners and collaborators from the UK and overseas a high-degree of confidence in the stability of the UK research environment. For private sector, charitable and overseas funders and collaborators in particular, stable, long-term public funding for research and research infrastructure lowers the risks associated with collaboration and is a critical factor in their selection of the UK as a partner of choice.

6.3 Universities are facing the challenge of operating in an environment where public funding will be tightened. Greatest pressure is likely to be around student support (see question 9) and maintaining the unit of resource for teaching funding. Enabling research-intensive universities to continue to compete for and deliver excellent, basic research in this difficult environment is critical to achieving the Government's ambitions for maintaining the international competitiveness of the UK's research base. The ring-fence around the science budget provides a continuing guarantee not only to the universities, but also to funding agencies and potential collaborators of the long-term stability and security of public investment in the UK's research intensive universities.

6.4 Research funded by Government Departments is primarily commissioned for specific policy purposes and funded on a contractual basis. Whilst Departments and Research Councils collaborate to co-fund basic research in key policy areas, it is important to continue to maintain departmental R&D budgets to avoid further erosion of Science Budget funding for basic research. The Russell Group would like to encourage greater visibility of the funding available for research and greater transparency about the research priorities likely to be supported—particularly in relation to research which is subject to open competition or tender. Publication of information about the volume of funding available for research from individual departments and their agencies would be highly valuable, and would also help to encourage effective cross-government collaboration between departments, Research Councils and the TSB.

7. *Whether the government is achieving the objectives it set out in the "Science and Innovation Framework 2004–2014: Next Steps" including, for example, making progress on the supply of high-quality STEM graduates to achieve its overall ambitions for UK science and innovation*

Maintaining the UK's world-class university system

7.1 The RAE has been integral to enhancing the quality of the UK research base. The Next Steps document included recommendations to develop a metrics-based RAE to "maintain the UK's world-class university system".

7.2 The results of the 2008 RAE demonstrated that Russell Group universities continue to excel both in terms of the consistently high quality of researchers and also in the sheer volume of excellent research. Twice as much of the research conducted within Russell Group universities was rated as 4*, compared with the rest of the sector. However, the new methodology introduced in the 2008 RAE and subsequent allocation of QR funding in England and Wales saw a much wider dispersal of research funding across the HE sector than in previous years. A number of Russell Group universities saw a decrease of QR funding in cash terms of between 1% and 13%. In real terms, in 2009–10 half of the Russell Group of universities saw either a flat or reduced allocation of QR research funding compared to 2008–09. This means that despite a 5.6% increase in QR funding, only half of the Russell Group universities received any benefit from this increase despite the fact that most improved their performance, in some cases significantly eg LSE and the University of Manchester.

7.3 "*Higher Ambitions*" is clear that now more than ever the UK's research-led institutions have a crucial role to play in helping the country to recover from the economic downturn. It sets out the Government's commitment to supporting and protecting the UK's "strongest, world-leading centres of research", and recognises that in a climate of scarce resources public investment must be prioritised on strengthening research centres with world-class capability and that this should mean more concentration of research and resources. This is necessary to protect the UK's international reputation for research excellence and to enable the UK to compete successfully to attract the world's best researchers, brightest students, and inward R&D investment. The Russell Group believes that it is important that the REF reflects this agenda in its assessment methodology and in the methods used subsequently to allocate QR funding. The REF should recognise and reward the very highest levels of excellence in research, and should avoid driving a growth in volume of lower quality research.

7.4 Higher concentrations of research excellence help to maximise the impact of research and provide a rich environment for training and developing post-graduate researchers. Critical mass within an institution is also the foundation for innovative, interdisciplinary research collaborations that are key to solving global challenges. The REF needs to recognise and reward such concentrations of excellence, particularly where this involves interdisciplinary collaboration. More information is provided in the Russell Group's response to the Funding Councils on the development of the REF, as referenced at paragraph 2.10.

Improving STEM skills and the supply of scientists

7.5 Highly skilled STEM graduates are essential to the future prosperity of the UK. Recent government consultations,[4] as well as the wage premium which STEM graduates continue to command in the marketplace,[5] show that demand for STEM qualified graduates remains high amongst UK business and industry. Employers continue to report difficulties in recruiting sufficient numbers of STEM graduates.[6] The Russell Group response to Sir Mark Walport's review of science and learning for DCSF sets out the concerns of our institutions about the supply of qualified applicants to STEM degree courses and provides evidence of the work that universities are doing with schools and colleges to try and address these issues.[7]

7.6 The supply of STEM qualified graduates depends on the supply of students choosing to study STEM subjects at A-level or equivalent. Although the commitments made by the government in the Next Steps document were a welcome move towards boosting STEM skills, concerns remain about the continued long-term decline in the numbers of students studying core STEM subjects such as physics, chemistry and maths,

[4] *The Demand for STEM Graduates,* DIUS, CIHE, ETB and IER, January 2009.
[5] See, for example: (1) 1994 Group (2008). *Graduate Employment and Earnings: are universities meeting student expectations?* London: 1994 Group; (2) PricewaterhouseCoopers (2005). "The economic benefits of higher education qualifications". Rates of return in comparison with those that left school with only two "A" levels.
[6] Emerging stronger, CBI/Nord Anglia education and skills survey 2009; ABPI (2008) "Skills needs for Biomedical Research": http://www.abpi.org.uk/publications/pdfs/2008STEM_Skills_Report.pdf
[7] Russell Group response to DCSF consultation on science and learning, Sept 2009.

at A-level. Over the period 1989 to 2008 entries have fallen by 22% in maths, 36% in physics and 13% in chemistry despite total A-level entries soaring.[8] Take up of A-level STEM subjects is showing some improvement with maths, further maths, physics and chemistry A-levels all seeing an increase in 2009 in both total number of candidates and those achieving grade A (Source: JCQ Results 2009). However, as a proportion of total A-level candidates, science candidates have remained largely static (*Source: Cambridge Assessment, A valid overview of entries in schools and colleges, 2009*). It is important that growth in numbers of A-level STEM entrants is maintained through reinforcing policy commitments, increasing the number of specialist STEM teachers and increasing the numbers students at state schools taking triple science at GCSE and then progressing to A-level STEM subjects:

— Despite small increases in the uptake of STEM subjects at A-level, this increase is skewed towards independent and grammar school pupils, where the number of students studying at least one STEM subject at A-level far outweighs the numbers at comprehensive schools.[9] This makes it challenging for Russell Group universities to recruit larger numbers of state school pupils into STEM courses where there is high demand and stiff competition for places. This remains a significant barrier to widening participation at Russell Group universities.

— Taking separate sciences at GCSE is an important stepping stone to progression and success in A-level sciences. However, there are inequalities of opportunity in this respect, with less than a third of non-selective maintained schools having pupils taking separate or "triple" science at GCSE.[10] The Government's commitment that all able[11] state school pupils will be afforded the opportunity of studying separate sciences at GCSE is welcome and needs to be reinforced to ensure that this opportunity is more widely available and take-up encouraged.

— High quality teaching in schools is also a pre-requisite to more able students going on to study STEM subjects at university. The Government's commitment to recruit more chemistry, physics and maths specialists into teaching is welcome. Equally important is that good teachers are retained in the profession. Progress in these areas is essential if all students are to have equal opportunity to learn science and maths from well-qualified, specialist teachers. The differences between schools can be significant. For example, physics teachers in comprehensive schools are far less likely to have a degree in physics than their peers in the independent sector. If disparities of this kind remain it will continue to be challenging for universities to recruit larger numbers of state school pupils to STEM degrees.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in STEM courses*

8.1 The Russell Group supports the Government's longstanding aim that more students should have the opportunity to benefit from going to university. However, to maintain the confidence of students, parents, employers and others in the value of a university education it is important that the high quality of the teaching and learning experience is maintained. Sustainable public investment coupled with prudent financial management in universities is needed to ensure that the quality of provision is maintained in the longer term.

8.2 STEM subjects such as chemistry and engineering are particularly expensive to teach because of the need to provide hands-on access to modern laboratory facilities and equipment. Many Russell Group universities are teaching these subjects at a loss (see case study below). Most English Russell Group universities decided not to take up the offer of extra student places for STEM subjects in 2009–10 because of the lack of additional government funding for teaching and concerns about the impact that this could have on maintaining teaching quality. Whilst this has delivered some limited growth in recruitment to STEM degrees, in the absence of corresponding funding from HEFCE for the teaching of these students, there remain serious concerns about the lack of sustainable funding for these places.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

9.1 The Secretary of State's Grant letter to HEFCE on 22 December 2009 outlined a further £135 million of cuts on the overall funding council support for universities in England, on top of previous cuts of £180 million which were announced for 2009–10. The combined effect of these cuts is a reduction in the HEFCE funded grant for teaching of £215 million. According to the figures quoted in the grant letter, this will result in a reduction of the planned unit of resource from £4,140 to £3,950.

9.2 As indicated at paragraph 3.6 research-intensive universities face specific cost pressures on teaching. The case study below provides an example of the income gap which one Russell Group university has experienced in teaching chemistry.

[8] JCQ entry trends—A, AS, AEA Tables.
[9] Less than 1 in 10 students take 1+ science A-level in mainstream and science specialised schools compared with 1 in 3 at grammar and independent (Source: House of Lords Science and Technology Committee, 10th report of session, 2005–06, Science Teaching in Schools, Evidence from DfES.
[10] Coyne M, Goodfellow J M *Report to the Secretary of State, DIUS, on universities' links with schools in STEM subjects* (September 2008).
[11] The commitment applies to all pupils achieving level 6 or above in science at key stage 2 (age 14).

Case study: the cost of teaching undergraduate chemistry student X at an English Russell Group university in 2007-08. The student:staff ratio for chemistry at this institution is just over 13:1

- Cost of teaching (per undergraduate FTE): £14,190 per annum
- Income received per student:.
  - Funding Council grant: £7,500[12]
  - Tuition fee: £3,070
  - Total = £10,570 per annum
- Loss = £3,620 per undergraduate FTE per annum.

(1) Based on HEFCE standard resource for chemistry in 2008–09 plus additional targeted allocations/ weightings.

9.3 The reduction in the overall unit of resource will only exacerbate this situation. Since STEM subjects receive funding within the HEFCE T-funding model based on a weighting of the "standard resource" an overall reduction in the unit of resource could have a proportionately greater impact on these subjects. However, as indicated above, HEFCE has not yet indicated how it will make the savings that it has been asked to make in the teaching grant for 2010–11. Therefore, it is too early to comment on what the impact of those cuts will be on STEM education in particular. Moreover, individual institutions will make their own decisions concerning the budgets of individual science and other departments, based on the overall financial position of the university.

February 2010

Memorandum submitted by University Alliance (FC 69)

Alliance Universities: Shaping the New Economy

1. University Alliance represents 22 major, dynamic, business-like universities at the heart of the sector which deliver world-leading research with impact and are actively business-focussed. A significant proportion of STEM research (often near-market research) and teaching is under-taken in these universities.

2. Alliance universities are research engaged, providing a research informed, academic and entrepreneurial learning environment for students. These universities contribute valuable insights through peaks of excellent research which are recognised as world class, as demonstrated in the 2008 Research Assessment Exercise (RAE) and in the recently published University Alliance publication, "Concentration and diversity: understanding the relationship between excellence, concentration and critical mass in UK research".[13]

STEM Provision Within Alliance Universities

3. Alliance universities are significant providers of high quality STEM higher education in the UK and have contributed significantly to the government's targets in this area:

- Nearly 22% of all students studying STEM-related subjects are at an Alliance university.
- Around 45% of all students at an Alliance university are studying a STEM-related subject.
- Alliance graduates have some of the highest graduate-level employment rates (eg 93% of Northumbria graduates are in graduate-level employment after three years and less than 1% are unemployed).
- Alliance graduates have some of the highest graduates prospects (eg Engineering graduates from Nottingham Trent University have joint highest graduate prospects with Imperial Engineering graduates).
- Alliance universities are leaders in developing graduate attributes, meeting the needs of employers and giving graduates a head start in the graduate market place (eg the world-leading "WOW" (World of Work) programme at Liverpool John Moores University http://www.ljmu.ac.uk/wow/)
- Alliance universities are often the largest provider of postgraduate provision in their region (Northumbria, UWE, LJMU).

4. It is too early to confirm the full effect of the additional 10,000 higher education STEM places announced by the Government in July 2009 (as the UCAS figures will not be available until 8 February 2010). However, early indications from Alliance universities indicate that there has been a significant growth in STEM applications.

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[12] The Rt Hon Lord Mandelson, Secretary of State for Business, Innovation & Skills; Grant letter to HEFCE, 22 December 2009 (http://www.hefce.ac.uk/news/HEFCE/2009/grant1011/letter.htm)

[13] http://www.university-alliance.ac.uk/UA%20Concentration%20and%20Diversity_for%20publication.pdf

Outline of Submission

5. We welcome this opportunity to respond to the Select Committee Inquiry given the strong focus on these subjects within Alliance universities. While we believe it is relatively early to asses the full implications of the announced STFC budget cuts we have used this response to outline:

- the extent of science, technology, engineering and mathematics provision (STEM) within Alliance universities;
- principles for funding research;
- important evidence highlighting the rational of funding research based on selectivity rather than concentration—in order to drive excellence; and
- examples of world leading Science, Engineering and Technology research with impact undertaken in Alliance universities.

6. Should the Committee find it helpful we would be pleased to outline further details of our position on these matters as oral evidence.

Principles for Funding Research

7. Support for the dual support system and the role of QR:

- University Alliance strongly supports the dual support system for research and the role of the funding councils in distributing the core grant as Quality Related (QR) funding.
- We recognise the Research Excellence Framework (REF) as an essential component of a UK system which has driven the quality of UK research through a policy of selectively funding excellence in research wherever it exists.
- These drivers have improved the sector's ability to deliver world class research, as demonstrated by the UK's increased share of global citations.

8. The UK should continue to fund excellence in research wherever it is found:

- We support the aim of research assessment "to secure the continuation of a world-class, dynamic and responsive research base across the full academic spectrum within HE",[14] and believe that the best way to do this is to ensure that excellent research is funded wherever it is found.
- We believe that a continued policy of selectively distributing research funding, based on quality, is essential in order to continue to drive the quality and impact of UK research and secure the future health of the UK research base.

9. Support for moves to assess the impact of research as long as the measure is sufficiently developed:

- We understand the importance of the REF promoting impact alongside excellence in order to maximise the benefits of our research innovations and welcome the inclusion of impact in principle.
- We also support the broad definition of impact proposed in the REF to incorporate economic, social, public policy, cultural and quality of life impacts in order to ensure that the measure is applicable across the Units of Assessment (UOAs).
- We do, however, have concerns that the 25% weighting currently proposed is too high given the difficulties in assessing impact and the fact that this measure remains relatively untested. We acknowledge that this element is still undergoing development through the pilots which are currently underway and support HEFCE in this approach.
- We would not want to pre-empt the findings of this work but at this stage Alliance universities have raised significant concerns about the robustness of the impact measure. We therefore suggest that this measure should be re-weighted to 15%.
- We are also concerned about the proposed timing for the pilots. University Alliance would recommend that the implementation of this element is delayed in order to allow further consultation with the sector and to ensure that final proposals are sufficiently robust.

Selectivity not Concentration has Driven Excellence in UK Research

10. There is clear evidence to demonstrate that it is a policy of selectivity, funding research based on quality, not concentration that has driven up the quality of UK research since the introduction of the RAE. Selectivity has resulted in concentration of research funding where quality exists. This is fully supported by University Alliance.

11. The UK has one of the most highly selective research funding methods in the world—QR funding in 2009–10, based on RAE 2008, has not changed that:

- In 2007–08, four institutions received 29% of Quality-related (QR) funding (and 23 around 75%).
- In 2009–10, four institutions received 32% of QR funding (and 25 around 75%).

[14] HEFCE, Research Excellence Framework: Second consultation on the assessment and funding of research, September 2009/38, p5.

12. There is no direct correlation between volume and excellence outside some of the physical sciences. The relationship between volume and excellence varies by discipline. Three broad categories were identified by experts at the University of Leeds for the HEFCE Fundamental Review of Research Policy and Funding:

— high impact at high volume (where volume is related to impact, for example the clinical sciences);

— higher impact at high volume (where small units can be effective, for example in engineering and social sciences); and

— no clear pattern (where the "lone researcher" can produce excellent research with high impact, for example in mathematics, arts and humanities).

13. Even in the small number of science-based disciplines where there is a correlation between volume and quality:

— there is no identifiable "threshold" or "critical mass";

— volume is "evidently not the only factor" (HEFCE Fundamental Review); and

— the increasing capacity for both interdisciplinary and international collaboration can redefine what counts as critical mass.

14. It is the peaks of world-leading research excellence that determine the position of the UK as a world leader in research. These peaks of research excellence are more widely distributed across the sector than had previously been recognised before RAE 2008. Indeed, recent analysis by Evidence Ltd, published by HEPI, has shown that the sector as a whole has a higher percentage of "highly cited papers" than the major research-intensive Russell Group universities (excluding "Golden Triangle" institutions).

15. Further details of the evidence around research concentration are outlined in the University Alliance publication "Concentration and diversity: understanding the relationship between excellence, concentration and critical mass in UK research".[15]

World Leading Research with Impact Undertaken in Alliance Universities

16. Alliance universities have a strong track record in engaging in near market research and development work which is underpinned by the excellence revealed in the 2008 RAE results. These universities are using world-leading science, engineering and technology research to achieve significant impact; addressing social, economic, social, public policy and, cultural needs.

University of Portsmouth

— The University of Portsmouth's Institute of Cosmology and Gravitation has achieved an RAE result in which 75% of the work was judged as 4* or 3*, a proportion not exceeded by any other institution in this UOA. The Institute works in fundamental areas of cosmology and astrophysics, supported by the Research Councils, the European Union and other international funding bodies.

— Its areas of expertise include The Cosmic Microwave Background, Galaxy Surveys, Dark Energy, Brane-world Cosmology and String Cosmology, Relativistic Dynamics and Geometry, Relativistic Astrophysics and Gravitational Waves.

University of Hertfordshire

— The University of Hertfordshire has been placed in the Shanghai Jiao Tong League Table of the World's Top 500 Universities for Research. The University entered for the first time in 2008 and has just been reconfirmed for 2009.

— Hertfordshire's Physics and Astrophysics Research has been strongly supported by the University for over 30 years and it attracts a large amount of research income from organisations including the Research Councils, Royal Society, Leverhulme Trust, Nuffield Foundation, Meteorological Office, Defence Science and Technology Laboratory and NASA. The RAE 2008 submission in Physics included 28 staff and with 90% of its research internationally recognised. The submission incorporated two Research Centres within the University's Science and Technology Research Institute, namely the Centre for Astrophysics Research and the Centre for Atmospheric and Instrumentation Research.

— The two Research Centres have a balanced portfolio of research in fundamental physics, astrophysics and atmospheric physics including both observational and experimental work, together with knowledge transfer and exploitation. In addition, the two Centres embrace interdisciplinary work in the development of instrumentation to measure light-scattering in situations ranging from extra-solar planets to dust in the Earth's atmosphere.

[15] http://www.university-alliance.ac.uk/UA%20Concentration%20and%20Diversity_for%20publication.pdf

University of Glamorgan

— The University of Glamorgan's very successful engineering research focuses on multi-disciplinary approaches to key issues facing society, including sustainable energy generation and clean technologies for power systems and vehicles. The University brings together staff with expertise across areas of engineering and links them with applied sciences to work with users to create holistic, innovative solutions.

— Relating to a key priority of the Welsh Assembly, "Building a low carbon economy" has been a major research theme. This research focuses on the use of hydrogen as a pollution free energy vector and addresses sustainable generation of hydrogen, uses of hydrogen in waste streams of industrial processes, hydrogen fuel cell technology, advanced materials for hydrogen storage and hydrogen powered vehicles.

University of Plymouth

— Research Fortnight's RAE 2008 Power Table showed that the University of Plymouth was ranked at number 50, with the highest increase in ranking (15 places) from 2001 to 2008. The University has attracted more than £5.6 million research income across its schools and faculties. The University's largest Unit of Assessment for the 2008 RAE, with 36.5 staff submitted, was Earth Systems and Environmental Sciences (UOA17), which includes the marine physical sciences and chemistry. In this unit 95% of the research was judged to be at least internationally recognised, with 50% being internationally excellent or world leading.

— The University was one of only two UK universities selected to take part in a landmark pan-European marine project worth €55 million. The Universities of Plymouth and Reading have joined forces with 60 of the leading marine organisations across Europe to carry out the landmark MyOcean project. Funded by the European Commission, the ambitious project aims to create the first-ever European-wide resource for ocean monitoring and forecasting by integrating the research skills and expertise across 28 countries. The University of Plymouth's role in the project will be to contribute its expertise to the numerical modelling of ocean dynamics and calibration/validation of prognostic services in the Black Sea, an area of research where the university has already achieved an international reputation.

Liverpool John Moores University

— The research strengths of Liverpool John Moores University primarily lie in the STEM and STEM-related areas. Amongst the highlights from RAE 2008, the University would single out the outstanding performance achieved by two, small, specialist research groups, namely General Engineering and Electrical & Electronic Engineering. Both units were rated with 60% of their activity at 3* and 4* in the 2008 RAE.

— Significant levels of external funding have been attracted by these researchers from a wide range of competitive sources, including EPSRC, industry (direct funding and KT schemes), TSB and from successive European Framework Programmes. Worldwide collaboration is a fundamental aspect of the research which engages with other Universities, world-leading hospitals and with industry (multinational and SME)—often through multidisciplinary projects. User take-up clearly demonstrates that their work has directly influenced; radiotherapy, medical imaging, advanced manufacturing, precision measurement, industrial inspection, material and chemical processing, communications, signal-processing and remote-sensing.

The Open University

— The Open University achieved the second largest climb in UK research rankings in the 2008 Research Assessment Exercise, with more than 50% of its research rated as "internationally excellent" (3*) and 14% as "world-leading" (4*).

— The University supports a vibrant research portfolio and fosters research teams who compete with top ranked institutions in the UK and worldwide. Research highlights include Dr Robert Saunders', work to develop a model system for studying the molecular and cellular nature of a genetic disorder known as Werner's Syndrome (WS) caused by defects in a gene.

— Ultimately, the research project is expected to shed new light on the nature of ageing known as WRN. Werner's Syndrome is a condition that leads to rapid ageing and early death, and is frequently used as a model for normal ageing. Because the condition is rare, human material is limited and it is often difficult to use experimentally. However, Dr Saunders and his team have identified a homologue in the fruit fly Drosophila of the gene involved in this syndrome, and have initiated a successful £271,462 research project funded by the Biotechnology and Biological Sciences Research Council (BBSRC).

Oxford Brookes University

- 75% of Oxford Brookes University research was internationally recognised in the 2008 RAE.
- The Movement Science Research Group at Oxford Brookes is based in Oxford Brookes' Biomechanics and Human Performance Laboratories and has excellent clinical links with the Oxford Centre for Enablement, Nuffield Orthopaedic Centre, the Oxford Centre for Functional Imaging of the Brain, John Radcliffe Hospital and the Department of Clinical Neurology, University of Oxford.
- The Group's many projects include:
  - mapping central nervous system activity during movement and motor learning and recovery; and
  - monitoring and improving safe mobility, activity and fitness levels in patients with neurological or neuromuscular disease.
- The Group is in receipt of Wellcome Trust funding to facilitate technology transfer of a methodology for gait analysis (the measurement of walking parameters) from a laboratory tool into a measure that is in every day clinical use.

University of Bradford

- The University of Bradford has 700 researchers and an annual research income of more than £16m. The University actively promotes interdisciplinary research across the University and through external collaboration with organisations such as the Ministry of Defence, the National Health Trust, and Universities worldwide.
- This research impacts positively on industry through regular collaborations. From small, local and regional companies such as Briton Engineering and Materia-Medica; to large multinationals like, GlaxoSmithKline, Smith & Nephew, Ford, and PZ Cussons (UK) Ltd.
- The University's Centre for Polymer Micro and Nano Technology has a world leading research capability in micro- and nano-moulding technologies advancing knowledge in areas such as materials modelling and characterisation, process optimisation, product characterisation and testing, and simulation. In parallel with and building upon these research activities, the Centre has developed comprehensive industry links. Knowledge transferred to companies of all sizes includes design consultancy, process and product development, proof of concept manufacturing, specification of turnkey systems for device manufacture and packaging and full-scale manufacture of devices. The Centre offers significant expertise in nano-materials preparation, materials understanding, design for micromoulding, process/product characterisation and modelling.

Manchester Metropolitan University

- The "Intermittent Predictive Control Systems" governing human movement and posture project interfaces between Engineering and Life Sciences and received glowing reports from all four reviewers in the 2008 RAE. Audited through Manchester Metropolitan University a three year EPSRC award will also support work at the University of Birmingham (Dr Martin Lakie) and in the University of Glasgow (Dr Henrik Gollee).
- A future application of this important fundamental research may be the development of artificial control systems that are interfaced to humans via brain machine interfaces and spinal cord interfaces. The collaboration with Dr Henrik Gollee in Glasgow's Centre for Rehabilitation Engineering, working with the Queen Elizabeth National Spinal Injuries Unit, is of particular interest since they are concerned with the use of electrical stimulation to restore movement to para and tetra plegic patients, in which field there is a need to develop an engineering control system that mimics human neural control.
- At Manchester Metropolitan University, the experimental work into physiological control will be conducted in the new IRM Posture Laboratory which is being built as part of the "state of the-art" IRM Research Institute development on the John Dalton site of the Faculty of Science and Engineering. The research will utilise a unique multisensory balance apparatus being developed by Dr Ian Loram and constructed by Messrs Tom McKee and Des Richards.

University of the West of England

- The University of the West of England's Institute of Biosensing Technology (IBST) is the first of its type using Bio-sensing technology in non-invasive detection of disease, healthcare (being able to detect metal fatigue in hip replacements before they hurt), security and many other applications. This attracts inward investment from overseas.
- IBST was formalised in 2008 and has already secured major research contracts such as a £1 million project in collaboration with DePuy (a Johnson + Johnson company) and Gwent Electronic Materials, funded by the Technology Strategy Board. The project aims to develop a new rapid,

point-of-care diagnostic system for the measurement of metal ions after joint replacement. This will inform clinical decision making around the need for pre-emptive revision in case of high levels of metal wear.

— IBST has also become an affiliate member of the Sensors & Instrumentation Knowledge Transfer Network (SIKTN), a government funded initiative to develop a joined-up approach to the bio-sensing and instrumentation community. The Institute is already working with the SIKTN on a project to develop a National Directory of UK companies working in bio-sensing.

February 2010

Memorandum submitted by the 1994 Group (FC 48)

INTRODUCTION

The following is the 1994 Group's response to the Science and Technology Committee's inquiry on the impact of spending cuts on science and scientific research. For more detailed information please refer to the individual responses of our member institutions.

Members of the 1994 Group are: University of Bath, Birkbeck University of London, Durham University, University of East Anglia, University of Essex, University of Exeter, Goldsmiths University of London, Institute of Education University of London, Royal Holloway University of London, Lancaster University, University of Leicester, Loughborough University, Queen Mary University of London, University of Reading, University of St Andrews, School of Oriental and African Studies, University of Surrey, University of Sussex and University of York.

The 1994 Group of medium-sized, research-intensive universities have demonstrated their research excellence in the 2008 RAE achieving 1st place in seventeen subject areas. 57% of the 1994 Group's research is rated 4* world leading or 3* internationally excellent.

1994 Group universities are delivering an excellent academic experience to their students. In the latest National Student Survey seven of the top ten universities rated on overall student satisfaction are 1994 Group members, 88% of students saying they are satisfied with the overall student experience compared to a national average of 81%.[16]

1. *The process for deciding where to make cuts in SET spending*

1.1 It is crucial that the UK's Higher Education research base is appropriately supported to play a major role in addressing global challenges and ensuring the UK's future prosperity. Despite the pressures on state finances, there should be investment, rather than cuts, in higher education and scientific research. A recent poll on university funding, commissioned by the 1994 Group, shows that 86% of the public back such investment. There must be increased investment on a longer-term basis to enable universities to retain the scope to respond flexibly and rapidly to emerging challenges, and to create an environment in which UK research productivity and impact is world leading and our universities remain internationally competitive.

1.2 In a period of public spending cuts it must be the priority to maintain investment in high-quality teaching and research at universities, across the disciplines. If cuts are forced upon us the decision of where they fall must be an evidence-based decision made as strategically as possible, with a view to supporting the scientific base which will be needed in the longer term. Importantly, the criteria for deciding where to make cuts in SET funding should be based on quality of teaching and research, rather than on the scale of operation. There should not simply be increased concentration of funding in large universities.

2. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

2.1 We welcome the fact that, through the developing methodologies for allocating QR funding and Research Council grants, researchers are being encouraged to think about the wider impact of their research, but would advise caution in focussing this too narrowly on economic impact. While it is of course important in the current economic climate to consider the economic impact of research, we must not overlook the social and cultural impacts of our research.

2.2 We must also not forget the fact that our future sustainability and prosperity depend not only on addressing today's most immediate challenges, but also on the generation of knowledge and discoveries which our coming generations can apply for the good of their society. We must retain a significant funding stream for what might currently seem like fundamental, curiosity-driven research, but may well enable us to think in new ways, to train new skills, and to provide some of the answers to tomorrow's problems. The current Dual Support system should be retained in order for the real value of fundamental and purely curiosity-driven research to be recognised.

[16] The National Student Survey 2009 http://www.hefce.ac.uk/news/hefce/2009/nss.htm

2.3 There have been recent studies of the effectiveness and economic return on QR and grant funding using case studies, this methodology could be used to show that research has had direct economic and other impact. The 1994 Group has a number of examples of world-leading multi-disciplinary research within its institutions, which has benefited from the provision of QR and responsive mode funding, and is meeting major global challenges and generating economic and wider impact.[17]

2.4 The consultation on the Research Excellence Framework has led to an Impact Pilot Scheme. It is important that this is completed and thoroughly assessed before any judgements are made on how to gauge economic impact, and particularly if and how this translates into allocation of QR funding. There also needs to be very careful consideration of how impact varies between disciplines.

3. *The differential effect of cuts on demand-led and research institutions*

3.1 The classification used here is perhaps not the most useful; it may be more helpful to think in terms of research-intensive and non research-intensive institutions. The 1994 Group supports the decision to distribute QR funding according to excellence, while ensuring critical mass in world-class research areas, and believes that the level of research concentration prior to RAE 2008 was appropriate, in line with UUK's position.[18]

3.2 The 1994 Group's primary concern is that quality is maintained, so that universities are able to meet the nation's needs, including strengthening the economy, delivering novel solutions to major challenges through research, and developing a world-class highly skilled workforce. Research-led institutions will need to maintain their critical mass and invest in the future to maintain world-leading facilities and activity.

3.3 An example on a practical level of what we mean by critical mass and concentration is in regards to postgraduate provision. The 1994 Group demonstrated in a recent report[19] that it is the research-intensive institutions of the 1994 and Russell Groups that show the greatest productivity of PhDs, and it is these universities that are dominant in the sector in terms of the volume of PhDs produced across the subject areas. Furthermore STEM PhD activities in the Russell Group (without Oxbridge) and the 94 Group are very similar, the STEM area is not massively different in terms of productivity. It is the quality of infrastructure around research teams that seems to be the important factor in producing PhDs, and if a critical mass is to be recommended in postgraduate research provision then it clearly lies within these two groups' member institutions. We believe, therefore that a new quality threshold on PhD provision must be introduced. HEFCE's funding should be more concentrated than it currently is, in order for the Government's funding to be channelled as effectively as possible and at the best value. This would still allow all institutions to provide PhDs if they wish, but provision below the quality threshold would be reliant on fee income rather than Government funds.

4. *The implications and effects of the announced STFC budget cuts*

4.1 A number of our members have serious concerns about STFC budget cuts, in particular their effect on Physics Departments, in terms of reduced funding for research with possible closure of departments, transfer of funding to specific fields, and a potential "brain drain" due to loss of the best academic staff.

4.2 There are three classes of effect for these cuts:

(i) impact on Physics departments;

(ii) impact on specific fields; and

(iii) impact on UK science and brain drain; discussed below.

4.3 It is clear that the amount of money being distributed to Physics departments as part of the domestic programme is being reduced. STFC supports around half of the research carried out in Physics departments and this reduction in the science exploitation grants will affect departmental finances. We expect that some Physics departments may be forced to close or merge into Natural Science type units.

4.4 The effect seen by our universities is a transfer of funds from the Particle Physics, Astronomy, Space and Nuclear Physics areas into support for facilities such as Diamond and ISIS, meaning that the UK is not reaping the full reward from its international investments as it withdraws from telescopes, space projects and Particle/Nuclear Physics experiments.

4.5 Over the past decade, the UK has recruited from the best available international talent, and as opportunities and funding in the UK dries up, the very best will return to their own countries, which are increasing their support for education and science.

[17] These case studies are available on the 1994 Group website: http://www.1994group.ac.uk/members/research enterpriseexcellence.php
[18] RAE 2008 outcomes and funding. Research Policy Committee Report. RPC/09/03
[19] www.1994group.ac.uk/documents/public/Research_Policy/Postgraduate_Provision_Research_Report_Jan2010.pdf

4.6 The announced STFC budget cuts have created uncertainty and disruption, coupled with an inability to plan, which is bad for research programmes, and for universities' international reputation. Cuts also lead to a loss of vital expertise in particular disciplinary areas to overseas countries. Furthermore, teaching in our universities will suffer due to higher staff-student ratios.

5. *The scope of the STFC review announced on 16 December and currently underway*

5.1 We welcome the STFC review and the opportunity it affords us to consider its role and function.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

6.1 The Government has rightly recognised that increased investment in research is crucial and that Higher Education is more critical to our future prosperity and well-being than ever before. The funding for STEM subjects and medicine has also been enhanced, since these disciplines are clearly vital for key sectors of the economy. They encourage new technological developments and drive economic growth, and improve population health and well-being. It is essential, however, that resources are available for a broad and robust research foundation in order that we can compete effectively in the new global economy and ensure future sustainability and prosperity.

6.2 We need to complement investment in STEM subjects and medicine with continuing investment in new ideas and world-leading research in arts, humanities and social sciences to support the culture and heritage on which so much of UK GDP depends, and to support research on national priorities. We cannot afford to conceive our "science" base too narrowly. We must protect our entire research base. Addressing current and future global challenges depends on the successful interplay of all subjects. Increasingly, success in markets, which have frequently been assumed to be dominated by technological advances, depends just as much on factors such as design, economics, branding, and consumer understanding and changing behaviour. Innovations in the form of new products, processes and services will inevitably occur at a faster rate when technical feasibility is allied with an understanding of cultural and social change. Thus, the sciences, technology, arts, humanities and social sciences complement one another; they do not exist in a hierarchical relationship. Furthermore, the boundaries between the natural sciences and the social sciences and humanities are becoming increasingly fluid as research at the frontiers of knowledge become increasingly inter- and multi-disciplinary. If we are serious about identifying national priorities and making new investments in solving global problems, we will need to retain a comprehensive research capacity and make greater effort in trans-disciplinary initiatives. This in turn will require resources to be allocated in such a way as to sustain a comprehensive research capacity, and enable flexibility and inter-disciplinarity to flourish.

6.3 Whilst ring-fencing can have a role to play, it is essential that strategic decisions on research support are not set by measures and mechanisms constrained by the short-term. Setting research budgets should be done according to the national value placed on their outputs and consequences, and tensioned properly against other priorities.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–14: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

7.1 Many of our member institutions experienced pressures of falling demand a few years ago, particularly in the subjects of Mathematics, Physics and Chemistry, which in a number of cases resulted in closure of these departments. However, there has been improvement in this area in recent years, which has been aided by the Government's investment framework. We have seen some positive effects from STEM initiatives in schools resulting in a growth in interest in these areas, combined with extensive efforts of institutions to preserve this activity, which has led to an upturn in activity and in students applying, entering and graduating in STEM subjects.

7.2 It is also essential that we monitor the extent to which these students progress to Master's and doctoral levels, as our nation is in need of people with the highest level skills, particularly in light of the challenges of the recession and the global economic situation.

7.3 Finally, it is necessary to acknowledge the need for high-quality graduates in all subject areas (arts, humanities and social sciences, as well as STEM subjects). It is vital to remember that non-STEM subjects contribute very significantly to Intellectual Property and to UK PLC.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

8.1 We do not accept the principle of accepting unfunded student numbers, due to the impact this has on the unit of resource for teaching and the subsequent impact on the quality of the student experience. The majority of our members refused the extra student numbers offered in July 2009 because they were unfunded.

Some HEIs did accept a small number of places due to the fact that they had a clear strategic need for them. These were in STEM courses but also the broader disciplines eligible under the scheme, which aligned to the New Industries New Jobs disciplinary categories.

8.2 We support the allocation of additional student numbers on the basis of demonstrable excellence (in quality and outcomes) in all subject areas, however it is essential that these places are fully-funded in order to ensure that there is no dilution in the unit of resource for teaching and no subsequent decay in the quality of the student experience.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

9.1 The high quality academic experience delivered in the UK is under threat as student numbers have risen, coupled with rising expectations and increased costs. Universities are struggling to fund their activity in a sustainable way, and this will be a significant threat to the quality of their delivery if the issue is not addressed. The Financial Sustainability Strategy Group reported early last year that the sector was already papering over the cracks in the delivery of the student experience, and that universities need an additional 20% funding for current teaching levels to be sustained. Without further investment the "quality of the student experience and the reputation and contribution of English higher education will suffer".[20] UK universities remain the most productive in the G8 and rank second only to the US in the world ranking despite the fact that investment in UK higher education as a proportion of GDP hovers between 1.3% and 1.4% below the OECD average, and half that of the US (at 2.9%). Moreover, our competitors are increasing their relative investment in HE as we slip back.

9.2 The current unit for funding for SET subjects is already at a dangerously low level. We would suggest that in recent years it has been increasingly difficult to maintain the technical support base for SET teaching, to maintain teaching equipment at the level required and to maintain practical class size levels at sensible levels.

9.3 Therefore cuts in the unit of resource will clearly have a significant impact on the quality of the student experience in high cost SET subjects, which will result in a deterioration of the infrastructure and worsen staff/student ratios. For example:

(i) larger class sizes, as a result of a poorer staff/student ratio, will make certain types of laboratory work, which requires intensive supervision or specialist small laboratory facilities, near impossible or at least very costly to teach. This may lead to an unintended effect on the STEM curricula; and

(ii) in field based disciplines such as Geology and Geography, a poorer staff/student ratio and a loss of resource may impact on the number and quality of field courses that are currently on offer, due to shortages in staff who could supervise the students abroad, leading to a narrower learning experience.

9.4 Any impoverishment of the student experience is an area of great concern, in particular as student expectations continue to rise. Universities need long term sustainable funding if they are to continue to maintain the quality of the academic experience at world-class levels and continue to enhance the student experience and develop highly skilled, knowledgeable and well-rounded graduates.

Witnesses: **Professor Michael Arthur**, Chair, Russell Group; **Professor Janet Beer**, Chair, University Alliance; **Professor Les Ebdon**, million+; and **Professor Paul Wellings**, Chair, 1994 Group, gave evidence.

Q131 Chairman: Good morning and welcome to our panel of expert witnesses this morning in this inquiry into the impact of spending cuts on science and scientific research. Our main interest is not in the broader higher education system and the impact of cuts on it; it is very much focused at science, technology and engineering in the university sector. Clearly any cuts in the sector have an impact in those areas, we understand that, but principally we are interested in what is happening in terms of science and engineering. Could each of you say briefly, as far as your organisation is concerned, what your involvement is with science, particularly the teaching of the next generation of scientists?
Professor Arthur: Thank you and good morning. We are a large university with a broad range of science activity, biological sciences, medicine, engineering, the full range of physical sciences, earth and environment, so five of our nine faculties are science-oriented. We have a research turnover of about £110 million per annum of which the vast majority, three-quarters perhaps, would be in those science faculties.

Q132 Chairman: You represent the Russell Group here this morning. Is it typical across the Russell Group that that sort of proportion of activity is in STEM?
Professor Arthur: It would be typical but not universally so. There is the London School of Economics with social sciences, so there are some variations on the theme but generally a large science activity.

Q133 Chairman: So any cuts in the science budget will seriously affect the universities that you represent?

[20] The Financial Sustainability Strategy Group report for HEFCE "The sustainability of learning and teaching in English higher education" http://www.hefce.ac.uk/Finance/fundinghe/trac/fssg/

Professor Arthur: Very much so.
Professor Beer: Good morning. The Alliance is 22 major dynamic institutions that are at the heart of the sector. They are business focused but also produce world-leading research. If I can give you some idea of the numbers of students that we have in the sector with three percentages. Alliance universities educate 26% of students in HE. Nearly 22% of all the students studying STEM disciplines are in the Alliance universities. About 45% of all students in any Alliance university are studying a STEM-related subject. We have benefited over the last decade from investment in science infrastructure as a group of universities and we have high-quality research, as I said, which is very much linked into business but also into the public sector.

Q134 Chairman: The million+ group?
Professor Ebdon: The million+ group has 28 subscribing universities, all post-1992 universities with significant numbers of graduates because we are often described as teaching intensive. There is a lot of STEM activity. For example, the University of Coventry has a very significant presence in engineering, and London South Bank University similarly. Some universities like my own at Bedfordshire are looking to re-enter STEM after a period of retrenchment. The University of Central Lancashire, for example, is distinguished by re-opening chemistry a couple of years ago, very successfully. We produce a large number of graduates, the majority of whom go on into either jobs in industry or the public sector, so for example in the National Health Service we produce a lot of the bio-medical scientists from our universities. We have been delighted that the last Research Assessment Exercise recognised the excellence and the world-class research going on in some parts of our group and I suppose that up until now that has countered the cuts in the quantum of research because we have had an increase in research funding because of the methodology used in the last Research Assessment Exercise.

Q135 Chairman: We are going to come back to that particular element in a minute. I am just trying to get a flavour of the different sectors. Professor Wellings, the 1994 Group?
Professor Wellings: We have 19 members, all pre-1992 institutions, and all those institutions represent a full spectrum across the sciences and some very fine science, engineering and technology departments and, rather like the Russell Group, links into health and medicine. We have a very strong portfolio in post-graduate-taught courses and a very strong portfolio of activities in post-graduate research areas as well. Those activities spread across all the disciplines so science, engineering and the health sciences well-represented across our institutions.

Q136 Chairman: Would any cuts in the general budgets—and we will come on to some more specifics on that—impact disproportionately on your members' ability to deliver the set agenda?
Professor Wellings: It is hard to know whether it would be disproportionate. The cuts as they would fall would come as part of either the block grant through the funding council or our competitiveness with the research councils. Of course the block grant is an institutional cheque that comes and it is a decision within the institution as to how they would proportion that. That would be true of all universities. Within the 1994 Group we receive something like 24% of the QR allocation that is allocated by the funding council, and so clearly if there was a substantive cut around the research funding coming from HEFCE that would then filter down to our institutions and be reflected through our institutional strategies around where there were relative changes in investment that we were having to make as a part of the strategy.

Q137 Chairman: Michael Arthur, were you in the higher education sector in 1997?
Professor Arthur: Was I in it?

Q138 Chairman: Yes.
Professor Arthur: Very much so.

Q139 Chairman: What role did you have at that point?
Professor Arthur: That is a good question. I think I was Research Director for the School of Medicine in Southampton and a Professor of Medicine.

Q140 Chairman: I say that secondly to ask you whether you feel since 1997, and particularly since 1999, investment in the university sector, and particularly investment in science, engineering and technology in universities with which you have been involved, has been significant?
Professor Arthur: Very much so. It has been a very good decade. I have been amongst those who have thanked the Government for the investment in science in higher education over that period.

Q141 Chairman: Yet in an article in the *Guardian* you said: "It has taken more than 800 years to create one of the world's greatest education systems and it looks like it will take just six months to bring it to its knees." Do you feel that is a responsible response to what has been a decade of investment and what lies ahead?
Professor Arthur: It is in part because of the investment and the subsequent potential downturn that I felt it was very important to point out the likely outcome if further cuts are visited upon the sector. I was fairly careful in that article and in subsequent correspondence to point out that my major concern was the cuts that are pending. You and I both know that in the Treasury at the moment there are a lot of people who are designing the next Budget and there are estimates of what will go on in that Budget from the Institute of Fiscal Studies for one.

Q142 Chairman: With respect, the Institute of Fiscal Studies does not run the Treasury at all and you extrapolated from the Institute of Fiscal Studies' Green Budget a 12.5% cut over the next four years. Do you think this is a responsible way to actually approach what is a difficult situation but which is based from 1997 on huge growth in the sector since then?
Professor Arthur: But huge growth that has got us to a very important international position which will be severely threatened if further cuts are visited upon us and I think it is responsible to point that out.

Q143 Chairman: Going back 800 years?
Professor Arthur: I think it is responsible to point that out and make it clear to politicians and to the public that if those cuts occur at that level there will be a devastating effect upon our ability to continue to perform at that international level, so I do think it is responsible, yes.

Q144 Chairman: You genuinely believe as a responsible academic leading the research-intensive universities that the cuts, which would not even take us back to 1997, would take us back 800 years.
Professor Arthur: That is not what I said.

Q145 Chairman: That is your exact quote, it has taken 800 years to create and it looks like it will take six months to bring it to its knees.
Professor Arthur: That is not quite the same as saying it would go back 800 years. I said that it would seriously impair our international competitiveness, and I believe that.

Q146 Graham Stringer: May I just follow that point up. Would it not have been helpful to say if the current cuts go through, followed by 12.5% cuts, which year it would take us back to in terms of the level of funding?
Professor Arthur: I do not know the precise answer to that question.

Q147 Graham Stringer: It would be useful to know that as you are talking over nearly a millennium perspective. I do not know the answer to the question but it might take us back three or four years. Would that not be a more responsible thing to say?
Professor Arthur: It depends very much on where those cuts fall of course.

Q148 Graham Stringer: Yes, but you were talking about overall funding, were you not?
Professor Arthur: I was talking about the overall funding picture, yes.

Q149 Graham Stringer: So it would be reasonable to compare like-with-like and say this will take us back to 2004/2005, would it not?
Professor Arthur: The figures I am carrying in my head—and they may be incorrect so forgive me if they are—is that about £1 billion per year extra has been put into science by this Government over this period and cuts at that level are of the order of £2.5 billion a year. According to my calculations if the further 6%, plus 6%, plus 6%, in 2011, 2012 and 2013 are visited upon the sector—

Q150 Chairman: Can you tell us where that has come from because we do not recognise those figures? Has HEFCE given you those figures? Have the research councils given you those figures?
Professor Arthur: Of course not, but we do know what the annual HEFCE budget is, we do know what the annual science budget is and we do know what the annual student budget is.

Q151 Chairman: You said 6% year-on-year for the next three years. I want to know where those figures have come from. This is a Committee that feels passionately about not cutting science at all. We want to produce a report that wants to continue investing in science and not see any cuts, but you are making assumptions which have no basis whatsoever and I want to know why you are doing that.
Professor Arthur: I have been receiving information of that nature from departmental officials. I have read the Institute of Fiscal Studies' report. I have read the interview with the Chancellor in the *Financial Times*.

Q152 Chairman: Can I ask the rest of the panel then, have you had the same discussions with the Department about 6% year-on-year cuts over the next three years; yes or no?
Professor Wellings: I have not had discussions with the Department but Michael is right the IFS study says 6.4% for the next three years—

Q153 Chairman: The IFS Study is based—
Professor Wellings: Let me finish and the £915 million that was announced on 22 December equates to 12.1% if all of that fell to the funding council. It is unlikely that all of it would fall to the funding council but that is its equivalent, so 12, plus six, plus six, plus six is a large number.

Q154 Chairman: Sorry, is that based on IFS's prediction or on the Treasury's predictions which have been given to you?
Professor Wellings: I think what is being said here is that the ultimate scale of this is £915 million, which is announced, plus the additional Fiscal Studies' calculation that would come off that base if that was the new base that we were working off, and that would then be a very substantive cut and that would take us back in funding terms an awfully long way. You can think of it another way. Currently the unit of T funding is about £4,100 from the funding council plus just over £3,000 a year on student fees. In order to maintain the unit of funding for teaching, if those cuts went through, you would have to increase student fees by 36% or if you wanted to get to the sustainable level it would go to 60%.

Q155 Chairman: Are you assuming that the £915 million that you are talking about is all revenue?
Professor Wellings: No, there is a capital item in this clearly.

Q156 Chairman: How much do you think?
Professor Wellings: I am trying to remember what the capital sum was now. I have not got it in my head.

Q157 Chairman: Because that is a significant factor, is it not?
Professor Wellings: It is but the bulk of the 915 is not capital, it is revenue.

Q158 Chairman: You think it is all revenue?
Professor Wellings: It is not all revenue but the bulk of it—

Q159 Chairman: What proportion do you think is?
Professor Wellings: Most probably 75%.

Q160 Mr Boswell: Could you say a bit about the scenario planning you have to do. Presumably, the 6% year-on-year cuts that have been talked about would be outliers as to the extreme case which led Michael to make his remarks. On the other hand, in looking realistically at the situation, and I appreciate you are not conducting negotiations even with HEFCE in the room, if not on the panel at this stage, what is the sort of level that you can contain? Given that we are looking specifically at the science resource, is there any specific protection that is required for your science departments or otherwise within that figure? In other words, when you have got to make your institution run, what can you manage without damage and is it necessary to reallocate the damage between departments in order to protect the science base?
Professor Arthur: We plan on a five-yearly cycle. We are asked to submit those plans to HEFCE each year. Of course it is quite difficult to project forward for five years but it is not too difficult to project forward reasonably accurately for the first three of those years, and of course in recent times there has been a lot of stability in HEFCE funding and some growth related to HEFCE and also to student fees and, as you have pointed out already, to the science budget. You have to make a number of assumptions in those plans which are quite complicated related to costs—pay, pensions, et cetera. You also have to make assumptions about your research income and particularly the amount of money that you would recover in full economic cost recovery and obviously how you will deploy that money in institutions. These are very complicated projections. One of the difficulties about the scenario that we are facing is the uncertainty of when cuts will fall and in which budgets against that planning scenario. I have an organisation to run which has a turnover of half a billion pounds a year and has 6,800 staff. I absolutely need to know what is happening in 2011 and 2012 in order to get 2010 right. Against that background, coming back more specifically to the science departments, most science departments in the country are on the edge of financial viability.

Q161 Mr Boswell: Presumably one of the elements is they are inherently more expensive to run than the average humanities department?
Professor Arthur: They are inherently more expensive to run but you have several streams of income. You have the teaching income. You might or might not have international student income. You have research income and QR income. If any one of those elements becomes unstable then you have difficulty achieving financial sustainability in the science departments. I suspect we might get on to this later. A cut in a research council budget and therefore a downturn in grants and in FEC is just as serious as a downturn in QR or T funding.

Q162 Mr Boswell: Can we now turn to the impact issue. To be honest, the more I think about this the less I am clear that the impact that is talked about has made an impact on me or that I can tie it down. I think it would be fair to say—and tell me if I am caricaturing this—that the four witnesses have greeted this with a degree of qualified rapture as to what this means. As we now have some HEFCE clarification, and it appears that you look back to what happened to look forward and this is the best predictor—and perhaps this is caricature but I hope not—can you tell whether the impact of research conducted in the department, say, two decades ago is really going to tell anybody about how excellent today's research is? There is something about track records, I understand, but how are we going to tie down this impact to make it something worthwhile and indeed credible to you as academics.
Professor Beer: I can do rapture. The first thing to say is we welcome some measure of impact. We need to demonstrate impact and we need to make the case for investment in universities. That is why we are here. We believe in higher education. People give their money to universities on a voluntary basis because they believe that we can do the research that ameliorates and solves problems in advance.

Q163 Mr Boswell: Can I interrupt you for a second. What worries me is that nobody is saying your activities should not be relevant, that is clear, but it is not quite clear to me how you measure what the impact is, apart from your general judgment on the worth of your institutions.
Professor Beer: This is why we think we should take it slowly. We have recommended that 15% of the balance should be impact: 70% quality, 15% environment and 15% impact because we need to ease this in. As you have already made reference to, these are things that need testing and they need testing in a variety of different discipline areas. It is clear that the impact in one area will take longer than

the impact in another. So while we welcome it, we want there to be some caution around the way in which it is used.

Professor Wellings: I am just reflecting on that. The average life-span of a project within most departments is around 15 years, so most academics involved in serious long-term activities around their area—

Q164 Mr Boswell: Is that in STEM subjects?

Professor Wellings: That would be in STEM subjects but I suspect it falls into social sciences and humanities as well. The important point about the impact debate is what was achieved as a result of the investment of government funds rather than what will be achieved. I think that is an important distinction and it is looking backwards. I think the way the funding council has devised this is to say you can make the arguments about economic impact, environmental impact or social impact or any combination of those. It is a catholic view around what impact might be. I think that is a really important step. It is not about what was the widget in the box; it is not about commercialisation; it is a much broader discussion around how did you do fine science and then find a route to its adoption as well.

Q165 Mr Boswell: Perhaps I can ask this question: is there is a danger that this will end up with more—small "c"—conservative solutions in that something that seems to have been useful a little back is now being used as a funding mechanism for research which is going forward and may or may not be related to the quality of what is going forward? Is it stuffing it into places that have a track record or is it better than that?

Professor Wellings: I think it would be better than that. I think we would be surprised at what comes out of different departments in different institutions and the types of claims that are able to be made. Let me give you a parochial Lancaster example. We are receiving a Queen's Award next week for our research on food security. It is a 20-year project that goes back to looking at how plants use water. It is now in active use around the world, in Australia, in Turkey, in Greece, in China. In China it will be part of the cornerstone for how they use water for food production for the next 20 years. I think that is a fantastic outcome for a QR investment years ago that now has promulgated into something which will change the lives of lots of people and the way we secure food. If every institution in this country can tell a story of that sort we will have done a fantastic job in arguing the use of fundamental science resources that then lead in some cases to market adoption.

Q166 Mr Boswell: Thank you and congratulations. Can I ask a final question to Michael on impact. In terms of the excellence of research, is impact, in any case, a necessary or sufficient condition for that? Can it still be good even if it has no impact at all?

Professor Arthur: It depends on whether you think the creation of new knowledge always has impact and I am slightly in that camp. It is difficult to imagine how new knowledge, if it is truly new, cannot have some impact.

Q167 Mr Boswell: Even if it does not immediately, without putting words in your mouth?

Professor Arthur: Exactly, so I think there is a relationship. One thing that I think is fundamentally important if it is going to be funding the impact assessment is it must be related to original research formed in the institution under question.

Q168 Graham Stringer: Can I just follow that up. I understand that this is a very difficult area but if you are going to assess projects and put 15 to 25% on the basis of impact, is that not necessarily going to make it more difficult for purely curiosity-driven research to get grants? To put that another way. The work that Rutherford did in Manchester and Cavendish probably had one of the biggest impacts on the 20th century imaginable. How do you think the impact of his research into the structure of the atom would have been assessed? Do you think he would have got through this assessment process for impact?

Professor Arthur: I do. I would separate very clearly in my mind the measurement of impact in the REF looking backwards to look forwards and inform QR funding from the types of assessments that the research councils are now asking scientists to put forward. It is my understanding that they are not asking them to predict the impact of their research; they are asking scientists to show that they will engage on what the pathways of engagement are to distribute their research after they have conducted it which it seems to me, considering they are consuming public money, is an entirely reasonable thing to ask people to be prepared to do. I sit on the Council of the MRC and I am also reassured that the research councils are assessing the grants on their excellence but asking for impact to go alongside that. The excellence is informing the grant-funding decision primarily, so I think Rutherford would have been funded.

Q169 Graham Stringer: We had a distinguished physicist here last week who said he found it next to impossible to work out impact in the future. He simply did not know how to assess research projects in that way. Do you think he is wrong? Do you think he is failing in what he is doing?

Professor Ebdon: My understanding from talking to people who were actually around when Cavendish was doing that experiment was that there was enormous excitement on the campus at the time, that the students knew what was going on, and it was impactful on the teaching environment at that time. Of course much research is impactful on the teaching environment, and if we are going to have high-quality, world-class teaching in this country then it is important that it is done alongside impactful research. I understand that the atmosphere on that campus at that time was quite electric. People knew

what was going on but nobody actually knew what would happen when you split the atom, much as people got a bit excited about the Hadron Collider until it broke down. We need to put research in universities in the context of teaching and the impact that research has on teaching.

Q170 Dr Naysmith: Can we move on to the support for 10,000 STEM places announced last year. I was going to ask if it brought any benefits, but since three of you on the panel have been rather sniffy about the offer in various ways, which we will come to in a minute, can I ask Professor Beer whether she thinks it has brought any advantages?
Professor Beer: They were managed in most institutions either within the tolerance band or in terms of distributing numbers through use of the block grant. Obviously there are issues around unfunded numbers. None of us wants unfunded numbers. We want to protect the student experience. One of the things we have not spoken about this morning is the fact that the benefits of a research environment accrue to students at under-graduate as well as post-graduate level. They are benefiting from research-informed teaching and the kind of projects they undertake are always highly valued by the kind of employers for whom they go on to work and can make a substantial difference, particularly in the STEM subjects.

Q171 Dr Naysmith: Did anybody study science who would not have studied science because of the 10,000 extra places?
Professor Beer: It certainly allowed us to be discipline-specific in terms of the ASNs.
Professor Ebdon: The impact was tremendous: 10,000 students who would otherwise have not had an opportunity to come into higher education, so for them it was terrific.

Q172 Dr Naysmith: Do you think it actually got people who would not have come otherwise?
Professor Ebdon: There would not have been places otherwise for them. We had a cap on last year and therefore these were 10,000 additional students who otherwise would not have been able to study. It was slightly counter-intuitive to direct them towards the most expensive parts of the university but having made that commitment as a vice chancellor, and other vice chancellors, to take on additional students without funding, okay, we could do it within the tolerance band and therefore it was not really different to other years, but I think there is a sense of betrayal that we were told that the student support money had been found and now it would appear from the letters which have been exchanged that in fact that money is coming off this year's HEFCE budget. The interaction between the student support budget and the funding council money is causing us serious concern. Of course, what is of great concern this year is there could well be a quarter of a million applicants who will not get into university. There have been 106,000 more applications to university this year than previously. There were good strong increases in many STEM subjects but there will not be places for those students and no way in which we can create additional places ourselves this year because, as you know, we are absorbing £416 million worth of cuts this year. That is the context in which we should be talking about these cuts.

Q173 Dr Naysmith: You were a bit critical that some of the subjects were excluded from it that you thought should have been included, the practice-based science subjects.
Professor Ebdon: Practice-based science subjects were excluded. Frankly, we did not understand the logic of that selective list, but any places were welcome because of the crisis we had last year, which is turning out to be even bigger this year.

Q174 Dr Naysmith: You were a bit critical. In fact, you did not welcome it at all because of the unfunding.
Professor Wellings: Within the 1994 Group our starting point was to say let us preserve the unit of teaching and not allow that to be eroded. Members of the 1994 Group had offers of about 16% of the 10,000 and we took 5% of the 10,000. Where we took them they were directed to science subjects so at Durham I think there were students there that went comprehensively across all the sciences and, at Surrey, maths, electronic engineering, chemical engineering and biosciences all benefited, so you can see that where the 5% were taken up by 1994 Group members they were specifically designated for science courses and that allowed us to add a few extra students into the classes that were already recruiting very well. It is Les's point. There were a very large number of very well-qualified students in the system last year. When universities went in and took them they were able to absorb students who were well-qualified for the courses that were on offer.

Q175 Dr Naysmith: On balance, was it a good thing or not? Professor Arthur, you were not too keen on it either?
Professor Arthur: I was not keen on it because of the unfunded nature. I have already described how every science department is on the edge financially and to take on more work without the appropriate income to support it seemed to me to be at times worrying.

Q176 Chairman: What percentage did you take?
Professor Arthur: The University of Leeds took no additional students. The Russell Group took about 400 in total out of the 10,000, in I think three or maybe four of our institutions.

Q177 Dr Naysmith: What is more important if we are trying to encourage people to study STEM subjects, the amount of financial support for students or maintaining the quality of education that they receive? Should these two be put in opposition or are they both needed?
Professor Arthur: I think both are important obviously.

Q178 Dr Naysmith: This was aimed at supporting students.
Professor Arthur: The quality of what we provide has to be of paramount importance.
Professor Ebdon: If you want to encourage more students to study STEM you have to have more places. At the moment it is an impossibility. It may be that with the £10 million that HEFCE may be able to make available that we can reorientate some of our programmes from cheaper areas of study into STEM subjects, but what is needed is investment.

Q179 Dr Naysmith: Would you be in favour of the unit of funding being realigned in favour of STEM subjects? Do you think that would be a good thing to do?
Professor Ebdon: To a certain extent. We forget that universities are funded by block grant. The funding council and the Government do not have the power (and rightly do not have the power) to intervene at the individual subject level in individual universities and they need to be aware of the law of unintended consequences. I remember the last time there were very major cuts in universities under a previous administration, they were directed against what I think was loosely called the social sciences and, in fact, they ended up by striking the sciences, the STEM subjects, quite hard because of course they are more costly and if your income is reduced, you are looking as a manager to reduce your expenditure, and expensive areas come under scrutiny more quickly than the less expensive areas. I think we need to be careful about that.
Professor Wellings: I was going to make the point that because of the way the student support mechanism works, that is an entitlement to an individual, so the first slices of the cake, of the budget, get allocated to those individuals with entitlement. The funding council then deals with what is left over. Where we take additional students, as we did last year, clearly the student support costs, which are entitlements, get drawn off first and there is a smaller proportion left to allocate, and that will be a driving variable while we have a budget system that allows those two things to intersect in that way. That is a worthwhile area to explore to say do we want to understand the full costing of student support and the full costing of supporting the funding council and then the STEM elements within it, because until we can do that, we are always going to have this boundary problem as people draw down their entitlements.

Q180 Mr Boswell: Following that, from what you have said it appears that if you operate in one area it may well come out in another because the criteria are not fully aligned. I think that is my understanding. Can I just ask you and others on the panel, there seems to be a disparity both within your representative groupings and also across the sector on take-up of these STEM students. Is this related very much to the marginal costs of the individual departments? Where people want to fill additional places it would seem to make some sense but if you have to go and create new capacity, then that is a very different matter. Is that a proper take on it?
Professor Wellings: I take a slightly different angle. I think that what you saw last year, certainly among 1994 Group members, were very successful marketing programmes that allowed students to make applications to our institutions. They were of a high quality and we made offers and because of all the constraints that were in the system when the 10,000 came in, it allowed individual institutions to make strategic decisions to move away from the risk area by taking some additional STEM students and making sure that those students who were qualified to go to those institutions and had offers actually came in successfully. As Michael said, small numbers of institutions took pockets of numbers in order to mitigate risk. That allowed an expansion of science activities within the system. That was successful because it meant that pre-qualified students at the right level got to the institutions to which they were qualified to go.

Q181 Chairman: Professor Ebdon, by my calculation, roughly 5% went into the 1994 Group, roughly 4% went into the Russell Group, so the rest, some 91%, actually went into the million + and the Alliance universities. You took the bulk of those. Next year the 10,000 places have disappeared because that was also in the grant letter. Have you any commitment to fund the existing 9,100 students that you have taken between you for the next two years? They are there for three years. They do not just drop out at the end of that first year, so what happens to their funding?
Professor Ebdon: It all depends on how a particular university works in the income allocation model because students do not arrive with a little cheque or a voucher; we get a block grant and then we allocate that.

Q182 Chairman: But is it reflected in the block grant?
Professor Ebdon: No, it is not reflected in the block grant.

Q183 Chairman: You have to carry those costs? That is the point I am making.
Professor Ebdon: We will be carrying those costs for the three-year period. When we were talking earlier about cuts to university budgets, one of the points I would have made then if there had been time would be to point out that the fixed cost base that we carry in university staffing is not something that we could change very rapidly, and of course we have a commitment for three years to the average student and therefore a cut coming down in any one year changes our income much more quickly than we can change our fixed cost base.

Q184 Chairman: I was at Huddersfield two weeks ago seeing some fantastic work going on there, but I think they felt a little miffed, if I might say so, that the wealthiest institutions, which are the Russell Group and the 1994 Group, did not take much of

this pain. Your members and indeed the million+ members took virtually all the pain and have to live with that. Were you foolish or were they very smart or are they very selfish and you are very generous? What is it?
Professor Beer: Of course we are all very smart.

Q185 Chairman: But some are smarter than others.
Professor Beer: It depends in which area you want to be smart, or indeed too smart.

Q186 Chairman: You are left holding the baby really?
Professor Beer: Not necessarily because you make adjustments year-on-year in terms of your student numbers. Recruitment is an inexact science, so in my university we have eight applications per place, and sometimes you get a rush into one discipline, students move in vintages, things go in and out of fashion, and you have to make those adjustments. It is a difficult process but we will make adjustments this year in terms of the students that we took last year. Students will not be disadvantaged in our institutions by us having taken them into areas where we felt, rationally and sensibly, we could accommodate students. It was not just science, it was business as well. Those numbers were included in there and even with 91% across 50 (28 plus 22) institutions, you are not talking about huge numbers into each institution. I can understand my colleagues in Huddersfield saying that they wanted to give the best possible student experience to those that they took in under that latitude last year, and I have every confidence that they will give them a fantastic student experience. I think those numbers were used in Alliance institutions in order to prevent universities from going into a situation where they might be fined for taking extra students, so we used them as a safety net partly.

Q187 Chairman: Were you foolish or just over-generous?
Professor Ebdon: With all due respect to colleagues at Huddersfield, you can spend your life complaining about how unfair life is.

Q188 Chairman: And they were doing a wonderful job, if I might say.
Professor Ebdon: The unit of resource that we get in post-1992 universities is generally lower than in pre-1992 but, equally, because we tend to take more students from poorer backgrounds, we spend much more of our additional fee income on bursaries. This is well-known to this Committee. That is another piece of life's unfairness. What I was thrilled about was the opportunity to transform, in our case, 120 more lives because people who come to the University of Bedfordshire have their lives changed. They have opportunities they otherwise would not have. Million+ universities as a whole take in just 8% of students whose parents are in professional and managerial classes and 17% of our graduates are. Lives are changed.

Chairman: We got the advert. I understand that. I thought you might criticise your colleagues but you never do.

Q189 Graham Stringer: Professor Ebdon, you made an interesting point a few moments ago about this is not the first time there have been cuts to universities or science funding. What lessons have we to learn from the previous round of cuts under the previous administration? Given that these cuts appear to be inevitable, is there anything that we can do better than last time?
Professor Ebdon: I think we need to, as I say, really recognise the potential of the law of unintended consequences. Clearly, if we are seeing a certain size of cut and you have a ring-fenced area, then the cut is even greater in the non-ring-fenced areas. We are seeing that working through as a result of the decision to ring-fence STEM subjects in the last RAE and that has meant a significant cut for those subjects which are not STEM subjects. As the cuts become deeper then the consequence of that can become greater. As I said, in terms of managing a university it may be that you are so destabilised by cuts that you have to take out expensive areas of provision, which is what happened, as I say, under a previous administration. I am a chemist and we saw many chemistry departments close not because that was the intention of the then Secretary of State (in some ways it was stated to be quite the reverse) but because of the economics of how universities are run, so I think we certainly need to learn from that. Particularly when we look at cuts in science funding we need to look forward strategically. We went through a period where it was extremely difficult to recruit good scientists from within our own country and we know that we have a demographic time-bomb amongst university professors and lecturers. We know that we have a lot of replacements to make. If we do not sustain the numbers of post-graduate research students in our universities then I think we will be in some difficulty, so we need to prioritise research students. We need to use the strength of the whole sector to produce doctoral students because of that looming challenge that we have.

Q190 Graham Stringer: Can we be a bit more specific about the pre-Budget cuts, not guessing what else might happen in the future. Can you give us a flavour of what the cuts announced in the Pre-Budget Report will mean? Will it mean less time in the laboratory, larger tutorial groups or a bigger impact than that?
Professor Ebdon: It is different in different universities because of the mix of funding. In my own university we have had considerable success in international recruitment and that gives us a growing income stream which shields us somewhat. However, it is quite clear in other universities that there are more acute problems and we are seeing redundancies being announced and indeed departmental closures being talked about, so that may happen in some universities. I think we will look for greater efficiencies. We are certainly looking at

shared services with other universities. If this Committee can do anything about the VAT impediment to sharing services with another university then we would all be very grateful indeed, because we have to do things more efficiently, and we need to look at saving back office costs rather than front-line costs if we can. Many other universities are slowing their capital programmes. We talked earlier as if a cut to a capital budget was somehow not really a cut.

Graham Stringer: No, but it is different.

Chairman: It is disingenuous for you to say that.

Q191 Graham Stringer: It has a different impact but it is still a cut.

Professor Ebdon: It has a different impact but, again, it is in the context of historically under-funded investment in the teaching infrastructure. Great strides have been made in improving the research infrastructure, and I think all universities have to acknowledge that, but the teaching infrastructure was next in line for improvement and that clearly is not going to happen through funding. Many universities are slowing their capital investment programme. That will damage not only the experience of tomorrow's students from this country but make us less competitive internationally. You only need to go round China to see the investment there.

Q192 Dr Naysmith: What does teaching infrastructure mean? We know big science means equipment in labs and all that sort of thing. What is teaching infrastructure?

Professor Ebdon: If you go around many of our universities' teaching laboratories they are the same as they were when I was a student. If you go around industrial laboratories they are totally transformed compared to what they were when I was a student.

Professor Wellings: I was going to come back in on what the cuts might mean. My starting point is the international context. I think I am right in saying in the last two weeks there was a note in *Science* magazine that shows that in terms of the integrated R&D taking place, Asia has now overtaken Europe for the first time, so we are in a deeply competitive area here, and for the UK it is particularly important that we think carefully about what the nature of the R&D spend is. If there are to be cuts and those fall to science, it is to the background of what happens not between universities but what happens in terms of UK plc and our competitiveness for the future. That is the first point. The second point I would make is if there are to be cuts I think it is really important that politicians then get out of the way, having said what the cuts are, and allow individual institutions to get on and make the decisions they need to make in order to have secure sustainable futures. There is no point in chasing individual institutions that might want to close department X or Y because you do need to leave space for institutional leaders and governing bodies to make those difficult strategic decisions. It would be the Government's job to think about what the scale of the cuts are and at that point to allow autonomous institutions to get on and make strategic decisions. The third point—and Les is right—is the post-graduate review is immensely important, and I think you are seeing Adrian Smith later in this process. I think that is a key area for us for the future. The final point about cuts is that they will be differential across institution, so in the 1994 Group approximately 30% of our funds come from the funding council, 16% of our funds come from international fees, and the other 50-something per cent come from domestic fees, research councils and other operating income. The research council interaction with the HEFCE cut will be immensely important for research-led universities in this country and we do need to try and understand how those two things come together.

Professor Arthur: I would like to encourage the government of the day, this Government or the next, to think strategically in how that public deficit is dealt with and to be thoughtful across the piece, across all government departments, about where it is most appropriate to make cuts. I assume that the next Government would want to lift us out of recession and therefore you can make some judgments and assessments of which aspects of public spending will actually help us come out of recession. Of course, I would make the case that higher education is an absolutely essential element of coming out of recession effectively, and therefore to cut higher education is a potential long-term mistake. I would also like to encourage people to think strategically about our international standing as a nation and where the profile of research and British higher education fits into that overall picture. Paul has already drawn international comparisons. Look at what is happening in Germany, France, China, Australia, the United States of America, where politicians are making investments in higher education in order to lift the international standing of their countries and their economies. We seem to be going in the opposite direction and that does not feel terribly strategic to me.

Q193 Graham Stringer: You made it clear in the first round of questions that you think further and deeper cuts are going to happen. What action are you taking to either stop those cuts happening or what do you think the response should be to them? Do you think if the taxpayer is not going to carry so much of the burden that students should by increasing tuition fees?

Professor Arthur: I think the key point of interest at the moment for leaders in higher education—and you can ask the others and I know you have Steve Smith coming in next—is that we would like to try and absolutely minimise any further cuts to government funding of higher education and science because of the damaging effects. I think that is absolutely critical because it is not clear at all to me where money will come from if those cuts are visited upon us. I think the politics of raising student fees just to replace government funding is a nightmare for all politicians and for the students and for us. I

think that the primary point of attack is to protect as much government funding into higher education and science as we can, for the strategic reasons that I have just outlined. There are multiple conversations going on back into BIS, into the Treasury, into Number 10 from leaders in higher education. We are enlisting the help of as many third parties as will support us. I think the CBI's evidence to the beginning of the Brown review was a good example of that. It is extremely helpful for industry to be saying that they feel higher education is important. I presume that we have only a matter of weeks because I have worked out that if further cuts are announced in the spring Budget it is very unlikely that money will ever come back into higher education and science for a very long period. That is why I think we should be very focused on that and anything that you can do to help us would be most gratefully received.

Professor Beer: I would like to draw attention to a couple of possible unintended consequences in terms of how we fund. One of the things that has happened over the past several decades is the change in patterns of work in terms of collaboration. We were talking about impact earlier and I think we have to be very careful that we do not, in a sense, impede the kind of progress that has been made in terms of not only collaboration between institutions in this country but international collaboration. We are talking about HE in the international context and we need to ensure that our colleagues have the right facilities and are able to punch their weight internationally and to carry on collaborative research. We also need to ensure that we fund excellence where we find it. If you do that you achieve concentration and that has benefit for HE plc in terms of the international dimension but it also has benefit for staff and students.

Q194 Dr Harris: To what extent would it now be sensible to concentrate almost all the research in research-intensive universities and some teaching, arguing also that teaching should be where the research is as long as there is still a geographical spread across the country?

Professor Beer: The association needs to be between funding and excellence, not necessarily volume. I think that it has been proven and we have the evidence to suggest that it is only a very few disciplines where concentration of research is associated with volume. I have a simple line here: if you fund on the basis of excellence you achieve concentration but you need to fund excellence wherever it is found.

Q195 Dr Harris: Right, but in terms of teaching, because of the way the research funding budgets go, if you do not have much in the way of research and research-active academics, do you still think that they should be funded to teach there? Do you think they should be funded to teach more or do you think, arguably, we should say let us have economies of scale and put the teaching with a geographical spread where the research is going on, wherever it happens to be?

Professor Beer: I do not believe that you can separate research and teaching. In many of our universities students are being given a licence to practise. They need to be taught by academics who are at the cutting edge of their disciplines.

Q196 Dr Harris: Les, do you agree?

Professor Ebdon: To concentrate research further—and indeed you are also talking about concentrating teaching—would be absolute madness. There is no evidence base for this whatsoever. There is no evidence base that suggests that the excellence of research is related to concentration. In fact, what evidence there is in the debate actually says that the larger a research group gets the less productive it is. You can only make an argument in very high-cost science and there, of course, the answer is to bring people together in some kind of research centre. That obviously happens in things like the Hadron Collider, and we know some of the challenges that produces. In terms of teaching, I think we impoverish students if they are not taught in a research active environment and therefore I think that you would indeed, if you concentrated research in that kind of way, damage teaching in a number of universities. Then of course you would not be able to supply the nation's need for skilled scientists and engineers in the future. A few universities cannot supply the need of this country. You need to expand, not to contract.

Q197 Dr Harris: A slightly separate question: to save money could more teaching be done by post-graduate students, doctoral students? It has been suggested. It is done; what about more of it rather than sacking staff?

Professor Ebdon: There is no question that post-doctoral students and post-graduates add to the richness of the teaching environment in many universities, but I think it almost defrauds students who are attracted to university by big-name professors if they do not ever meet them.

Q198 Dr Harris: Is there any teaching done by graduate students that is unpaid in universities in million+? If so, would that be some sort of use of fraud?

Professor Ebdon: I cannot speak for them all but I would be very confident there is not. That would be a disgrace.

Q199 Dr Harris: Are they cheaper than the lecturers?

Professor Ebdon: Yes.

Chairman: Could we come back to this crucial issue because I would like to bring Professors Arthur and Wellings in.

Q200 Dr Harris: I assume they are going to echo what has been said. Do you disagree with what Professor Beer said, Professor Arthur?

Professor Arthur: About research concentration generally? I think that there is an appropriate level of research concentration. I think it would be the view of the Russell Group that it was about right after RAE 2001. There is international acknowledgement that the RAE and the successive concentration of research funds in part drives the success of our research base internationally. That is corroborated by the World Bank, for example, who use the research concentration in this country as an example for other countries and is supported by major international researchers such as at Harvard.

Q201 Dr Harris: So where we are is okay at the moment?

Professor Arthur: Where we were after 2001 is okay. Where we are now after this year is probably okay actually. The Russell Group is very pleased about the most recent change.

Professor Wellings: I think the most recent announcements from the funding council in terms of how the resources will be allocated would move us back from 2008 to slightly more concentrated, although others who come later can speak to that. The important point about research concentration, and I said this to the previous secretary of state when I was asked to review intellectual property and research benefits, is that you can see very strong relationships between the number of post-graduate students, the number of publications that are produced, the linkage of the industry, research income from industry, intellectual property that comes out of the number of patents, all of those things are cross-correlated. We are now in a world where something like 36 universities deliver 80% of the PhDs in this country, 24 universities get 80% of the QR funding and about 20 universities get 80% of the research council funding. It tells you that some of the big expensive science is in the right place and when you map that there are at least two universities in every region of this country that are research intensive. It is hard to argue that you would want to have lots more full spectrum universities across every region of the country. It is a nice ambition to have but a very expensive ambition to get to.

Q202 Dr Harris: I am a bit confused because your written evidence says you oppose increased concentration of funding in large universities.

Professor Wellings: I am reflecting what Michael just said. The current pattern, which is somewhere between 2001 and 2008 in terms of concentration, is about right. I know for a fact that within the 94 Group institutions, 17 of the 50-something are units of assessment, 94 Group universities are the leading universities in the country, so there is some degree of concentration around some disciplines which sit amongst my members. We would be very opposed to just, say, mechanically put all the money into six universities because that structural model rather than doing what Janet said of funding excellence wherever it is found leads you into a very different space very quickly.

Q203 Chairman: That, I understood, was your position on behalf of the Russell Group. I heard you speak at the Royal Society saying that you wanted 90% of funding to go to 30 research-intensive universities, so you must believe that or you would not have said it.

Professor Arthur: I think you should quote me accurately on what I said.

Q204 Chairman: I am sorry.

Professor Arthur: I am more than happy to send people a copy of my slides. I made a very careful point to say that I was going out to one extreme to make a point in that discussion. I looked at the existing figure, which off the top of my head was something like 79% in the top 25 universities and I said, as an extreme, one might want to go to 90. I also made the point that we should not super concentrate, that the number could be 25, 30, 35, 40, but we ought to make a strategic decision about roughly what the level of concentration should be. I was also very careful to point out my support for the diversity of the sector and the fact that people further down the QR league table should be able to migrate up and down and get in and out of that top 40. I have been much misquoted, or partially quoted on that speech. I just want to put that on the record.

Chairman: We started with, hopefully, a misquote and we finish with a misquote and you have been able to put both right. Can I say it has been a really lively session. Thank you very much indeed, Professor Arthur, Professor Beer, Professor Ebdon and Professor Wellings. Thank you very much indeed.

Memorandum submitted by the Department for Business, Innovation and Skills (FC 70)

1. This memorandum covers BIS responsibilities for spend in science and research including:
   - The Science and Research Budget, including for the Research Councils.
   - HEFCE funding for research in Higher Education Institutions (HEIs) in England.

INTRODUCTION

2. The economic downturn has affected the world economy. Government, every sector and every household has had to face tough choices. As with every Government Department, BIS needs to make some savings to contribute to the unprecedented pressure on public finances.

3. The Government is maintaining its commitment to HEFCE research funding in 2010–11, given the vital importance of research to economic growth.

4. The Pre-Budget Report was not a spending review, but it does set out where efficiency savings will be needed by 2012–13. The savings will amount to 4 to 5% (£600 million) of the total Government spend on higher education and science and research.

5. Decisions on precisely how savings will be achieved across HE teaching, HE research, student support and science and research budgets will not be made in advance of Lord Browne's Independent Review of HE Funding and Student Finance. This study will report by summer 2010.

Objectives of Publicly-funded research

6. Research enables us to deepen our understanding of global issues, and this knowledge underpins a wide variety of economic outcomes. These include drivers of productivity and competitiveness including innovation and skills creation. A strong research base is crucial for our future economic prosperity and lies at the heart of many of those areas where we shall have a competitive advantage in the future—such as life sciences, advanced manufacturing & low carbon technologies. The Government seeks to secure from the research it funds the maximum benefit for society and the economy. It is committed to sustained investment in science and research—and will spend £6 billion on science and research by 2010–11, a doubling in real terms since 1997.

7. In the 1990s there were serious problems with the research base—and higher education more generally—as a result of historic underinvestment. Since then investment in the research base has: reinvigorated the physical infrastructure (through Research Capital Investment Fund [RCIF]); created a critical mass of professional capacity in knowledge transfer (through Higher Education Innovation Fund [HEIF] and the Public Sector Research Establishment [PSRE] fund); and put research funding on a financially sustainable footing.

8. Despite growing international competition, the UK remains first or second in the world at research in most disciplines. The UK's research base is now second in the G8 for excellence and is the most productive country for research in the G8.[21]

9. Continued investment in recent years has allowed this modernised research base to create exciting new organisations and alliances such as the Office for Strategic Co-ordination of Health Research [Medical Research Council/Department of Health (MRC/DH) research coordination], the Energy Technologies Institute [a public-private partnership of up to £1 billion][22] and cross-Research Council programmes on climate change, ageing and global security that deliver major benefits to the economy and society.

10. Investment in science has significantly strengthened our ability to innovate, and past investments in health, energy technologies, ICT, nano and biotechnology, materials and environmental science are now being commercialised. Our investment in science, technology and innovation is increasing our competitiveness. For example, the UK's excellent research base is a strong incentive for location of Foreign Direct Investment, for which the UK is the EU leader.[23] UKTI have used the strength of the research base to attract over 450 R&D investments to the UK between 2007 and 2009.[24]

11. Going forward, the drive toward ensuring that the UK exploits the benefits of the research that the taxpayer funds will continue. Public funding for research is governed by the principle of excellence. This means that the quality of the research, as judged by the research community, is the prime criterion for the allocation of funding.

The process for deciding how to allocate research spending

12. The process for deciding where to allocate research budgets is the same whatever the overall level of funding. Government sets high level objectives and creates incentives, informed by views from: business, charities, and co-funders of research; the Government's Chief Scientific Advisor and Chief Scientific Advisors' network; Government Departments and strategic challenges for the nation; and the research community and National Academies.

The Science and Research Budget

13. The allocation of the Science and Research budget is underpinned by a body of evidence including draft delivery plans from each Research Council. The BIS Director General of Science and Research (DGSR) has committed to Parliament that he will consult widely in the run up to the next Spending Review. The consultation will be wide-ranging and visible to ensure it is of high quality and has the confidence of the community. It will not be at the disciplinary level.

[21] "International Comparative Performance of the UK Research base" Evidence Ltd 2009.
[22] Since 2007 EPSRC has played a key role in establishing the £1 billion Energy Technologies Institute and developing its research strategy.
[23] International Comparative Performance of the UK Research Base. Evidence Ltd 2009.
[24] The implications of R&D off-shoring on the innovation capacity of EU firms, Report by LTT for PRO INNO EUROPE (2007).

14. The DGSR has asked the following bodies to provide formal advice:

— The Royal Society.

— The Royal Academy of Engineering.

— The British Academy.

— The Council for Science and Technology.

— The Chief Scientific Advisors' Committee.

— The Confederation of British Industry.

15. The process of consultation will involve the following steps:

— Early in the process, the DGSR will attend a Council meeting of each of the above bodies for a discussion around the core issues.

— Each of the above bodies will publicly submit advice to the DGSR at two stages in the process:

— Before the departmental submission is sent to Treasury.

— After the departmental allocation is received from Treasury but before the allocations to HEFCE and Research Councils are made.

16. At least twice during the process the DGSR will chair a meeting of the Chairs/Presidents of each of the above bodies to discuss the advice given in plenary. This process is already underway.

HE Research Funding

17. HEFCE Quality-related research (QR) funding for Higher Education Institutions in England is given as block grant to universities. Most is allocated by formula according to the excellence and volume of research submitted by departments in the Research Assessment Exercise (which will be succeeded by the Research Excellence Framework) with additional amounts for research degree supervision, London weighting and supporting research with charities and businesses.

18. Periodic assessment by expert panels identifies the proportion of departments' research activity meeting each of five quality levels: 4*—world-leading, 3*—internationally excellent, 2*—recognised internationally, 1*—recognised nationally, and unclassified. Funding is weighted by quality to provide greater funding for higher quality research, 1* and unclassified research attracts no funding. Following the RAE 2008, the Secretary of State asked HEFCE to maintain the proportion of QR allocated to STEM subjects, although there were larger increases in volume in some other subjects.

19. Full details of HEFCE's selective research funding system, the data which inform allocations and the allocations to institutions are publically available at: http://www.hefce.ac.uk/research/.

20. In his letter of 22 December 2009 to Tim Melville-Ross, Chair of HEFCE, the Secretary of State said that: "*Higher Ambitions made clear the Government's presumption in favour of more, rather than less, research concentration, especially in the high cost, scientific disciplines. I should be grateful for your views, in time to inform the 2010–11 allocations, on how to achieve this, alongside our commitment to supporting research excellence*".

21. HEFCE allocations for the 2010–11 academic year are expected to be announced in March.

Departmental Funding.

22. Other than the Department of Health (DH) ring-fenced budget (and the Science and Research Budget), public funds are generally not directly allocated to science and research as part of the spending review process. Spending by departments on science and research is a matter for individual departments and is driven by the policy and delivery requirements of those departments. However, in view of the importance of science and research to good policy making and delivery and reflecting the Government Chief Scientific Advisors (GCSA's) overall responsibility for advising the Prime Minister and Cabinet on the level and effectiveness of departmental investment in research and development, the Government has agreed that "Departments should consult the GCSA and HM Treasury, in advance, of any potential cuts to research budgets or expenditure, including those that have implications for the funding of cross-cutting research".

23. The Government refers the Committee to the letter of 27 January 2010 from Lord Drayson to Phil Willis, Chairman, Science and Technology Committee, on resources for science and research across government.

What evidence is there on the feasibility or effectiveness of assessing the economic impact of research?

24. A clear distinction should be drawn between economic impact assessments that are from a historical perspective and those that are forward looking. It would be difficult to try to predict the future economic impact of research as impacts can take many forms; there can be long time-lags between undertaking research and its eventual impact; and impacts may arise in unexpected ways. Assessing the economic impact of past investments in science and research can be challenging—some economic impacts are readily

quantifiable, in terms of greater wealth, cheaper prices and more revenue; some are less easily quantifiable, such as effects on the environment, public health and quality of life—but significant work has been done to develop methodologies in this area.

25. The primary report that looks at the economic impact of the UK research base as a whole is produced annually by Government, and is structured around an Economic Impact Reporting Framework, which portrays the generation of economic impacts at the aggregate economy level.[25] The Research Councils and HEFCE have also been working in this area of assessing impact from a historical perspective for a number of years. Recently individual universities, mission groups, subject areas and researchers have started to proactively commission their own work. The Russell Group have evaluated the impact of research in their universities,[26] the Wellcome Trust along with the Medical Research Council has assessed the economic benefits of medical research[27] and Oxford Economics have assessed the economic effects of fundamental physics.[28]

26. Research Councils have also recently introduced "impact" sections on grant application forms. The Councils are asking grant applicants to consider the potential for future impact they do not ask academics to predict the impact of the work. The introduction of the impact section does not signal a change of policy in the type of research the Councils will fund. It will not disadvantage basic research—excellence will continue to be the primary funding criterion. The purpose of the impact section on the grant forms is to encourage academics to think early on about potential users of their research and how they can maximise the benefits of their discoveries.

QR Funding

27. The Higher Education Funding Council for England (HEFCE) issued a formal consultation on the Research Excellence Framework (REF) on behalf of the UK's funding bodies on 23 September 2009. This consultation closed on 16 December. The REF will be the new process for the periodic assessment of research in UK higher education institutions, enabling the selective allocation of QR funding. Through the REF, the UK funding bodies aim to develop and sustain a dynamic and internationally competitive research sector that makes a major contribution to economic prosperity, national wellbeing and the expansion and dissemination of knowledge.

28. The REF will build on the success of the RAE, which is recognised worldwide as an effective and authoritative system. It incorporates important new features, particularly in recognising the impact of research of all kinds, including impacts on the economy and society, public policy and services, and quality of life. While excellence remains the most important criterion in research funding, it is right to recognise and reward the contribution that researchers are making through the impact of their work, taking account of previous criticisms that research achievement was too narrowly defined under the old arrangements. The REF does not ask researchers to predict their impacts in advance: like the RAE it will assess achievements already made, rewarding departments with a track record of working to reap the benefits of excellent research of all kinds, including "blue sky".

29. To test and develop their proposals HEFCE is currently conducting a pilot impact assessment exercise involving 29 universities from across the UK, focussing on five broad subject areas. It will run until mid 2010. The final form of the REF will take into account over 500 responses to the consultation and the pilot impact assessment exercise.

30. HEFCE continue to build the evidence base on the impact of research, and recently published a review commissioned from RAND Europe of international approaches to evaluating the impact of research in order to identify relevant lessons from international practice. They also recently published "Securing world-class research in UK universities: Exploring the impact of block grant funding". Both reports and further details are available from HEFCE's web-site www.hefce.ac.uk.

Research Council Grants

31. The excellent research funded by the Research Councils has a huge impact on the wellbeing of the UK. The Research Councils have been working hard for a number of years to improve the way that they demonstrate the impact of the research they fund. Over the last 10 years they have produced more than 35 impact studies. These studies have reflected a range of methodologies from qualitative case studies and surveys to quantitative approaches. The UK uses a more comprehensive range of techniques to evaluate economic impact than any of our major competitors. Independent experts report that the UK is ahead of the US and Canada in assessing the economic benefits of research.[29]

32. As well as through creating new businesses, improving performance of existing business and attracting inward investment there are other important routes to economic impact: improving public services and the environment can have dramatic effects on the quality of life, while benefitting the economy. For

[25] *Economic Impacts of Investment in Research & Innovation*, DIUS (2008).
[26] *The Impact of Research produced by Russell Group Universities*, Russell Group (2009).
[27] *Medical Research: What's it worth?*, Health Economics Research Group at Brunel University, the Office of Health Economics and RAND Europe (2008).
[28] *The economic impact of fundamental physics research on the UK economy*, Oxford Economics (2009).
[29] Metrics for the Evaluation of Knowledge Transfer Activities at universities (Library House 2009).

example, research into cardiovascular disease carried out from 1975 to 1992 has since saved many lives and improved quality of life for hundreds of thousands of people. But according to a recent study, it also produces an economic return on investment of 40% per year each year in perpetuity.[30]

33. As noted above the introduction of impact plans on grant application forms by Research Councils is not designed to ask researchers to predict the outcomes of their research in advance. Impact plans aim to encourage and enable researchers to consider the potential impact and user communities of their research at the earliest opportunity, alongside research creativity and scientific discovery, and for Research Councils to support them in this endeavour. This is intended to enhance and enrich the research funded by the Councils, but does not signal a change in policy in the type of research they fund. The primary criterion within the peer review process across Research Councils UK is excellent research. This has always been the case and remains unchanged.

Future steps on resource allocation

34. This Government is committed to our Higher Education sector and there has been a decade of sustained investment in the infrastructure; in supporting teaching and learning and the quality of the higher education experience and in support for science and research. Public funding has increased over the last decade so there are now more students at university and college than at any time in our history, with over 2 million students now studying. The Government is maintaining its commitment to HEFCE research funding in 2010–11, given the vital importance of research to economic growth.

35. This Government recognises that the Higher Education sector is a precious asset and a key engine of growth. Total output generated by the 169 UK Higher Education Institutes was estimated at £59 billion in 2007–08. HEIs create directly and indirectly around 670,000 jobs and create export earnings worth £5.3 billion.[31]

36. The Government's agenda for the sector over the past decade has been about far more than just increasing the quantum of public investment. The Government has created the climate to mature the relationship between universities and business, for example through supporting technology transfer, and the introduction of Foundation Degrees. The capacity has been built for universities to draw from non-state sources—from fees, from partnerships with industry, and from charitable donations; HEI income in 2007–08 totalled around £23.4 billion per year.[32]

The implications and effects of the announced STFC budget cuts

37. STFC's budget has not been cut. In the CSR07 settlement STFC's budget was increased by 13.6% over the CSR period. This includes a Near Cash real terms increase averaging 2.6% per annum.

38. However, after the CSR07 allocations there was speculation about an alleged £80 million "hole" in STFC's budget. The £80 million figure that STFC used in public in early 2008 was derived from the gap between STFC's actual budget for the CSR period (2008–09 to 2010–11) and its plans, which it drew up before it received its budget from the Department. These plans never constituted an agreed set of activities or funding for them. The suggestion that £80 million was cut from its budget is simply wrong, though it is still repeated by some in the community.

39. The gap between STFC's aspirations for CSR2007 and the actual increase it received, meant that STFC has found it difficult to get its expenditure on a sustainable trajectory. BIS has made available to the Council £40 million in loans over the past two years to assist it in achieving a sustainable trajectory. In reaching the decisions announced on 16 December 2009 STFC needed to address a residual budgetary gap of around £40 million in 2010–11 arising from the historically high levels of expenditure and the need to pay back £20 million still due from the £40 million in loans.

40. In addition, BIS has provided STFC with £42 million to cover exchange rate pressures resulting from STFC's subscriptions to international organisations such as CERN. In addition, the other Research Councils provided £14 million to STFC in 2010–11.

The process

41. STFC conducted a major, robust and transparent science prioritisation exercise, commencing in May 2009 and concluding in December 2009. The five-year £2.4 billion prioritised programme announced on 16 December 2009 was based on recommendations from the STFC Science Board and its advisory bodies, which comprise leading academics from across the disciplines supported by STFC. Other advisory bodies also provided input. The process ensured that the best science was given the highest priority. The announcement included the managed withdrawal from some projects. The detail is contained in the STFC Media Release of 16 December at http://www.scitech.ac.uk/pmc/prel/stfc/CouncilNews161209.aspx

[30] *Medical Research: What's it worth?,* health Economics Research Group at Brunel Universtiy, the Office of Health Economics and RAND Europe (2008).
[31] The Impact of Universities on the UK economy, Fourth Report (UniversitiesUK 2009).
[32] HESA Data 2009.

42. The next stage in the process will be to develop an implementation plan. The implementation stage will include discussion with relevant national and international stakeholders including universities, departments and project teams. This will include discussions with EPSRC and the University funding councils on the impact of these measures on physics departments in universities.

The scope of the STFC review announced on 16 December and currently underway

43. The objectives of the Review are to identify, by end February 2010, means of:

— establishing better long term planning for the development and use of UK and international large facilities; and

— avoiding, as far as practicable, significant in year pressures on STFC due to uncontrolled external influences, and thereby, the risk that short-term changes may be needed to balance available budgets.

44. The Review will consider:

— how better to manage overseas programme costs;

— the improved management of the exchange rate risk;

— the current structure of the STFC grant portfolio; and

— planning the use of facilities managed by STFC but available to researchers across several Research Councils.

45. The Review, undertaken with the close involvement of STFC, will engage key stakeholders from the STFC scientific community, the other Research Councils and their scientific communities, the relevant learned societies and the Treasury. The Review will also examine arrangements overseas for the funding and operation of large scientific facilities and for the equivalent of STFC research grants.

46. The Review will not consider the overall size of STFC's budgets, nor the funds allocated to particular activities within its portfolio.

Operation and definition of ring fences

47. The Government over the last 12 years has been consistent in its support for science and research. In the 10 year Science and Innovation Investment Framework 2004–2014 the Government set out its long-term policy for investment in science and research. The Government remains committed to the 10 year Framework and it is this commitment that has been vital for the growth of funding levels for science and research. How the commitment is translated into money is determined at each spending review.

48. The Science and Research Budget ring-fence and the HE research ring-fence both safeguard the implementation of the Government's commitment to research spending in the 10 Year Science and Innovation Investment Framework.

49. Ring fences are created (or confirmed) at the time of each spending review settlement. There are two relevant ring-fenced budgets for science and research within BIS both are of long-standing. These are (amounts are for 2010–11):

— Science and Research Budget £3.9 billion.

— HE Research funding £1.9 billion.

The Science and Research Budget

50. The Science and Research Budget is ring-fenced and has been for over 35 years. In view of the medium-term nature of research activities and commitments (research grants are typically for three to five years) it is important for Research Councils to have this certainty of funding. This enables effective planning of programmes and helps achieve better value for money.

51. As a separate Request for Resource, the Science and Research Budget can only fund activities which fall within the scope of the Request for Resource. The scope covers funding of "public good" research activities in the UK Research Base, which consists of (1) University research departments, and analogous bodies, (2) Research Institutes and facilities owned by Research Councils; and (3) the UK's involvement in international scientific organisations and facilities such as CERN and the European Space Agency.

52. The research funded from the Science and Research Budget covers all areas of research (for example from arts and humanities to particle physics) and helps generate the knowledge base which underpins a wide range of applications throughout the economy and the public service.

53. The Science and Research Budget does not fund industrial research and development. Support for business innovation including the funding of R&D is provided separately through the TSB.

54. Research Councils do however have a strong track record in collaborating with business, including funding academic research as part of a co-ordinated programme (for example with the TSB) involving complementary business research activities.

HE Research Funding

55. The HE Research funding ring-fence covers the Higher Education Funding Council for England (HEFCE) research budget. The ring-fence covers the block grant funding provided to English universities for Quality-related research (QR) funding of circa £1.5 billion in 2010–11. HEFCE also provides money for university research capital to maintain the physical infrastructure of universities circa £0.4 billion in 2010–11 through the Research Capital Investment Fund (RCIF). The devolved administrations provide similar funding within their own territories.

56. The HE Research Funding ring-fence is administrative which means that the funding cannot be used for any other purpose without Treasury approval. This is the standard form of ring fence used across Government; the separate Request for Resource provided for the particular circumstances of the Science and Research Budget is relatively rare.

Departmental Ring fences

57. The Department of Health (DH) has a ring-fenced Research Budget (currently just under £1 billion rising to over £1 billion in 2010–11).

58. Other than the DH ring-fenced budget (and the Science and Research Budget), public funds are generally not directly allocated to research and development as part of the spending review process. The allocation of funds to research is a matter for individual departments and is driven by the policy and delivery requirements of those departments. Further, how individual departments fund research and development in support of policy and delivery varies. Depending on what best meets their requirements, some departments choose to have central research budgets, others allocate money to research through specific policy programmes (in which case there will be no central research budget).

Implementation of the 10 Year Science and Innovation Investment Framework—is the Government meeting its objectives?

59. The Government considers that over the first five years sustained progress has been made on the main objectives of the 10 year Science and Innovation Investment Framework (SIIF) and SIIF Next Steps. Headline progress against each of the main themes in the Framework is as follows:

World class, financially sustainable research.

60. The UK research base continues to perform strongly with clear evidence that recent investments in research infrastructure have paid off. The UK Research Base remains the most productive among the large economies of the G8; it leads on publications per pound of public money and citations per researcher, and attracts a share of 14.4% of highly cited papers ahead of all competitors except the USA.[33]

Knowledge transfer

61. Knowledge transfer activities are now firmly established across the university sector and within Research Councils. Knowledge Transfer income in HEIs has grown at annualised rate of 11%, doubling in real terms since 2001 to £2.8 billion, whilst commercialisation income in PSREs grew 23% annually from 2003. The numbers of patents and spinouts generated by the UK Research Base fluctuate year on year but overall they remain at healthy levels ahead of other European Countries.[34]

Business investment.

62. Although in cash terms private sector R&D is increasing, this growth has only matched the growth of the overall economy and as a result Business R&D as a percentage of GDP remains stable. Securing an increased percentage of GDP into Business R&D remains one of the toughest challenges. The UK's strengths in the services and creative industries—where innovation is less likely to be picked up in indicators such as R&D—mean that overall the UK's innovation performance is under-stated. R&D tax credits were extended further to SMEs in 2008.

63. More details on progress are available in the 2009 SIIF Annual Report http://www.dius.gov.uk/~/media/publications/A/annual-report-2009.

64. SIIF Next Steps had a strong focus on increasing STEM participation at all levels. BIS and DCSF are working closely together to attract students to STEM subjects throughout the course of their education and careers. To this end, the Government announced a £140 million strategy in January 2008 to educate the next generation of scientists and mathematicians and to help recruit and train more science and mathematics teachers. The uptake of STEM subjects at GCSE and A level has been rising steadily since 2005, with recent growth in A Level Mathematics entries having been particularly strong (40.2% since 2005). 2009 saw a 5.3% increase in science A level entries overall relative to 2008. Entries for Mathematics were up by 12%, Physics by 3.8%, Chemistry by 2.3% and a small fall in Biology entries of −0.8%.

[33] 2009 SIIF Annual Report http://www.dius.gov.uk/~/media/publications/A/annual-report-2009.
[34] Ibid.

65. The Government is currently on course to achieve the 2014 targets in this area—indeed, the target for A level Maths has been revised upwards from 56,000 to 80,000, as the previous target had already been reached in 2008. This indicates that there is likely to be a strong future demand for science in Higher Education.

66. HEFCE run a £350 million support programme for Strategic and Vulnerable Subjects. STEM courses receive the most support for activities to increase demand under this programme. Additionally, HEFCE have also developed a £20 million national HE STEM programme to run from August 2009 to July 2012 to attract students to STEM subjects in HE. At undergraduate level during the period from 2004–05 to 2007–08, some key STEM subjects have seen increases considerably above the average for all subjects (including non-STEM). These include a rise of 18.2% for Physics, 14.0% for Mathematical Sciences, 15.4% for Chemistry, 9.6% for Biology and 4.3% for Engineering. When looking at all students currently registered on a STEM course (ie not just first years), we find that numbers are up by 3% at undergraduate level and 7% at postgraduate level in 2008–09, compared with the previous year.

67. STEM skills are an important component of the wider Science and Society agenda and are key to the work within BIS on the UK Science and Society strategy. This has key objectives to encourage greater awareness of science, technology, engineering and mathematics (STEM) careers, and to promote opportunities to engage with science and technology more generally. Independent expert groups on pre-19 science education and science for careers intend to publish their reports and action plans in spring 2010. Major Government programmes, including STEMNET, STEM Ambassadors, the STEM Programme (a joint BIS-DCSF activity), and the "Science: [So what? So everything]" campaign continue to encourage young people to consider the relevance of STEM to their lives and career prospects. Over time, these initiatives will significantly improve the availability of skills in many specialist disciplines.

68. The Government recognises the many challenges that remain over the second half of the Framework—to raise levels of investment in R&D and to build on the recent encouraging rises in the take up of STEM subjects at all levels of the education system—but remains committed to its long term vision for science and innovation.

The Government announcement of 20 July 2009 for 10,000 higher education places for students in science, technology, engineering and mathematics courses

69. On 20 July 2009, the Secretary of State announced an increase in funds for student support to support 10,000 additional students in higher education. In response to the demand they had experienced, institutions indicated to Government that they were able to support additional students without compromising the quality of their offer. Government therefore provided financial support to enable an extra 10,000 full time undergraduate student places for 2009–10, in courses to support our New Industry, New Jobs agenda. Places in sectors such as digital industries, the low carbon economy and advanced manufacturing, together with business services that would lead the way in the recovery. No additional teaching grant accompanied these extra places.

70. A range of institutions bid for these places and HEFCE Circular 17 sets out the names and distribution of places for those who had successful bids. http://www.hefce.ac.uk/pubs/circlets/2009/cl17_09/

71. Data from UCAS for 2009 entry illustrated a welcome increase of around 8% in accepted applications for engineering and maths related studies in institutions across the UK.

Strategy for increasing uptake of STEM subjects amongst undergraduates

72. In Higher Ambitions, the Government set out its strategy for increasing the uptake of STEM subjects at undergraduate level, and for supporting universities in the modernisation of STEM programmes.

73. In doing so, it is looking to build on a track record of recent success. STEM subjects have become increasingly popular with students in recent years as the impact of long-term initiatives to stimulate interest in the sciences at school level begins to be felt.

74. There are three main elements to the Government's proposals for STEM studies at undergraduate level in *Higher Ambitions*. The first is to provide space for growth in STEM student numbers as demand increases, in a tighter fiscal climate over the next decade. Whilst block grant funding for universities will continue, this should be accompanied by public funding that is contestable, with universities being funded to provide the programmes that best meet the nation's high levels skills and knowledge requirements. Universities can only expect to grow via public funding routes if they can successfully compete for such contested funds. STEM subjects—together with other disciplines that will equip strategic sectors of the economy with the highly skilled individuals they need—will be a priority for such contested funding. This principle was followed when HEFCE were asked to allocate the additional 10,000 places announced in July 2009 to STEM and other priority disciplines. In addition, the Council have been asked to be proactive in supporting Strategically Important and Vulnerable Subjects (SIVS), monitoring the balance between supply and demand to maximise capacity to provide for qualified applicants.

75. The second element involves asking HEFCE to maintain a funding system which does not create disincentives for universities to offer STEM provision. In particular, as part of its review of the principles that should underpin the allocation of teaching grant, the Council is looking at the fee assumption that it

makes, with a view to making it more equitable for subjects which attract higher rates of HEFCE funding. The Council will keep under review the accuracy of the subject weightings it uses to determine teaching grant. The recent efficiency savings announced for 2010–11 do not impact on HEFCE's subject weightings.

76. The third element concerns the continuing relevance of STEM programmes, through improving the dialogue between businesses and universities about labour market needs. This involves improving and bringing together in one place the information that is available for potential students about their courses, including teaching methods, contact time, facilities, and how the university will prepare them for a career after graduation.

77. It is absolutely clear that a high quality student experience with excellent teaching is vital. Both Government and HEFCE are striving to protect the funds to support teaching of STEM at universities. Of course, it is up to universities themselves how many students they recruit and whether they recruit to the maximum permitted levels. Systematic over recruitment will inevitably dilute the unit of funding.

January 2010

Memorandum submitted by the Higher Education Funding Council for England (FC 50)

BACKGROUND

1. The Higher Education Funding Council for England was pleased to be invited to submit a memorandum to this broad-ranging inquiry. We have focused on those elements in the call for evidence on which we have specific things to add. We are happy to provide further comment should the committee wish.

2. The HEFCE was established by the Further and Higher Education Act 1992 as a non-departmental public body operating with a high degree of autonomy within a policy and funding context set by the Government. The Council's main function is to administer grant provided by the Secretary of State for Education and Skills. We provide independent advice to the Secretary of State on the funding needs and development of higher education. Further information about the role, policies and funding allocations of the HEFCE can be found on our web-site at www.hefce.ac.uk.

3. The annual grant letter from the Secretary of State for Business, Innovation and Skills confirmed HEFCE's budget for 2010–11 to be £7,291 million. In comparison, HEFCE's budget in 2005–06 was £6,186 million.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

4. HEFCE research funding is allocated selectively to HEIs that have demonstrated the quality of their research by reference to national and international standards. This quality assessment was previously measured by the Research Assessment Exercise (RAE) and will future be measured by the Research Excellence Framework (REF). The dominant factor for judging quality in the REF will be assessment, by expert review, of nominated outputs.

5. In the REF, we intend to recognise and reward institutions for building on excellent research to contribute to society and economic prosperity. We have consulted widely on proposals for the REF, and there is widespread support from institutions, the national academies and other key stakeholders for including impact in the REF, and for the proposed approach to assessment. Concerns were raised by some academic associations and the UCU about the potential adverse consequences of using impact as an element in assessment and that the assessment of impact should be more fully developed before it can carry a high weighting in the overall assessment.

6. We are currently running a substantive pilot exercise to develop and test the proposals for assessing impact, involving 29 institutions across the UK and 5 expert panels. We are taking the various concerns into account as we develop the method, and the results of the pilot are due in autumn 2010.

7. Our broad proposals are as follows:

(a) There will be an expert panel for each main research discipline. Institutions will submit evidence to the relevant panels and the panels will make judgements on a five-point scale about the quality of research outputs, research impact, and the research environment. The results will be used to inform QR funding allocations to institutions.

(b) Each panel will assess impacts that have arisen from research in their particular discipline, and will consider the appropriate kinds of benefits relevant to that research (whether social, economic, cultural, public policy, health, environmental or other quality of life benefits). We intend that panels will comprise of leading academics in the field, supplemented by research user representatives from the private, public and third sectors.

(c) Institutions will submit evidence of impact in the form of brief case studies, backed up by indicators where appropriate.

8. In developing our proposals we drew heavily on the existing evidence. There have been a number of studies that have estimated the impacts of research in economic terms, particularly in the health area (see, for example, M Buxton and S Hanney's work using the "payback framework"[35] or "Medical research: What's it worth?" published by the Wellcome Trust in 2008).[36] These tend to quantify the impact of particular research themes or funding programmes, and hence involve significant effort in collecting and analysing data. While the REF is a different kind of exercise (a process of expert judgement rather than quantified measurement), these studies have helped us to identify common methodological challenges and have shown how they can be overcome. In particular:

(a) Future impacts cannot be predicted and there can be long time-lags between undertaking research and its eventual impact. The REF will account for this by assessing benefits that have already arisen, from research undertaken over a sufficiently long time-frame (perhaps 10–20 years).

(b) The relationship between research and socio/economic outcomes is not linear or directly causal, and there are many intervening factors involved. It is therefore difficult to "attribute" particular socio/economic benefits to particular pieces of research. We believe that experts can make judgements on the basis that the research portfolio (considering a body of work done over a period rather than individual outputs) of an institution has been shown to have made a significant contribution to particular socio/economic benefits, without evaluating in detail the precise causal relationship.

(c) We recognise the force of argument that curiosity-driven research should be acknowledged by recognising when impact arises even though the submitting unit did not stimulate that impact.

(d) We recognise the broad portfolio of research activity within an HEI. There is no requirement for individual academics to demonstrate impact from all of their work. A selected number of case studies will represent the portfolio of activity.

9. We also commissioned a review of approaches in other countries, which reiterated the known methodological issues and found the approach developed in Australia, based on case studies, provides a promising basis for developing the impact assessment in the REF. (See "Capturing Research Impacts: A review of international practice", RAND Europe, 2009).

The differential effects of cuts on demand-led and research institutions

10. On 28 January the HEFCE Board will be considering proposed principles for the distribution of the 2010-11 recurrent grant for teaching and research. Information on individual institutional allocations will be available after the March meeting of the HEFCE Board.

11. The Secretary of State's letter of 6 May 2009 to HEFCE requested that efficiency savings were sought outside of the Science and Research budget ring fence. The annual grant letter from the Secretary of State provides for a 7% increase in research funding for 2010–11 (£1,618 million) in comparison with 2009–10 (£1,509 million).

Whether the Government is making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

12. The HEFCE's chief executive's Strategically Important and Vulnerable Subjects (SIVS) Advisory Group, chaired by Peter Saraga will be reporting to the HEFCE board at the end of January. Paragraphs 13 to 20, below, are taken from the Advisory Group's forthcoming report which we anticipate will be published in April.

13. Overall, the trend in the supply of graduates in vulnerable STEM is positive and be expected to continue to improve.

14. During the last three years, the number of students in Chemistry, Physics and Mathematics programmes in higher education has increased at a greater rate than the average across all subjects and to a level beyond that at the beginning of the decade. The latest data on A-level and entrants to higher education suggests that this trend will continue. A significant increase in students taking Mathematics A-level can be expected to have a positive impact on higher education admissions throughout science and engineering.

15. In engineering, the number of students in higher education programmes has been declining for some time, but the pattern varies between sub-disciplines. During the last three years, the number of Electrical Engineering students has declined, albeit from a large base, whereas Civil and Chemical Engineering numbers have increased at a rate well beyond the average for all subjects. Other areas of Engineering appear to be more stable, although a significant decline in entrants to Minerals, Metallurgy and Materials Engineering Programmes suggests that numbers in this area will decline during the coming years.

[35] See following website for the Health Economics Research Group's publications relating to the payback framework: http://www.brunel.ac.uk/about/acad/herg/publications/payback

[36] http://www.wellcome.ac.uk/stellent/groups/corporatesite/@sitestudioobjects/documents/web_document/wtx052110.pdf

16. Across the vulnerable STEM subjects, and particularly Engineering, the number of part-time students and the number in post–1992 institutions has declined. Students in these categories are more likely than others to be mature, in work, studying locally and from neighbourhoods with a record of low higher education participation. This suggests a limit on diversity and, in some locations, the availability of graduates in these subjects.

17. The dramatic growth in medicine and related subject areas may have had an impact on participation in other STEM disciplines. These disciplines compete for entrants with similar STEM backgrounds in terms of A-level or equivalent study. Growth in medicine and related subjects may, therefore, have reduced the pool of potential entrants to other STEM disciplines and contributed to their vulnerability.

18. Evidence from employers suggests that concerns about graduate unemployment arising from the current economic climate will be short-term. The Saraga report states that "given the consistent message from employers about STEM and changing student aspirations in this area, it will be essential for government and HEFCE to establish a means for ensuring that the upturn in student demand can be accommodated by an increase in provision".

19. Institutions across the sector are reviewing their provision in light of many factors, most importantly the current and anticipated constraints on public, private, charitable and endowment income. Although HEFCE's additional support for high cost STEM subjects, coupled with the ring-fence requested by the government for research funding in STEM subjects, will act as disincentives against closure of these areas it will be important to continue to monitor the availability of STEM provision across the country.

20. HEFCE continues to invest in activities to promote demand among students for vulnerable STEM subjects. Notable developments include the integration of four STEM demand-raising programmes into a single national HE STEM programme, which will coordinate activity throughout England and Wales, new industry standard Foundation degrees in the Nuclear, Chemical and Bioscience industries co-funded with employers.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses

21. UCAS recently published the final figures for student numbers accepted into university or college in 2009. These figures show an above average growth in the number of students accepted onto STEM courses.

22. HEFCE's annual grant letter from the Secretary of State for Business, Innovation and Skills, received in December 2009, informed HEFCE that the support for 10,000 extra students was a one-off increase in recruitment for 2009–10 only, responding to the particular needs of the time, and it will not be repeated in 2010–11. In addition it was reiterated that any over-recruitment by institution in 2010–11 could again result in a transfer of HEFCE grant back to the Department in this or future years.

The effect of HEFCE cuts on the "unit of funding" for STEM students

23. See paragraph 10 above. Information on the unit of funding will be available after the March meeting of the HEFCE Board.

Memorandum submitted by Universities UK (FC 68)

1. It is crucial that science and research remains a top political and public investment priority for the UK even within the context of tight public finances. Funding for science and research is a high value, high return investment for the country. The importance of science and research was clearly stated in Lord Sainsbury's report, *Race to the Top*.

2. The current Government's 10 year science and innovation framework and associated investment has been extremely good news. Now is the time for all political parties across the UK to renew and enhance their commitments to science and research. The success of our economy and ability to respond to the biggest global challenges will rest on the decisions we make now.

3. We are pleased that the Prime Minister recognised the importance of science and research in his Romanes Lecture in early 2009 stating that "the downturn is no time to slow down our investment in science but to build more vigorously for the future". The recent higher education framework *Higher Ambitions* reflects this, but does signal some challenges.

4. The protection of the science budget through the "ring fence" has been very welcome, as has the recent commitment to protect the levels of quality rated research (QR) provided by HEFCE in England. It must be noted, however, that the sector and funding bodies will be required to find significant efficiency savings across the board and the higher education budget is going to face considerable cuts that will put universities in England under severe pressure.

5. The sector will not be able to deliver more with less without compromising our longer-term sustainability and international competitiveness. The government must avoid sacrificing the long-term interest in favour of short term aims, particularly as serious stimulus investment in research and education is currently being made by many competitor governments.

6. Before moving on to consider the questions posed by the Committee we would like to request that by "science" you consider "knowledge" in all its forms. As others have pointed out, even if you take a priority such as climate change, where technological advances will be crucial to our response, the arts, humanities and social sciences will have a vital contribution to make, for instance in understanding and working out how to change patterns of consumption. In focusing research effort, we must be wary of closing off the broad contribution that a range of disciplines could make.

7. It is also important to note that QR or its equivalents may be allocated differently in Devolved Administrations through the Scottish Funding Council for Further and Higher Education (SFC), HEFCW or DELNI. These bodies may also support research in universities through other funding streams which differ from HEFCE's. Thus any comments on HEFCE funding or policy should be taken as relevant only to English HEIs.

The process for deciding where to make cuts in SET spending

8. We strongly support the Government's continued adherence to the Haldane Principle that research decisions should be made by researchers rather than politicians. Although we recognise that tough decisions about funding for science and research will need to be made in the coming years, we would urge against any direct political intervention.

9. At present the science budget is ring fenced and allocated for a three year period. Given the longer term and strategic nature of investment in research, pressure for short term cuts and savings is unhelpful, as it means less effective investment and a pulling back from commitments already made. UUK would urge for a continuation of the ring fence and the three year allocation.

10. The science budget is under considerable pressure with the Research Councils required to find significant efficiency savings (£106 million announced in Budget 2009). Research Council savings will be "recycled" within the science budget. As of yet unspecified savings will be required following the announcement in the Pre Budget Report that £600m will need to be found from the HE and science budgets.

11. The Research Councils are already making progress to meet these challenges, though we would express grave concerns that the requirement for increasing savings will have a detrimental effect on the science base.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

12. It is perfectly right for government, both national and devolved, on behalf of the public, to challenge the sector on how the huge public investment in research in the university system is benefiting society and the economy. Within the context of tight public funding and making the argument for sustained investment in the research base, it is particularly important that we are able to demonstrate the value of this investment.

13. The nature of research and academic inquiry means, however, that moves to encourage and demonstrate impact are far from straight forward. Challenges include the fact that research impact is in many instances not easy to predict, can rely on factors outside of the control of researcher or institutions, will vary across disciplines, or can have long lead times. The UK research base also has a diverse range of funding sources which each provide opportunities for policy intervention, which needs to be coordinated if it is to be effective.

14. Although recent moves by the Research Councils, and by the Funding Councils through the Research Excellence Framework (REF), have been relatively joined up and sought ways to address the challenges mentioned above, these developments have inevitably raised understandable concerns. These developments have led to accusations that include the emergence of an "instrumentalist" approach to funding research and that there is too great a focus on research as an economic driver. Underpinning many of these concerns is the fear that this will ultimately redirect funding away from "blue skies" research and undermine the success of the research base.

15. In reality UUK is reassured that moves by the Research Councils and HEFCE have, however, sought to foster a system which incentivises impact at every opportunity rather than seeking to redirect research funding into particular areas that have an immediate or apparent impact, economic or otherwise. In this regard the debate has, to an extent, unfortunately become distorted and artificially polarised.

16. UUK's submission to the recent HEFCE consultation on the REF, which includes details on our position on assessing impact, can be found at: http://www.universitiesuk.ac.uk/PolicyAndResearch/PolicyAreas/Pages/Research.aspx Universities Scotland's submission, while agreeing on nearly all points with UUK's makes some additional points specific to the Scottish context. It will be available shortly on their web-site www.universities-scotland.ac.uk.

17. We welcome the proposal that impact should be defined widely, including economic, social, public policy, cultural and quality of life. We stress the importance of REF outputs remaining the main element of the assessment process. We also stress that impact and environment should have the same weighting and have proposed relative weightings of 60/20/20 for outputs, impact and environment, but have asked that HEFCE gives serious consideration to relative weightings of 70/15/15 at this stage, thus giving outputs a clearer predominance.

18. We recognise that the pilots are currently exploring a number of issues and challenges involved in assessing impact and it will be important for this process to inform further development of the impact assessment element.

19. It will be important to ensure clear communication on the role and intention of the impact agenda to address misconceptions, and to periodically assess through the development of evidence whether policies in this area are achieving stated outcomes and whether the balance of incentives is right. UUK is currently in discussion with the Research Councils and other key stakeholders on the development work to guide the development of the impact agenda across dual support and other funders in a joined up way, underpinned by a clear unambiguous statement of intentions.

The differential effect of cuts on demand-led and research institutions

20. We interpret this question as a request for views on concentration of and diversity of research funding within the HE sector.

21. *Higher Ambitions* states that "excellence must remain the defining basis for allocating research funding" and that "We must use scarce resources well. In the future this should mean more research concentration not less".

22. Statements about concentration must be seen within the context of the tight fiscal environment and cuts to public funding for higher education, however, the HEFCE grant letter does state the government's desire to protect research funding. The grant letter also states a £109 million increase in recurrent research funding rising to £1,618 million in 2010–11 (c7%increase).

23. Although through *Higher Ambitions*, and subsequently the HEFCE grant letter, the issue of concentration of research funding has been defined directly terms of the HEFCE grant, it is important to note that this is also a wider issue for Research Council funding, which is highly concentrated, and for support in areas such as the provision of support for PhD training. Professor Adrian Smith will be considering the latter as part of his current Review, particularly the question of whether there is a case for concentration and critical mass to sustain excellence and ensure the challenges associated managing the costs of research degree programmes can be met.

24. UUK have stated that in some areas of PhD training critical mass may be appropriate, although UUK would not support a simplistic position where research training opportunities and support are restricted to particular institutions. There are other means to sustaining high quality provision than concentrating provision in a selected number of institutions.

25. In responding to *Higher Ambitions* UUK has stated that the selective distribution of research funding on the basis of excellence is in the best interests of the UK, and we support this, but we also need to have due regard for the long-term health, dynamism, and sustainability of the HE research base as a whole. The arts and humanities and social sciences are also particularly reliant on block grant funding and we would not want to see these areas undermined, given the important role they play.

26. UUK has undertaken numerous studies to examine this issue and inform policy. This includes work, which has examined wider trends in concentration of research funding and resources for institutions and across subject areas. Previous work to support UUK consideration of this issue includes:

- 2003—*Funding Research Diversity* (Evidence Ltd for UUK). This report examined the implications of proposals put forward by government in the 2003 HE White Paper to significantly further concentrate research funding within HE. The report found that the UK research base was performing exceptionally well and there was little available evidence to justify further significant concentration of funding within larger units, or any problems with the performance of the system that needed addressing. This underpinned the development of UUK's position that the levels of concentration in the system at the time were "about right".
- 2007—*Monitoring Research Diversity: changes between 2000 and 2005*. This report was commissioned as part of UUK's ongoing commitment to monitor the diversity in the research base. The main conclusion was that there has been a measurable overall increase in research concentration across the units of assessment featured in the study. However, it was recognised that the period under review is too short to draw any robust conclusions. This led to UUK reaffirming its previous position on research concentration.
- 2009—*Monitoring research concentration and diversity: changes between 2004 and 2007*. As part of UUK's ongoing commitment to monitor trends in this area, this report updated the previous one from 2007. This new report extends the earlier analyses by examining the data over a 14 year period up to 2007 and confirms previous trends. In the selected subjects under review, the study concludes

that the process of concentration continues although it recognises that there is still considerable diversity across the system as a whole. It recognises that the impact of the announcement of the funding allocations for 2009/10 on trends in concentration is currently uncertain.

27. Based on this work, the UUK position has been that we support the selective funding of research excellence and that the levels of concentration, as stated prior to the RAE2008 based allocations, were about right.

28. It is important to note that funding of RAE2008 has led to some redistribution of block grant funding, when looked at by institution (please see analysis in Annex A), mainly due to the nature of the new graded profile in RAE2008, which allowed for the identification of a number of "islands of excellence" which were subsequently funded in line with HEFCE policy to fund excellence wherever it is found. UUK is currently considering the implications of this position for sustaining world class research.

29. Scottish Funding Council Research Excellence Grant is less concentrated than HEFCE's equivalent QR grant. They also support the development of "research pools" and other collaborations between universities, some of which also include other partners.

The implications and effects of the announced STFC budget cuts

The scope of the STFC review announced on 16 December

30. UUK recognises that STFC has had to make some difficult decisions and reprioritise funding following ongoing financial concerns, with added pressure from the financial downturn. The announcement of its five year investment strategy on 16 December was made following consultation with the relevant communities and input from advisory bodies, which comprise leading academics from across the disciplines.

31. As this strategy, and the review announced by Lord Drayson, Minister of State for Science and Innovation, is implemented, we would stress the importance of extensive communication and consultation with the STFC community. The scope and terms of reference for the BIS/STFC review are currently unclear.

32. In taking this strategy forward we would stress the particular importance of monitoring the impact on the significant progress made to stem the decline in the number of students sitting A-level physics, and applying to study physics at university level.

The operation and definition of the science budget ring-fence and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

33. As noted above, UUK strongly supports the "ring fence" around the Science Budget and its continuation. The operation of the ring fence has been largely effective, although as noted above the requirement for further efficiency savings from the Research Councils will put the budget under considerable strain. We would support the continuation of the allocation of the science budget on a three year basis.

34. We are pleased that in the Secretary of State's grant letter to HEFCE in December 2009 there was commitment to sustain investment in QR. Together QR and Research Council funding make up the dual support system. These streams are equally important but different in nature and allocated on the basis of different selective processes. Together they support the sustainability and diversity of the research base in UK universities, so it is crucial that investment across dual support is sustained. Indeed, much effort has been made in recent years to rebalance investment levels across dual support, and it important that this is not undone.

35. We would therefore support the need for an explicit statement of commitment to sustain overall levels of investment in block grant funding in England over the coming spending period.

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

36. UUK supports the strategy outlined in the 10 year framework and believe that significant progress has been made. Notable are the significant levels of investment provided to support science and research, and in areas such as progress towards achieving a more sustainable research base through the introduction of full economic costing. As noted above, we would urge renewed and ongoing commitment to science and research be made by government and all political parties.

37. In recent years there has been a huge effort to raise the number of STEM graduates. Further momentum was given to this by the Sainsbury Review. More recently HEFCE have announced a new £20 million national programme starting this summer that aims to increase the number of students graduating from science, technology, engineering and mathematics courses. Furthermore, the University of Birmingham has been selected to host the national higher education programme for science, technology, engineering and mathematics (STEM). The university will work with the current HEFCE-funded STEM

demand-raising projects to develop the national programme, which will run from August 2009 with the objective of delivering a sustained increase in STEM graduates, and satisfy the need for higher-level skills in these subjects among employers.

38. UUK has been supportive of the HEFCE led approach to stimulate demand in key areas, as well as protecting supply in those areas deemed vulnerable whilst demand picks up.

39. Data would suggest that these initiatives are having an impact and progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates is being made (for example, Physical sciences, engineering and technology all show strong growth in the most recent year (over 5.5% and 5.4% respectively, compared to total growth for all subjects of 4.7%). It will be important that the current financial situation does not undermine these significant longer term efforts.

40. We would also suggest that we need to guard against direct political intervention whilst these efforts bear fruit.

41. The Scottish Government has included STEM disciplines in its list of priority subjects, and SFC has policies to support teaching of these subjects in universities. Furthermore, the policies and funding streams outlined above help teaching indirectly by keeping science departments viable.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses; and concern over sustainability of unfunded growth

The effect of HEFCE cuts on the "unit of funding" for STEM students

42. Despite moves over the last 10 years to reverse the significant underfunding of UK higher education, both through additional public funding and contributions from fees, the current financial position of sector remains delicate. It is questionable whether the current situation is sustainable in the longer term, particularly for teaching.

43. Recently announced HEFCE cuts, together with the prospect of ongoing constraints on public funding for higher education over the short-medium term means there is a clear need for an informed public debate about where additional resources to support higher education will be found. These issues will be considered as part of the Independent Review of Fees Chaired by Lord Browne.

44. UUK will be submitting evidence to that review, which will include an analysis of the financial situation of the sector and ongoing pressures.

45. On 20 July 2009, Lord Mandelson announced 10,000 additional ("non-ASN") full-time undergraduate places for 2009–10 in specified STEM/business-related subjects, which would not attract any additional HEFCE grant. In addition to the significant funding cuts announced recently we would suggest that these places equate to roughly £100 million of lost funding in 2009–10. Details of the how the places were to be allocated can be found at: http://www.hefce.ac.uk/pubs/circlets/2009/cl15_09/#annexes.

46. These were mostly STEM subjects (linked to the New Jobs, New industry agenda) which fall under the more expensive price groups for teaching funding allocation.

47. We do not currently have details of how the final places were allocated according to subject, but assuming a distribution of a third in the most expensive subject groups and two thirds in the second most expensive gives a the equivalent of an additional £100 million cut in funding. Variations in this distribution would take the figure from £90 million—£110 million. We do not believe that this kind of erosion in the unit of funding is sustainable.

48. *Higher Ambitions* explicitly states that priority will be given to STEM subjects "and other skills that underwrite the country's competitive advantage". The document also states that "to allow funds to be diverted to courses that meet strategic skills needs they will be diverted away from institutions whose courses fail to meet high standards of quality or outcome". Alongside this, the Framework states that HEFCE will be asked to ensure that the funding system does not create disincentives for universities to offer STEM provision, involving a review of the "fee assumption" and expanding the Strategically Important and Vulnerable Subjects (SIVS) system to support the priorities identified in New Industry, New Jobs.

49. UUK has raised concerns about the Government's increasingly narrow interpretation of "economically valuable skills", and has pointed to the importance of disciplines across the arts, humanities and social sciences in meeting the needs of the economy and society. We have also argued that student demand is the principal determinant of supply of places in HE and moves to re-engineer provision are unhelpful. The days of central planning in Higher Education are over, and this represents a thoroughly outmoded solution. Ensuring that universities remain autonomous and are able to continue to plan within their own strategic priorities is a key priority for Universities UK.

50. The responses in this section are largely relevant only to England, although any changes will have knock-on effects throughout the UK. Universities Scotland, for instance, has responded separately to Scottish Government and SFC initiatives on funding for students, and will continue to do so.

February 2010

Memorandum submitted by University and College Union (FC 11)

INTRODUCTION

1. The University and College Union (UCU) is the largest trade union and professional association for academics, lecturers, trainers, researchers and academic-related staff working in further and higher education throughout the UK. We welcome the opportunity to respond to the inquiry on the impact of spending cuts on science and scientific research. In our response we will be focusing solely on the "the feasibility or effectiveness of estimating the economic impact of research". UCU has profound academic, constitutional, and practical concerns about the economic impact agenda, particularly the current Research Excellence Framework (REF) proposals.

2. These concerns are shared by large numbers of the academic community—nearly eighteen thousand of whom signed our petition calling for the UK funding councils to withdraw the REF "impact" proposals. Amongst the signatories were six Nobel laureates, eighty Fellows of the Royal Society and over three thousand professors. Nor were they limited to the arts and humanities, a significant number of them came from the scientific community.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants);

3. Over the last few years there has been a big push by government departments and agencies to force academics to focus on the economic impact of their research. The UK Research Councils have led the way on this agenda. Applicants for research council grants now have to submit an "impact summary", answering questions about who might benefit from the research and how an economic return could be secured. In January 2009 the Government insisted that the funding councils, via the annual grant letter, steer core research funding in the same direction, ie towards greater recognition of the impact research can make on business, the economy and society.

4. From a constitutional perspective, we are very concerned about how the HEFCE impact proposals have emerged. Although HEFCE began its review of the RAE in early 2007, impact assessment did not feature until the Secretary of State's funding letter of 22 January 2009 in which he emphasised that the REF should take better account of the impact research makes on the economy and society and gave examples of the sort of activities that he favoured.

5. We believe that this represents an unprecedented, direct interference by government in the content, nature and direction of the research carried out in our universities. It has been accepted for some years that government indicates broad priority areas of research which are taken into account by the research councils when they develop their funding programmes. However, the fundamental principle at the heart of the other side of the dual support system is that research is assessed through peer review on the basis of its intrinsic quality, not the changing policies of governments or the perceived needs of business. The implications of the Secretary of State's intervention are a matter of public concern that have not been adequately examined and debated. As a result, we strongly welcome the decision of the Science and Technology Committee to include the impact agenda within the remit of the current funding inquiry.

6. From an academic perspective, the REF proposals disadvantage researchers who cannot demonstrate that their research has an immediate practical impact on the economy, but which may of course eventually have a major impact or form the basis of research by others that will do so. The reservation of this large proportion of funding for "impact" is intended to apply across all subjects. While we all want to ensure that publicly-funded research benefits our economy and society, we believe it is counterproductive for government to make funding for the best research conditional on its perceived economic and social benefits. In general, the "economic impact" agenda is founded on a lack of understanding of how knowledge advances. It is often difficult to predict which research will create the greatest practical impact. History shows us that in many instances it is basic research that has led to major advances in the sciences and humanities. Although the REF proposals seek to measure retrospective impact, there is no real consensus on the issue of "time-lags" in research, ie the lengthy gaps between undertaking the research and its impact becoming evident.

7. Few of our most celebrated philosophers, historians, mathematicians, physicists and chemists would have qualified for impact funding. Over time, the REF proposal will damage our research capacity irreparably and we will lose some of our most brilliant minds to overseas institutions, while others will be tempted to misrepresent or distort their work in order to secure funding.

8. We are concerned that impact factors will lead to the further commercialisation, and therefore narrowing, of the research agenda. Although there are references to "culture or quality of life" in the REF document, the impact agenda is most likely to focus on narrow economic goals. For example, it is noticeable how many of the impact indicators listed in the HEFCE consultation revolve around "creating new businesses", "commercialising new products or processes" and "attracting R&D investment from global business". In our view, these types of indicators are better assessed through the Higher Education Innovation Fund (HEIF) and comparable funding streams in other parts of the UK rather than through core research funding. We regret the fact that higher education is essentially being asked to fill the gap left by the low-level investment in research and development of British companies. Research outputs that attempt to understand our world should be evaluated by the quality of their contribution to human knowledge, not on their contribution to company balance sheets.

9. From a practical perspective, the REF proposals do not meet HEFCE's own primary objective in reforming the RAE. That objective was to reduce the bureaucratic burden of research assessment and to simplify the process. The current proposals require the establishment of a whole new layer of bureaucracy, including panels of experts to assess impact and corroboration of claims by "third parties".

10. It is clear that the funding council has very little idea of how to carry out retrospective assessments of research impact. In fact, one of the most extraordinary aspects of the current HEFCE proposal is that this kind of impact assessment does not seem to have been tried or tested anywhere in the world. The Australian Research Quality and Accessibility Framework (RQF) is the most worked up example of measuring impact in a higher education context. However, it was abandoned in 2007 before it was properly implemented. At the time, Senator Kim Carr, the new Minister for Innovation, Industry, Science and Research, said the "The RQF is poorly designed, administratively expensive and relies on an "impact" measure that is unverifiable and ill-defined". A recent report from RAND Europe suggests that the "impact indicators" developed within the RQF are "not sufficiently developed and tested to be used to make funding decisions" (p 55). In addition, only 10% of funding decisions were meant to be influenced by the RQF impact assessment (p 4). Consequently, HEFCE's proposal to allocate potentially 25% of Quality-Related (QR) research funds on an untested and experimental assessment of "impact", seems foolhardy in the extreme.

11. For these reasons we are calling on the funding councils withdraw the current impact proposals and work with academics and researchers on creating a funding regime which supports and fosters basic and applied research in our universities and colleges rather than one which discourages it. In terms of a specific recommendation regarding the REF, we suggest that 80% of the weighting is given to academic outputs, with the remaining 20% allocated on the basis of a revised "research environment procedure.

Witnesses: **Dr Alastair Hunter**, President, University and College Union; **Sir Alan Langlands**, Chief Executive, Higher Education Funding Council for England; **Professor Adrian Smith**, Director General, Science and Research, Department for Business, Innovation and Skills; and **Professor Steve Smith**, President Universities UK.

Q205 Chairman: Could we welcome very much our second panel today in this brief but important inquiry about the impact of spending cuts on science and scientific research. We are delighted to have Dr Alastair Hunter, the President of the University and College Union. Welcome to you, Alastair, and to Sir Alan Langlands, the Chief Executive of the Higher Education Funding Council for England, Professor Adrian Smith, the Director General of Science and Research at BIS and last, but by no means least, Professor Steve Smith, the President of Universities UK. I wonder if I could start with you, Sir Alan Langlands. There is a move to increase the use of impact as an element in assessment. Do you believe that past performance is a reliable indicator of future success, particularly in the areas of science, engineering and technology in our universities?

Sir Alan Langlands: As came up in the last session, the issue of track record is important but, of course, the proposed look at impact in the REF is secondary, in a sense, to the central question which is assessing the quality of current research outputs. That is the prime issue in the REF, as it always has been before. Impact has to be seen in that context and it has to be considered as part of the overall excellence of a particular unit or group of researchers submitting.

Q206 Mr Boswell: Would it be fair to say, Sir Alan, that you really think of it as a kind of tiebreaker? If there are a couple of projects of apparently equivalent excellence, impact might be a factor you would take into account in deciding which to back.

Sir Alan Langlands: I do not think it is a tiebreaker in terms of determining research excellence. HEFCE does not fund projects; HEFCE funds infrastructure. The research councils fund the projects. What we want to do is find a reasonably reliable way of being able to fund selectively so that the universities or the groups with the best research get properly rewarded for that. We take not just account of impact but, as I said, the prime issue is the excellence and quality of recent research outputs, ie research outputs produced in the period covered by the RAE, and we also take strong account of the environment in which people are operating, which includes some of the issues that were talked about earlier, including—critical from my point of view—the vibrancy of the PhD and the post-doc community.

Q207 Dr Naysmith: Sir Alan, do you envisage any money going anywhere different as a result of the inclusion of impact in the REF, and on what sort of scale if you do?

Sir Alan Langlands: We have no way of telling that. What we want to do, as I have said, is reward universities or research groupings that primarily have excellent research to certainly make a move in the direction of supporting and rewarding those who built on that excellent research and found ways to contribute to the economy, to society, to cultural development and public policy. This is not just a utilitarian move to do with economic good, it is wider than that and I think that will be reflected.

Q208 Dr Naysmith: So it is historical rather than predicting the future?

Sir Alan Langlands: It is certainly historical and that point has been made already this morning. The people who have to consider possible impacts in the future will be those assessing research council grants. It is perfectly reasonable for the Higher Education Funding Council, that has a long-term commitment to the sustainability of the research infrastructure, to

look back, to determine what has been achieved and to take account of that in our resource allocation process.

Q209 Dr Naysmith: You were present in the previous session so you heard Graham mentioning the very distinguished scientist who gave evidence last week who said he did not know how he was going to assess impact. He could do the science and the quality of the science, but he did not know how to contribute sensibly to estimating what an impact would be.
Sir Alan Langlands: I have had direct discussions with them and there is certainly a group of physicists who are doing very fundamental work who see difficulty in this. Of course, we are not going to try and assess impact at the level of the individual, we are going to do it in relation to research groupings through some overall assessment of the group. It is perfectly likely that the person concerned, and I do not know who it was, will be working in a group that has perhaps more applied aspects to the work who have made impacts. I spoke to a physicist in Sussex the other day who is working on very fundamental work on ion capture but he had a very clear plan and he said, "In 15 years from now this is going to revolutionise computing, it is going to take us to quantum computing if my ideas are right". I think there is enthusiasm out there, certainly amongst young scientists, to be thinking in these terms nowadays.

Q210 Dr Naysmith: What was the original purpose of reforming the RAE? How will the impact assessment contribute to achieving it? What was wrong with the previous system?
Sir Alan Langlands: I think the original discussion prompted by government was to move away from a system that included so much reliance on peer assessment of the quality of research outputs and to have, if you like, a lower burden system that depended more on bibliometrics. That was a discussion not so many years ago. HEFCE had the job on behalf of government to take these ideas forward. We consulted and there was a very strong reaction from the research and scientific community around the country and that led to the ideas around the REF which draw much more on what we think is one of the great strengths of the RAE, but introduced this new element of attempting to measure impact.

Q211 Dr Naysmith: Dr Hunter, HEFCE seems to be going a long way to consult with you in every possible way, or so we understand. Do you think you will ever be persuaded that HEFCE's and the Government's motives are pure and the right thing to do?
Dr Hunter: That is a fairly leading question but I will try to answer it. I can certainly understand the concern that impacts should be something that could be recognised. Our fundamental concerns, first of all, lie in the possibility that we should be able to predict impact and, secondly, the feature of allocating, at the moment, 25% of funding to the proposal to measure something that no-one has yet found a satisfactory means of measuring. We are certainly engaged in discussions with it and there is a consultation process. I presume that our own extensive poll indicating considerable unease within the practitioners in the sector will be taken into account. I have no problem in principle with the idea that you can look at historic impact. The difficulty with that is how it would fit into current allocations. If the historic impact relates to research done in University A, to whom do you give the credit for that 25%? Indeed, if the historic work was done outside this country, what purpose does it serve in measuring the amount of research funding that should be given to institutions here, except to say that University B was very astute in hiring so and so from the United States because they could tell that their work was good? In other words, it is the level of subjectivity in the proposals to measure impact that would be of greatest concern. That is one of the reservations about the previous RAE, of course.

Q212 Chairman: Could I ask whether, in terms of surveying your members, there is a different response depending on the type of institution that your members are working in? In other words, will you get a different response from, for instance, academics in the Russell Group universities than, say, the Alliance or million+?
Dr Hunter: I am not aware of any difference across the responses.
Sir Alan Langlands: Can I just make two points which I think are really important, and these have come up before, but Alastair said it again. There is no part of the HEFCE REF proposals that seek to predict impact in the future. He then went on to say that they are looking back at the historic position, and that is correct. The second point he made, I think an important point, was about attribution, particularly with a scientific community that moves around sometimes between institutions, sometimes between countries. That gets to some of the methodological difficulties in following this through. We have geared up a series of quite elaborate pilots to try to get precisely to the bottom of these issues, pilots of which the full results will be published and the UCU and all the other stakeholders and interested parties will be part of the discussion on the application of those pilots. If the UCU are saying that they have no problem with looking backwards at impact achieved in the research community as part of the HEFCE scheme, I think we are in agreement on that point and we can now move forward to think about some of the methodological difficulties.
Chairman: That is nice to have.

Q213 Dr Naysmith: Can I just ask Steve Smith something? What do you say to critics who think that this is just a ruse by the Treasury to get more research, more impact with less science?
Professor Steve Smith: I do not think it is about that. The danger in the debate is actually polarisation. Everyone is talking and listening and we have ended up in quite a good place on where impact is going to be assessed. UUK's position is 25% was a bit too much, 15% seemed about right to us, a difficult judgment to make. I absolutely understand, especially

given the topics that you were discussing in the previous session of evidence, that the need to justify public spending on research is absolutely paramount. Therefore, there is no pure place here, we are balancing different pressures and, thus, for me, being able to show impact, and one of the great joys of working in university is people are now telling you about the impact of their work in ways they probably did not think about before. I think that is a great public benefit, not just for science but also for academic activity to show society what it gets for the 13.2 billion a year it puts into higher education.

Q214 Graham Stringer: Professor Smith, the Government has been successful in increasing the number of students doing science at university. Do you think these cuts that are proposed will damage that progress, will send us backwards?
Professor Steve Smith: I take it you mean this Smith. If you do not like the answer, Adrian will deal with it! It is a very delicate point. Let us be clear: higher education absolutely cannot be exempt from pressures on the public pursue, that is the first point. It would be ridiculous for us to say we should not be touched. The crucial question is what is the future for the UK with or without different decisions that governments make about investment. My reading is that this Government has massively supported science, its achievements are considerable. By any evidence we have the second strongest sector in the world and probably in terms of money put in clearly the most productive. Whilst I would not want to say, "Don't touch us, we can't be cut, there aren't efficiencies"—and, by the way, the point on VAT on shared services is a really serious one to come to about how that could help—the key point is what we do not want to do. I started teaching in a university in 1976 and that was the first year of cuts we had, 3%. From 1976–98 the unit of resource for teaching was cut in real terms by 56%. Every year 2 or 3%. At no point could you stand up and say, "This is unacceptable, stop it". The key issue for us is we see the 449 million that is being cut from HEFCE's budget this coming year as one thing, but we are very concerned about where the 600 comes from and what happens if there is a March Budget and then a Comprehensive Spending Review. The quick answer to your question is, I think, the 449 is absorbable but if we go beyond that we do risk damaging one of the great success stories, one of the great national assets actually, of our country.

Q215 Graham Stringer: Do you feel we will get back to the point we were in in terms of funding in 1997? In that sense, are physics and chemistry departments going to be closing all over the country?
Professor Steve Smith: You have to make certain assumptions in the answer I am going to give. To go back to something, the assumptions do come from the IFS data on the years of spend. If you take the 449 plus the 600, and if it all came off the funding council we need to debate that, that is not obvious, the 449 clearly does, you roll investment in science back probably to the early part of this decade, so roughly to 2000/01.

Q216 Chairman: But not 800 years?
Professor Steve Smith: Maybe eight. In the previous session you questioned a lot on the IFS data. I would point out that the IFS data, as supported by the Chancellor in his interview in the *Financial Times* a couple of weeks ago, are in the same ballpark, they are only 2% apart over a three year period. We are concerned very much, and that is where a lot of our activity is going into to stop that change. That change would be very serious indeed.

Q217 Graham Stringer: I will move to the other Professor Smith. Has business been properly consulted on these proposed reductions in budgets? What is the view of business?
Professor Adrian Smith: Whatever the size and shape of the overall science and research budget, I am committed, and I think it was through John Denham when he was secretary of state in DIUS, to having high level thorough consultation with a number of bodies and their responses to that consultation will be in the public domain: the three National Academies, the CBI, the Council for Science and Technology and the group of Chief Scientific Advisors. There is a commitment to undertake a very wide-ranging consultation, of which the CBI is one part. I could say in other arenas we are conducting a review into the postgraduate landscape at the current time and of my five external advisers, one is from the CBI and one from the Council for Industry and Higher Education. From a departmental point of view we are committed to seeking business response across the board to size and shape of bodies, prioritisation, all elements of the process. That process is ongoing at the current time.

Q218 Chairman: Could I ask Professor Adrian Smith another question? Clearly there are two elements to the way in which Government funds science. Through HEFCE is clearly one area, and an absolutely crucial one, and the REF is an absolutely central part of that. In terms of the science budgets per se which are coming through you, Professor Smith, to the research councils, how secure are they in the foreseeable future? What is your response to them being allocated in a more focused way through research-intensive universities? Does the Department have a view?
Professor Adrian Smith: As I say, what we are committed to is a wide-ranging and open and transparent consultation because ultimately a lot of this is to do with prioritisation. You have to unpick that and it is quite complicated because of the landscape that is out there. We have institutions, world famous higher education institutions; we have institutes, world famous institutes run by the research councils, like the Laboratory of Molecular Biology in Cambridge; we have facilities—Diamond; we have international activities—CERN; and, of course, underlying all this we produce people through PhDs and post-docs and try to attract the brightest and the best from around the world to come to the UK. There is a very complex landscape of balancing acts among all those things. We want to preserve the international competitiveness of the research aspects

of the universities, but we have to be able to attract the brightest and the best so we have to have the facilities. You do not start off from having an ideological position on concentration, you start off by what you are trying to achieve, and if what we are trying to achieve is a preservation of international competitiveness and the sustainability of the top research universities and institutions, that might drive one to particular conclusions in particular financial circumstances, but you do not start with that as the ideology.

Q219 Chairman: I understand that. Picking up Graham Stringer's point about the relationship with business, if there is an assumption amongst the vice-chancellors, and it would seem from this panel as well, that there are going to be cuts when everybody seems to talk a different language about how crucial it is to keep up with the United States, Germany, France, Japan and China in terms of increased investments, I find that quite depressing. We are looking at, for instance, an area of bioengineering, which we are about to produce our report on, where the UK has the potential to be world leading in taking some fantastic curiosity driven science into wealth creation and what you are saying to us, Professor Smith, is we are now going to have all sorts of consultations which just seem to be a way of procrastinating whilst Rome burns. We have been talking about concentration for years.
Professor Adrian Smith: Not to mix too many metaphors, Rome is not currently burning in the research base.

Q220 Chairman: Greece, let us put it that way.
Professor Adrian Smith: The research budget has not been cut in this spending round. In the sense that you are looking ahead, the consultation is precisely about looking ahead to prioritisation in whatever circumstance we find ourselves in some months' time. I think that is a sensible way to proceed.

Q221 Chairman: Will we not have lost our edge in key areas where we are ahead of the competition?
Professor Adrian Smith: If you are saying are there very real dangers from cuts to the research budgets in all sorts of dimensions, the answer must be yes. That is why one wants to assemble the evidence base and do the consultations and bring other major stakeholders into play to identify and make clear what those dangers will be.

Q222 Chairman: I think what I am trying to get out of you, and clearly I am not succeeding—it is probably my lack of clarity—is if you are going to reduce budgets, and you seem to assume that is a foregone conclusion, and we want to remain internationally competitive, simply salami-slicing, which was what happened year after year before 1997, seems to be the most disastrous way of actually approaching what we all agree is one of the most crucial areas in terms of preserving and enhancing science and concentrating it in areas.
Professor Adrian Smith: I have heard many voices who agree with you.
Chairman: I am not getting anywhere.

Q223 Graham Stringer: If I can move on to Sir Alan. In your memorandum you recognise and describe the 8% increase in applications for engineering and maths-related studies and say there has been a growth in all STEM subjects. How confident are you that is because of the 10,000 places?
Sir Alan Langlands: I do not think the growth that we referred to in our submission has anything to do with the 10,000 places. The strategy of boosting demand and provision for STEM goes back some years. There has been huge government expenditure on this, I calculate probably in total £350 million. It was a strategy designed to deal with market failure. Students just did not want to study this and there was not the demand coming through the school system. The thing that has changed dramatically is (a) we have managed to secure provision, essentially by subsidising it, and (b) we have managed to induce demand. I think the exciting thing and one of the things that falls into the category of surely to goodness we must not lose momentum is that we now have higher numbers of young people study mathematics at GCSE and A levels than we have had for years. These are the people who are applying for university and potentially some might be disappointed. We are trying our level best (a) to ensure that these subsidies for STEM provision continue, and (b)—someone alluded to it earlier this morning—in the absence of any additional student numbers going forward we have set aside a sum for next year which in reality is a three-year commitment. It is a £10 million commitment but it is a commitment that will roll up over the three-year lifespan of students, so it becomes a £30 million commitment, to try and encourage universities to shift some of their non-STEM places into STEM. We cannot produce, as we have been consistently over the last 10 years, additional student numbers but we can provide financial incentives for universities, given this demand and the importance of these subjects to the country, to make a move from some subject areas, non-STEM, into STEM subjects at no cost to them.

Q224 Graham Stringer: That is interesting. How important was the 10,000 initiative in the desirable shift into STEM subjects?
Sir Alan Langlands: Just drawing on the discussion you had earlier, it is important to recognise that the 10,000 additional students was not solely related to STEM. The Government's running instructions on the 10,000 additional students, which was a fairly hastily contrived move and had to be dealt with very rapidly, as you know, were to encourage universities to take additional students in the areas that would support the White Paper on new industry and new jobs. That was beyond STEM. For example, within that 10,000 there were a number of business studies students and accountancy students and others who might ultimately move into the financial services sector. It was not solely STEM. We will not know for some time, but I think a significant proportion of those 10,000 students did go into STEM. That is

10,000 that over the next three years will move through the system as a pulse, these numbers will not be available to us next year as new entrants.

Q225 Graham Stringer: How does increasing the amount of money available to pay tuition fees of undergraduate applicants increase the likelihood that they will be accepted onto their courses?
Sir Alan Langlands: That is a very interesting question. I do not know, but it is a question that is probably at the heart of the Browne Review. The thing that is stopping student recruitment and has stopped the idea of additional student numbers in its tracks right now is that the student support system has run out of money. That was why HEFCE had a cut of £135 million the night before Christmas. That was what happened. The student support system cannot sustain the numbers that we were recruiting. In my view, it follows that what Lord Browne has to do is think about what the market, if you like, public opinion or student opinion will bear in relation to the juxtaposition of public funding, student support, graduate contributions and the loans system. That is the balancing act, and that will ultimately determine the extent to which we can continue to increase the numbers of people going to university.

Q226 Chairman: Dr Hunter, would it not be better, for instance, to resolve one of these problems if universities did an undergraduate programme in two years and had the students there for 48 weeks of the year so they would get a greater throughput, greater intensity?
Dr Hunter: That is probably a superficially attractive proposal, but the underlying problems are many.

Q227 Chairman: What is wrong with it?
Dr Hunter: For a start, you would have to increase the number of staff to do that unless you were going to remove from staff the present role they have in research. Secondly, not all students, particularly younger students, are capable of concentrating everything into that short a period of time. We would argue that the learning process benefits from a somewhat more expansive approach. A possibility of maturing in study over three years is significant and not irrelevant. Also, particularly in terms of STEM subjects there is a clear building upon earlier knowledge, a clear progression through stages and if you tried to cut it to two years, while the seeming savings in time and money might be attractive, the associated problems would greatly reduce any perceived benefits.

Q228 Chairman: Do you know if there is any research being done into that?
Dr Hunter: There have been a few experimental programmes of two years. I am not up to speed on what is currently going on, although I do recall reading or hearing of one a few years ago. The report was that it had some limited value, but the greater value was for mature students who, if you like, had life reasons for wanting to complete their work sooner, but it did not appear to have a wide potential application.

Q229 Chairman: Professor Smith, in terms of Universities UK, if we went to a model where we had research intensive universities and teaching-only universities, surely that would be one way of being able to deal with the funding crisis?
Professor Steve Smith: I think we need to look at some of the assumptions there. I think what is special about a university experience is being taught by people active in scholarship and research. That is a common feature. The HE experience in HE is very distinctive indeed. The problem is what is driving the cuts the university sector is facing at the moment, and they are real cuts, is, as Sir Alan has said, the student support issue. Student support this year costs 26% of the HE budget.

Q230 Chairman: If you are only supporting them for two years you save a lot of money, do you not?
Professor Steve Smith: Then you have to remember that 30 or 40% of students work during the summer vacations, work in the evenings, and they need to because if they are part-time students they do not get the student support package anyway. You really have to look at this in some detail. As Dr Hunter said, it is very superficially attractive. I actually think the costs would turn out to be quite considerable indeed.

Q231 Chairman: Have you ever done any research on this as an organisation?
Professor Steve Smith: Not personally, no.

Q232 Chairman: Do you know anyone who has?
Professor Steve Smith: Not in the UK, no.
Sir Alan Langlands: There is some work being done at the moment led by a group at Stafford University that are looking at some of the small number of cases where this has been tested. I think it would be fair to say—I have not looked at the work in detail—from what I know a lot of the issues and problems and concerns that are being expressed around the table are surfacing.

Q233 Chairman: We just do not know in reality?
Sir Alan Langlands: We do not know but I think we are systematically trying to find out.

Q234 Mr Boswell: That would be presumably within the frame of reference of the Browne Committee?
Sir Alan Langlands: It started before the Browne Committee, but it is the sort of thing that they would be interested in. You have still got to do the same amount of work in two years that you would do in three. Do the universities only get two years of fees and how is that going to work? From the point of view of this Committee, there is probably quite a serious question about the juxtaposition of teaching load and research responsibilities that would have to be taken into the equation. It is certainly worth looking into.

Q235 Chairman: Can I just say we are not advocating that, it was a question to ask what you thought.

Dr Hunter: The only other point I want to make in connection with this is that the UK is firmly signed up to the Bologna Process which has a harmonisation of approaches to higher education across Europe and if we were to go over in a major way to two year undergraduate degrees we would immediately be very seriously out of step and I do not think it would be looked on in a favourable way.

Q236 Mr Boswell: Finally, if I can come back to the overall impact of the cuts that we have been thinking about. We have been reminded in evidence today about the interaction of the student support package with block funding from HEFCE and also the overlay of research council funding, so it is a very complex picture and at this stage it is not possible to tie down precisely. We have also had evidence about the fact that the institutions are individually managed and may make decisions which are not necessarily always quite those that ministers or HEFCE might like them to make in relation to their own position. I seem to remember having said publicly in the past there are no strain gauges that can tell you when it is going to blow up. Perhaps I could start with Dr Hunter: is there a point, and if so at what point, that the cuts to university budgets collectively through the various channels you have outlined place universities, and in particular science departments, under irresistible financial pressure? Is there a point at which we really do go bang?
Dr Hunter: Like you, I think there probably is a point. If you are unable to identify it, I do not think I can either. However, I think it would be fair to say there must be institutions for which significant cuts over the next few years will place them very, very close to the edge of viability. That is in an overall sense, not specific to the science teaching side. Many of them are institutions where we most need the presence of higher education in terms of the widening access programme. They are often institutions which are not part of the process of recruiting large amounts of money for research.

Q237 Mr Boswell: They are highly teaching dependent?
Dr Hunter: Yes, and obviously with a £190 per student cut in the unit of resource institutions in that territory are most likely to be the first to reach that tipping point, if you like, explosion point.

Q238 Mr Boswell: Professor Smith, do you want to comment on this?
Professor Steve Smith: I broadly concur with that view. The crucial question really is where are the cuts identified so far going to fall. We know where the 449 is going to fall. To be fair, HEFCE has done a fantastic job of lessening the impact on frontline teaching but, frankly, I suspect all their pockets are now empty, all the specialist funds have gone, and any further reductions would have to be either on capital, which may not have an immediate effect but clearly will in time, or on the fundamental teaching resource. The key issue, of course, is the status of the PBR and the 600 million which says "on higher education, science and research". That seems to me to be not just the 7.2 billion HEFCE, not the 3.5 billion in the research council as well, but also the 2.5 billion on student support. We are trying to find out where that money will come from. At the moment, the source of those savings has not been identified. Clearly, to the extent that they largely came from HEFCE then I do think you would see institutions starting to move towards a very difficult financial position. Just be aware, HEFCE data show that broadly speaking this sector makes about 2% surplus. Institutions will save money, and you see the consequences of that in the press very much at the moment and what that means. If further cuts come—I think the fair share argument of Lord Mandelson is very well taken—we need to be sure that the fair share is the fair share because the effect of cutting further when the sector has already had an announced cut is our major worry and what would, we think, tip the sector from being a great asset to the country to one in which, frankly, we would be back to that cycle of year-on-year cuts.

Q239 Mr Boswell: I wonder if I could move to Sir Alan. Do you have a take on this? You have heard what has been said in your praise in terms of managing so far. Are the pockets now empty? Is the real problem an institutional one? Are institutions going to fall over and, if they are, perhaps the technical question on that is are they tending to be those which have the highest proportion of HEFCE funding?
Sir Alan Langlands: I am interested in the idea of your strain gauge. Just for the record, Steve has pointed out that we have done well in relation to the 449 cuts to protect the unit of funding for teaching. I think it is also worth saying, particularly in this Committee, that we have fully respected the research ring-fence so that there is a proper in line with inflation increase for research for QR. We have maintained our commitment to STEM and, indeed, increased it by producing this fund that allows student numbers to be transferred from other disciplines. Another crucial point is we have protected research capital. Right at the beginning of the session you were talking about past history. Since 2002 there has been a publicly funded element of £3.6 billion in research infrastructure which has often been multiplied through grants from charities, donors and industry. There has been a huge improvement in the research infrastructure. For me, the first point to make on the back of a 60% real terms increase in higher education spending in the last 10 years is that we are starting from a very strong place. That was not the position in 1993–94 that prompted the Dearing inquiry. He was the man who set up, if you like, the unit of funding as the barometer for the wellbeing of higher education. I think that perhaps the most frustrating thing for people working in the sector is we have got this huge momentum and huge success going on research, on learning and teaching, on student recruitment, on widening participation, and everyone is terribly frustrated that we might be ready to hit the buffers. We will not do so in 2010-11 for all the reasons I have listed. Looking beyond that, the balance of the pain, if you like, on student support, student contributions, the research and

science budgets and HEFCE funding needs to be sorted out in relation to the 600 million. I do not necessarily buy into the IFS study because I think we have a hugely important case to make that says higher education in this country is good for the country and a good investment. Having said these positive things let me make two negative points which I do not think have been covered this morning. We have rightly focused on higher education funding, but public spending cuts will also fall on the RDAs, on the NHS, on government department research funding, and these are all channels of funding into universities. Some of the major charities will suffer as a result of the recessionary effect and the market effect on their investment portfolios. There will be other reasons why universities are under pressure and it is worth taking note of these. On the other side of the coin in relation to the cost base of universities, whilst we have on all sides a hugely responsible restraint on pay to 0.5% next year, we also have pressures in relation to National Insurance contributions and huge pension pressures across this part of the public sector, so there are cost pressures bearing down in universities. The sort of surplus that Steve referred to is probably at risk for some of these reasons. For me, on your strain gauge, we are not at red yet but getting the right result on the 600 million and making the case medium and long-term for investment in science and research and higher education is critical if we want to remain competitive.

Q240 Mr Boswell: Thank you. I think I detect nods from Professor Steve Smith and others along the panel on that really very comprehensive analysis. One final point, Sir Alan. I know you have been involved in this in a previous capacity in relation to professional development. If I can link that with the access issue which Dr Hunter has already referred to, I think all of us around this Committee, and I am not identifying STEM with the professions, although there is some overlap, are interested in enabling people who have the potential to meet it. In your more general remarks, you did touch slightly on the question of the access agenda. Are you satisfied that you can safeguard that or is that under some strain, let us put it that way, with the cuts that seem to be on the horizon?
Sir Alan Langlands: I think we are under strain across the board, but we have made huge progress on access. I only know the level of government funding up until the end of April 2011, but up until then I think we are in a reasonably good place. The aspirations that the Government have on that issue, on the back of Alan Milburn's work on social mobility and earlier work that I did on *Gateways to the Professions*, which is I think what you are referring to, comes right back to the central question of how Lord Browne is going to handle these issues. A quarter of the undergraduates in UK universities at the moment are studying for the professions and they are the people who will teach our children, nurse the sick, rejuvenate our buildings and do all of the important things that society needs. These people have to represent a broad spread of the society that they belong to.

Q241 Chairman: Can you throw any light on this 600 million that nobody seems to understand, Adrian?
Professor Adrian Smith: No, other than to say the description that Steve has given that it covers student support, higher education and research undifferentiated, that is where we are and there is no further picking apart. I would say in relation to the universities that there is a slight danger in thinking of the higher education pot and the science and research pot under those separate headings. If you take the QR component directly into the universities and you take the fraction of what goes through the research councils and comes back to the universities, which is half of that pot, then two-thirds of the science and research pot comes back to the universities. In talking about the sustainability or fragility of the universities, it is not a trade-off between HE and science and research, as it were. Two-thirds of the science and research budget is fundamental to the sustainability of the higher education system.

Q242 Chairman: Can I come back to the 600 million? In a debate I had last week in which David Lammy responded on behalf of the Government, he referred to a significant amount of what was the overall 925 million, which we are talking about, this 600 million, as capital. Is that not your understanding?
Sir Alan Langlands: We do not know the breakdown of the 600 million.

Q243 Chairman: Have you asked?
Sir Alan Langlands: Yes. I do not think we are going to know. I do not think we are going to know for two reasons. To position themselves on that, the Government would have to do two things. One, it would have to say something about the research science ring-fence going beyond the current period and, two, it would be at risk of pre-empting the Browne Inquiry. I think that is why we are going to have uncertainty on that issue.

Q244 Chairman: So this 600 million is meaningless?
Sir Alan Langlands: No, it is not meaningless. It is there absolutely stark in the PBR document. There is a question about whether that will be confirmed in the Budget, but I think most people are assuming it will be. The breakdown of that has not been discussed and certainly there is no component of that that has been separated out as capital. On your question, which is really about the more immediate part of the cuts, two figures have been used this morning, one is 315 and the other is 449. 315 plus 83 plus 51 is 449. We can explain the detail of that in a note if that is helpful.

Q245 Chairman: That would be helpful, yes.
Sir Alan Langlands: The crucial point is, of that total, 135 million is a cut on capital and it is a cut on capital on T-Funding budgets. The research capital is protected. It is an 84 million cut as a result of the

Government's reductions announced just before Christmas and then the removal of another sum of 51 million that was taken back from HEFCE which previously had been held as end-year flexibility. The cut in the capital budget is 135 million. Just to make life more complicated, of course, in looking at the year-by-year comparisons of capital in budgets we have always got to remember that as part of the fiscal stimulus package into 2008–09 and 2009–10 the Government brought forward 250 million, so that makes the figures look rather worse than they are. There is going to be a 14.9% reduction in capital but with research capital protected.

Chairman: On that very simple explanation we will end this session. Thank you very much indeed to Dr Hunter, Sir Alan Langlands, Professor Adrian Smith and Professor Steve Smith. Thank you very much.

Wednesday 24 February 2010

Members present

Mr Phil Willis, in the Chair

Mr Tim Boswell	Dr Doug Naysmith
Dr Evan Harris	Ian Stewart
Dr Brian Iddon	Graham Stringer

Witnesses: **Lord Drayson**, a Member of the House of Lords, Minister for Science and Innovation, and **Mr David Lammy MP**, Minister of State for Higher Education and Intellectual Property, gave evidence.

Q246 Chairman: Could I welcome our two witnesses, Lord Drayson, the Minister for Science and Innovation, and David Lammy, the Minister of State for Higher Education and Intellectual Property. Welcome to you both, gentlemen. This is an evidence session on the inquiry into the impact of spending cuts on science and scientific research, and could I emphasise that that is our clear emphasis rather than the whole of higher education, David. We are particularly interested in what is happening to science. Lord Drayson, in your lecture at St Catherine's College, you laid out five major points about the importance of science, particularly in terms of its underpinning the economy as we move forward out of recession, in your speech on 11 February, and you said specifically that "continued investment and a stable framework so that scientists are able to get on with what they do best" was absolutely at the heart of that agenda, and yet we have heard from scientists, certainly last week, and, indeed, from vice chancellors that they are very worried that beyond 2010–11 there is huge uncertainty about where we are going in terms of spending on science. What comfort can you give them?

Lord Drayson: Firstly, I can say that I recognise that that uncertainty is real. I think it reflects the sense that the whole nation feels that we have been through, and are still going through, very tough economic conditions. We are now starting to see a recovery, but that recovery is fragile. This presents the Government with a central challenge, and that challenge is how it can implement policies to reduce the debt burden as we go forward in a way which does not upset the important drive we have to achieve towards growth. Science is absolutely central to the delivery of the achievement of that growth, and so, as we move forward in putting in place the policy responses to that challenge, what we have to do is get that balance right. What we can point to is, firstly, our track record; that this is a government which has fundamentally understood the central importance of science, it has invested in science, but I understand that there is concern and uncertainty. What I can reiterate is my very strong belief, both as Science Minister and as a member of the Government, that it is science and investment in science and innovation which is at the heart of the answer, and so, therefore, that maintenance of investment is going to be key. In the speech that I gave at St Catherine's, what I was aiming to do was to highlight what I saw as two sides to the argument, making the point that, of course, we have to maintain investment in fundamental scientific research. I believe that our track record there, the evidence shows, is excellent, but alongside that what we also have to do is improve our success in seeing the translation of that scientific excellence from pure research through to commercial application to drive jobs and growth. The future for the scientific community is one whereby the nuancing of that balance has got to be got right, and what we have to do is bring the scientific community with us as we discuss the measures which will achieve this. I am sure we will get on to talking about such aspects of impact in terms of making decisions involving research and research grants, but I think these are very important arguments which lie at the heart of getting the balance right between maintaining the drive towards reduction in debt whilst ensuring growth.

Q247 Chairman: One of the areas that we are struggling with as a Committee, and it came out in a couple of the sessions we have had already, is this report by the Institute of Fiscal Studies which has basically said that if you are going to ring-fence schools and you are going to ring-fence health, then you end up with probably a 10.9–11% reduction elsewhere in terms of spending. There is a concern about how on earth you can maintain the science ring-fence, given that sort of pressure, having said we will protect things in terms of health and education, and yet the very thing which you and your colleagues say will drive our economic growth and take us out of recession are the things that we are not going to protect. How do you protect that against a 10.9% reduction?

Lord Drayson: Firstly, we are committed to maintaining the science ring-fence; we are committed to maintaining our trajectory on the 10-year framework. What matters is what is inside that science ring-fence in the next spending review. The answer to your question, Chairman, is that, along with my colleagues, I have to make very strong arguments to Treasury and other colleagues as to why investment in science and innovation is key to the answer to driving growth. Of course, that is going to be a discussion which takes place within the decisions that are taken by the Treasury in terms of the future spending round, but I get the sense that there is an understanding of the central importance right from the Prime Minister downwards. Just earlier on in the week the Government hosted a

conference for international investors in the United Kingdom, and at that very conference the Prime Minister, Peter Mandelson and other ministers emphasised the strengths that Britain has in science and innovation and made the clear link between investment in science and innovation, the attractiveness of the UK as a place for investment, future UK competitiveness and how competitiveness was a key component of achieving growth. It is a tough argument that has to be made and that argument has to be won.

Q248 Chairman: It is a popular thing to say that we are going to protect particular areas, but there is clearly a knock-on effect elsewhere. What we did not get from any of the vice chancellors or, indeed, their organisations was any sense of protecting science within the budgets which they allocate through HEFCE, through the dual support system. Indeed, Minister, you do not seem to have made any real statement to say, "I want to see science protected in our universities even if it means something else has got to go." Is that fair?
Mr Lammy: I do not think that is fair actually. I think the essential statement of government intent in relation to higher education is contained in *Higher Ambitions* which we published in the autumn. It was a long and extensive consultation that was begun under John Denham. We asked the sector to play a role in setting out the next 10-year vision for the sector, and on page 55 we said, "Investment in science and innovation is not an intellectual luxury for a developed country; it is an economic and social necessity and an indispensable ingredient of economic success." There is no equivocation there.

Q249 Chairman: No, it is translating those words into some action. That is the key.
Mr Lammy: Absolutely. At a time where there is belt tightening I would say to the sector, look, obviously there is a political context to this discussion and the political context is, I think, that there are some vice chancellors looking a bit too closely at the polls—perhaps not the recent ones—and anticipating other governments that might do other things and sending out very strong signals about the importance of higher education, but even if you look at the savings that we asked the sector to make in the grant letter that we issued shortly before Christmas, it is clear that HEFCE have sought to minimise the effect on science and research and indeed on teaching, and the lion's share of those savings fall, in fact, on capital. I think our commitment both to the ring-fence, to the 10-year framework, reiterated again in *Higher Ambitions*, is absolutely clear.

Q250 Dr Iddon: David, I have been through a period of retraction in the universities as a chemist and I know, because I saw it happening all over the country, admittedly under a previous administration, that when vice chancellors have to save a considerable amount of money on their budgets, the non-classroom subjects in engineering and science suffer the most because those subjects are the most costly to run. The evidence is being seen all over the country at the moment. Leeds is a typical example, where the Chairman of the Russell Group is making quite savage cuts, for example, in the biological sciences department, but that is just one example of many that I could quote around the country. It worries me that science is not being protected in the universities for those reasons. Does it worry you?
Mr Lammy: I think we have to distinguish between two things, and one of the things that bears on that is autonomy. In the end the Government sets the overall framework, and that is an overall framework in which we have specifically asked HEFCE to do two things, which they are currently doing. They have a pot of money, around about £10 million, to help institutions move from other subjects to STEM areas in this next financial year. So we have a contestable fund, which we also indicated in *Higher Ambitions*, again encouraging institutions to support STEM. It is not for me to comment on individual institutions, but you will be aware that vice chancellors are also making strategic decisions based on RAE determinations—those, in some senses, predate this next spending cycle—and they are making decisions in relation to where they want to focus their institutions. Let us not conflate decisions that would have been made about particular subjects and institutions that vice chancellors and management teams have to stand behind within this next period. Yes, it is belt tightening, but we are asking the sector do it in a way that minimises the impact on science and research and on teaching.

Q251 Dr Harris: You mentioned HEFCE was directing universities to concentrate on capital cuts. What do you think is more capital intensive: scientific facilities or English language or humanities facilities?
Mr Lammy: I do not really like the either/or that you are posing there, Evan.

Q252 Dr Harris: Let me put it another way then. Which costs more to set up: a science facility or a humanities facility?
Mr Lammy: Clearly a science facility costs more.

Q253 Dr Harris: Do you think the capital cuts might fall more on science facilities than humanities facilities?
Mr Lammy: I think the context is not a year-zero moment, is it? We have invested round about £6.4 billion in capital in the last 10 years. This year we have a capital budget of over £400 million. We have brought forward £250 million from last year as a fiscal stimulus. On any account, when you compare that, say, with the upstream pipeline and the capital budget of zero in FE when we came to power and, I think, roundabout £75 million in HE, we are building on 10 years of serious commitment to capital.

Q254 Dr Harris: I do not dispute that. I know you start from a much better base than in 1997 in terms of capital investment—I accept that—but going forward I was just trying to establish the question—
Mr Lammy: It is a different paradigm.

Q255 Dr Harris: —is it reasonable to say that because you are cutting capital that protects science, from whatever the base (and I accept it is a high base compared to 1997: I just want to make that clear) but I just want to ask you whether you would reflect on whether to say "it is not science, it is capital" is really logical?
Mr Lammy: No, I think it is reasonable to say that. It is reasonable to say that on the basis of two things: (1) on the basis of 10 years of serious investment in capital and (2) on the basis of the £23 billion income in higher education, £15 billion of that being overall spend from a government or related institution, but the sector has been able to lever in beyond that an extra £7 billion and, of course, let us be clear, universities are also in arrangements with banks and other things to ensure that they can take forward capital again.

Q256 Dr Harris: I am asking you about the future and you are referring to the past. It is a good record on capital, but let us look at this ring-fence question. Lord Drayson, you said that you are committed to the science ring-fence. I want to ask you two questions: one about what that means in terms of years and, second, what that actually means in terms of what the ring-fence is. First, in terms of years, are you saying that you are committed to what is planned to be in that ring-fenced budget in years 2011–12 and 2012–13, or are you saying you are only giving a commitment to retain what is planned to be in that for 2010–11?
Lord Drayson: Yes. I think there are two important aspects of the ring-fence. Firstly, what I am saying is that we are committed to the principle of the ring-fence in having a definition of a pot of money which is specifically protected from being spent on other areas as a long-term principle beyond the current spending round. It will not be determined until we get to the budget decision on the future CSR three-year period how much money is in that ring-fence, but I think it is important for the scientific community to recognise that the principle of a ring-fence, independent of how much money is in it, is very important. There has only been one occasion—I think it was in 2007—where money was taken from within the science ring-fence and spent on something outside of the science definition. In addition, it is important that we maintain our commitment to the current CSR and then we argue for the future under CSR of maintaining the investment on the science budget at the current levels going forward. That is an argument to be made and won.

Q257 Dr Harris: I think I understand you. The principle is that once the money is allocated for that year, it cannot be raided like it was in 2007?
Lord Drayson: Exactly.

Q258 Dr Harris: If something is not currently bought by ring-fenced money and then you put that cost pressure into that budget, you apply that budget to that cost pressure currently outside, is that not equivalent to taking money out of the ring-fence to purchase the thing that was currently purchased outside the ring-fence, and do you know of any examples where that has been done recently?
Lord Drayson: I think it would, in effect, lead to the same cause. I am very focused, as is John Beddington, on monitoring what is in ring-fences, what is on the shopping list, so to speak, and I think I know where you are going with this.
Dr Harris: I do not want to spring it on you now, but perhaps you might want to write to us in advance of it being sprung to see if you can find any examples of that that will put you on the front foot.

Q259 Chairman: You are obviously aware of it.
Lord Drayson: I am very aware of it, and further investigations are taking place.

Q260 Dr Harris: Let us see if you tell us before I tell you. One last question for the Higher Education Minister. The £600 million planned future cuts are set to be decided after the Browne Review reports. Can you give an assurance—and I know this is hypothetical but I think it is a reasonable question—that if the Browne Review recommends, as it may well do, an increase in the fee that students have to pay, which is money from inside, some of that income will not be lost, effectively, by a withdrawal of government funding, not necessarily on a like-for-like basis, but some of that, because that would not all be new income then to universities? That is what is seen to be implied by linking the £600 million planned cuts to a Browne Review on whether students will pay, through increased debt, higher tuition fees?
Mr Lammy: I think the £600 million looks across the whole terrain in relation to higher education, funding, research, science. Obviously, it is an independent review. I cannot anticipate what will come out of it and, therefore, it is very difficult to get into hypotheticals.

Q261 Dr Harris: But if it suggests raising £600 million more from students through higher fees, which is at least a possibility because it is in the terms of reference, would you accept that that fee income would not be extra income to universities because of the £600 planned cuts? In that circumstance, and it is not a difficult sum, I think, you could say that there is no net increase of funding to universities because what students are giving essentially with one hand is being taken way through these savings by the other. Would you accept that mathematic?
Mr Lammy: I understand where you are trying to direct me. I am indicating extreme reluctance to get into hypotheticals.

Q262 Dr Harris: Is that really hypothetical?
Mr Lammy: It is, yes.
Chairman: I think we have understood the question and we have had a response.

Q263 Graham Stringer: Can I go back to one question, David? You were saying in answer to whether you could really protect science in universities, universities have autonomy, which they do. Is that not just a straightforward contradiction, and is not the answer that while universities have autonomy you cannot really protect science?
Mr Lammy: No, I think the Government has to demonstrate leadership.

Q264 Graham Stringer: I do not want to interrupt, but you said that there are good words in demonstrating support for science; it is a good thing; we want it to be the basis of the future of our economy. We all agree with that on this Committee, but when it comes down to protecting science within universities, while universities are rightly autonomous, is not the answer that you cannot protect them?
Mr Lammy: Graham, I do not quite think it is like that. I do think that we are, and HEFCE demonstrated that we are, where we are asking for savings to be made, able of course to look right across the area and minimise the impact. For example, HEFCE have made a decision in this recent grant allocation in relation to old and historic buildings. I am a former Heritage minister. I happen to believe that heritage is hugely important, but these are tough decisions, and that is precisely the sort of decision that affects a certain group of universities. That is not as a consequence an impact on science. That is the sort of thing that the Government and the Funding Council can do, but, you are right, universities are autonomous. Vice chancellors must then make decisions about the focus of their institutions, understanding that each institution has a different mission, and, also, they must be able to make determinations, which ministers must not be involved in, about the merits, quality and other assessments about particular departments, and that is taking place at this point in time.

Q265 Chairman: The short answer is you cannot protect it because your priority is the autonomy of universities and preserving that.
Mr Lammy: I do not think that is quite how I have put it, no. I have said that we absolutely can lead, we can invest, but then, ultimately, for individual institutions, they must make a determination; but, of course, when this Committee talks about science, we are talking about the collective whole, so we are talking about the sum total of institutions, we are talking about R&D and BIS, a whole range of areas when we are talking about science. We are not talking about what is happening in Leeds.

Q266 Chairman: I think there is a huge frustration when yourself, the Minister, and, indeed, the Secretary of State, constantly bang the drum about how important science and innovation is to the future of our economy and yet the area where you can make the greatest impact, which is in our higher education system, you are basically saying, "No, no, we cannot touch that. Ultimately it is the vice chancellors that can make these decisions." That just seems to be incredulous to us.
Mr Lammy: Can I come back? Let us actually look at what is happening. PhDs in science are up; student undergraduates are up in every area of science this year. That is not a context in which we should be alarmist about the prospects for science in our country, surely.

Q267 Graham Stringer: There are varying achievements. Can I move on to the impact agenda, David? We have had a lot of witnesses who are concerned both about the potential retrospective assessment of impact, particularly HEFCE looking at their Research Excellence Framework and saying that they will try to assess the impact of previous research and weighting that up to 25% in their assessment. Is this not really a false quantification? We all know science impacts on society and it is by and large a good thing, but to try to quantify it and use that as a basis for assessing future research, is that not just false quantification?
Mr Lammy: I do not think that researchers are being asked to predict their impacts in advance.

Q268 Graham Stringer: I am coming on to predicting them in the future, because Professor Cox told us they were and you did not know how to do it. I am going to come on to that with Lord Drayson. The Research Excellence Framework: HEFCE are looking, and they are not quite sure how to do it, at assessing the impact of research up to 10, 15, 20 years ago. It just seems a bit strange. I am not sure Max Planck could have done it when he got to the basis of the quantum theory.
Mr Lammy: Let me tell you my view. I am very clear doing this role that the public do not fully understand the public impact of higher education in this country, and that is indicated every time you see a reference to higher education in a red-top newspaper and in quotation marks you see the word "boffin". We need to do better. We need to convey a much bigger national story about the importance of science and research, about the innovation, say, in the swine vaccine that Imperial were engaged in this year, the technology at Oxford Brookes producing our Formula 1 winning team. We are not able to do that and I think, therefore, that economic, social, public impact is important. If you are hugely committed to the sector, as I am, I actually think if we can get this right it will help alleviate any future concern of withdrawing funds, or whatever. The determination on the "how" must be for the academics themselves, and it is a HEFCE consultation: they must determine the outcome, they must determine the weighting, but the direction of travel is important, to look back and make a determination about what impact particular bits of publicly funded money has generated in our economy.

Q269 Graham Stringer: Can I ask the question about the future to Lord Drayson? Research councils are asking as part of their assessments of giving grants for scientists to predict what impacts their research will have on research projects of equal value in research terms. That could be a discerning factor. Do you really believe it can be done? Professor Cox told us when he was here that when he was asked to predict future impacts he had absolutely no idea how to carry out that assessment?

Lord Drayson: Yes, I do, and I am well aware of Brian Cox and others' views on this. I read with interest the transcripts of this Committee's meetings where there is a range of opinions within the scientific community upon this. My sense is that actually the majority of the scientific community do believe this is sensible, do believe that it can be done and are willing to work with both HEFCE and the research councils in the projects which they have to try and do this in an effective way. I think we need to recognise these are pilots, for example, that we are at the early stages of doing this, and so we are sensing our way. There are some people who really do not believe that it is possible for it to be done, and I respect their views. David has already mentioned one reason why it is important to do it. There are two others, I believe. One is making the case for continued investment in science in more difficult economic times. That is going to be the difference between making the case for the science budget going forward and making the science budget case over the past 10 years: it is much tougher economic circumstances. The lack of data on impact which exists at the moment makes it more difficult to make that case effectively within government. The third reason why I believe it is important is that from my own experience of doing research in my own PhD, my own experience as a science entrepreneur, the conversations that I have had with people on this subject, I get a sense there is a real value in asking researchers to think about this issue, not expecting them to implement the impact themselves, not asking all scientists if their research leads to commercial impact for them to become entrepreneurs—of course not—but making the point that this is taxpayers' money; that, therefore, researchers should expect to be part of a process which ensures that taxpayers' money has the biggest impact that it possibly can have for the benefit of the country, whether that is economic, or social, or what have you. Therefore, I believe that these efforts are worthwhile. We are at an early stage of trying to do it; I think we should carry on with it.

Q270 Graham Stringer: Are we not on dangerous ground here? I understand what you are saying. You have to make your case within government for science and we are in tough times and if you are arguing against health and saving people's lives, or whatever, you have to make a case, but are you not going to get into conflict with just pure curiosity-driven research? When I think back to the classic cases in science, whether it is Rutherford or Max Planck, people have made huge impacts on society with the research that they did. I do not believe that they could have answered these questions when they were doing that research. Do you, and are you, in effect, moving away from curiosity-driven research to applied research?

Lord Drayson: Absolutely not. I think that if you read the biographies of those individuals about what was going on at the time around their laboratories, for example, you get the impression that there was no doubt at the time that the work that they were doing was going to have massive impact. Therefore, if they had been asked to give some consideration to what the impact might be of their research, I do not think they would have had much trouble in doing it.

Q271 Chairman: Not when they started though. You are asking them to do this when they are starting the work.

Lord Drayson: You are asking people to give some consideration to this as part of the overall assessment of a research project in the same way that we are starting to ask them to take consideration of the communication of science. This is another theme which we believe is important and which we need to provide the incentives for people to do. We are not saying that this is the main way that we are going to judge research. In fact, in the case of the research councils, the idea of asking for this consideration of impact is to enable the peer review panels in a dead heat, a tie, between decisions, between grants, where the overriding criterion for making that decision is research excellence, and if they have come to the conclusion that those grants are equivalent in terms of excellence that there is a further differentiating factor which can be looked at. Sincerely, I really believe with my 20 years' experience in science as a science entrepreneur that this has value. I really do believe it can be done. You hesitate to characterise a scientist in the company of the Maxwells and Plancks and so forth, but, I think, if we look at it, there have been enough really seriously eminent living scientists who have said, "It is fair enough for us to be asked to do this; it is early days; let's see", to suggest that this is worth doing. I think that there the concern that I have said I recognise is all to do with a general concern: is there a shift away from pure towards applied? Absolutely not. What we need to do is make sure we continue being excellent and pure, but we need to get a bit better at the application of applied research, and so I do not think that this impact agenda should be seen as a part of any kind of intention by the Government to shift allocation of research funding between that pure and applied spectrum, but I do believe it has huge potential benefit and should be followed.

Q272 Dr Iddon: Lord Drayson, words like "prioritisation" and phrases like "strategic choices" are now being used more commonly in your speeches, and I think David has used "prioritisation" as well. In the Nairne Lecture the other day you stressed a focus on space, the digital economy and life sciences. Does that mean there is going to be a shift of money from other areas into

those favoured areas and, if so, who is going to make the choices about those shifts of money and will it not damage some areas like particle physics?

Lord Drayson: The fundamental thinking behind all of this relates not just to scientific research but it relates to the central question of the economic future of Britain and the Government's plan to ensure that Britain has a prosperous and successful future in the context of the difficult economic circumstances in the near term but also very strong global international competition, and that has been pursued through a strategy, described as "industrial activism" by Peter Mandelson, whereby the Government has worked to identify with industry and the academic community those areas where Britain has real clear strengths, where the markets in those areas are growing strongly and where, therefore, if Britain invests in those areas, both on the supply and the demand side, it is most likely that Britain will succeed in generating future economic growth. You mentioned space. Space is a classic example. It is as if the recession did not happen in the space industry. It has been growing at 9% a year for the last 10 years or so, it is projected to grow at 5% a year globally for the next 20 years, an opportunity for Britain to increase its global market share to 10%, create 100,000 new jobs, but to do that investment has to be made to maintain the fundamental science, first of all—just the sort of things that Professor Brian Cox would be keen on—but at the same time to make sure that that is translated into success in the economy, which means making sure of that translation of that science into projects. The best example I would give of success in doing this is Surrey Satellites. Out of one of our leading universities, a world lead that we have now in small satellites, Surrey Satellites just having won a major contract for the supply of the Galileo System. 500 million, I think, is the number, half of which will be coming to the UK, so there is a clear policy here. What that means, though, is that both the academic community, industry and government need to work together in the example of space, the innovation and growth team, to come up with a plan and a plan that the academic community supports. Therefore, it is the role of the academic community, through peer review, through the research councils, under the Haldane Principle, having been asked to think by the Government of what these priorities should be, for them to provide that advice. It is not for ministers to tell the scientific community these are the areas, because it is for the scientific community to come up with the conclusions.

Q273 Dr Iddon: I think all members of this Committee would agree with what you have said, but if we are going to put more emphasis on all of what you have said, does that not mean that something down the line somewhere has got to give, because it is a limited budget?

Lord Drayson: Absolutely; choices have to be made

Q274 Dr Iddon: Is there not a danger that some of our fundamental aspects of science are going to suffer? I have mentioned particle physics; I could mention nuclear physics as well. I was at Manchester a few days ago and the nuclear physicists, at a time when we are developing the nuclear industry in this country, are suffering quite badly across the country at the moment.

Lord Drayson: I believe there are two dimensions of this. One is the dimension from pure fundamental research to the most applied research, and then there is the dimension of the field of research. What I have been talking about really is the fields of research. What are those fields where Britain has real critical mass, it has real leadership in, where the science is moving at a pace which is part of a big shift which leads to a big market opportunity? It is not a question of whether or not you make a short-term or a long-term decision. Pure research, by its nature, has a long-term impact, but it can be absolutely fundamental to success in an area of real importance. I do not make this link that some are making that if you are concerned to ensure success in these areas of strategic importance that that necessitates a shift from pure research to applied research: you have to do both. I think we have got to improve our success of translating our applied research to economic growth. We have made a lot of progress but we need to go further.

Q275 Dr Iddon: Let me turn now, Lord Drayson, to the STFC. Are you able to tell the Committee when your work with Professor Sterling will be completed?

Lord Drayson: Very shortly. I have received in the last few days proposals from Professor Sterling, as a result of the work that he has done with the Research Council in response to my asking for this review. I am now reflecting on the proposals that he has given, talking to colleagues across government, and will be making a decision very shortly.

Q276 Dr Iddon: There is a feeling in the community represented by STFC that when CCLRC and PPARC came together that that was probably a mistake. Is it possible that there might be some more restructuring of the STFC?

Lord Drayson: I recognise that the creation of STFC has led to a situation where, because of the very nature of STFC as a research council which has a larger proportion of its funding being spent on large international facilities, costed not in sterling, where Britain is an important but a minority partner, the creation of this structure through the merger has meant that pressures which are not within the control of the Research Council, like exchange rate risk, changes that are decided by the majority of other countries to increase costs, leads to pressure on the grant-giving side of the Research Council. I have said that I accept that that is a problem. The purpose of the review is to come up with solutions to that problem. I am optimistic we can come up with solutions to this.

Q277 Dr Iddon: The astronomy community and the nuclear physics community, in particular, but others as well, feel they have no clout within the STFC, they have no say on the council of the STFC and they are now being marginalised. We are talking about some

pretty important areas of fundamental research. Do you feel that we should in some way try to protect those areas like nuclear physics and astronomy that are being marginalised at the moment?
Lord Drayson: I hear what you are saying about the concerns that that community has. There have been a number of communications to me and to other ministerial colleagues about the concerns within the STFC community and we are listening to those very carefully. As part of the review we are not just looking at the structural elements of the organisation of STFC but we are listening to the community. I can say that I absolutely recognise the fundamental importance and excitement in those areas. I have a child who is particularly keen on astronomy, and so I am well aware of the importance of astronomy, not just in terms of the answers it gives to some very fundamental questions in science, but also its power in terms of enthusing and motivating young people to study science.

Q278 Dr Harris: I wanted to ask the Higher Education Minister what your view is of the health of physics in higher education at the moment.
Mr Lammy: I obviously see it through the lens particularly of entrants. I am pleased that we have seen a 3% rise in students taking physics, which sits alongside the increases in all the other STEM subjects.

Q279 Dr Harris: What is the baseline for that rise?
Mr Lammy: It is a year-on-year rise because of investment.

Q280 Dr Harris: So if there were a 6% fall in a previous year, would that give you pause to say that maybe picking your baseline to create the rise is not necessarily the most statistically appropriate thing to do?
Mr Lammy: No, because this Committee in previous incarnations would, quite rightly, have been concerned about a fall of 19% in chemistry, a fall of 7% in maths and physics struggling as well.

Q281 Dr Harris: Between when and when?
Mr Lammy: This is going back to the 1999-2000 period. We are now seeing progress. We are also seeing progress in Masters courses, which I think is very important, and PhD levels. In terms of the appetite, partly because of the capital conversation that we had previously, the investment in facilities and a whole range of activity, that feels to me to be a healthier environment.

Q282 Dr Harris: Do you think the astronomy and particle physics community in higher education, particularly those funded by STFC, are happy with their lot at the moment, or do you think that it is fair to say that there is a problem there, if not a crisis?
Mr Lammy: I recognise what Lord Drayson has just said. I too see some of the concern that has been raised.

Q283 Dr Harris: Lord Drayson, in respect of partnerships that we have in this area, for example with Wellcome over the Diamond Light Source, do you think as a matter of principle that if you do a partnership deal to create a large capital facility, then it should be a first call on government resources to live up to the obligations to then fund the recurrent running costs of that facility, otherwise you are not maximising your return on the investment and you also could be perceived as letting down the people you entered into a partnership with because you are pulling the plug on your share of the running costs? Do you see that that is a reasonable thing to be a high priority first call?
Lord Drayson: I do accept the point that you are making that the partnership depends upon an understanding of the principles by which the long-term nature of funding decisions on those facilities would be made and, in particular, not just the capital funding for the facility in the first place, but the ongoing development work and the allocation of funding to be able to ensure that those facilities are maximised. I think your question referred to the difficulties that STFC has faced with the pressure which is being caused, as I have already said, and we do need to address that and we are looking at that aspect in the review that we are taking. To actually commit today to a prioritisation, I am not in position to do, but I accept the point.

Q284 Dr Harris: My final question is to ask whether you have any concerns, whether you have heard of any concerns over the cost of setting up the shared services centre by RCUK?
Lord Drayson: Yes, I have heard about those concerns.

Q285 Dr Harris: What is your take on that?
Lord Drayson: Like all aspects of the administration of science, we need to be alive to making sure that those are done as effectively and as efficiently as possible, and I think that is one of the areas that we will need to put increased attention into as we go forward.
Chairman: We will leave that hanging in the air.

Q286 Mr Boswell: A quick question to the Higher Education Minister. Given the pressures we know there are across the higher education sector, some of which have been announced and others of which are to follow, not specific to STEM, and given also the acknowledged improvement or beginning of an uptake in STEM enrolments, does the Minister have anything to say about any anticipated safeguarding of STEM subjects and whether he will be talking to the Browne Review? One has a suspicion that Lord Browne may have an interest in STEM subjects as well. Would he give us a take on whether, at the end of this process, I think the welcome improvement which we have seen will be maintained or will be reversed if not in absolute possibly in relative terms as well?
Mr Lammy: We have already indicated in *Higher Ambitions* and HEFCE already are implementing a £10 million pot to ensure that universities are able,

in a sense, to safeguard and move to STEM to continue to see the improvement that we have seen since the introduction of the framework, and the figures that I gave previously are as a result, if you like, of the introduction of the framework. We are already saying to the sector that we are making some funds contestable to also see a shift to the New Industries, the New Jobs agenda, and STEM obviously lies behind that. Of course, the review is independent of government and we will reflect on it as it comes to us, but I know and would expect that certainly our more research-intensive universities will have made the case that you are outlining.

Q287 Mr Boswell: Beyond that, in relation to graduates and career entrants into STEM subjects, will the Minister also be taking a lively interest in the fact that this is not simply a matter of undergraduate recruitment, but it is a need to get people trained to be the scientists of the future?
Mr Lammy: I think that is a very good point. We have seen a huge increase at Masters level. We must ensure that we are seeing a good proportion of UK postgraduate students. I think Adrian Smith's postgraduate review is very, very important in relation to this and, clearly, we have to build on what the CBI outlined at the end of last year. We do need to see more sandwich courses in the sector, we do need to see continued increases in employer co-funding, and I think the whole sector understands that the proximity to industry and the commercialisation of science must be the key to growth in the sector.

Q288 Ian Stewart: Paul, can it be taken from your answers this morning that you are comfortable with these cuts and comfortable with the consequences that they will bring about?
Lord Drayson: No, I would not say that as Science Minister I am comfortable; quite the opposite. My role is to argue very strongly for investment in science. I think that we have to be very clear that the £600 million that has been looked at as an efficiency saving is off a figure which has not been determined yet, and so, therefore, my lack of comfort is due to the fact that I am arguing very strongly for the figure for the overall future research budget. I think it is important to be absolutely clear on that. The PBR figure, the £600 million efficiency saving in 2012-13—people talk about a percentage. You cannot calculate a percentage because you do not know what the CSR numbers are yet. The argument is still to be made and won.

Q289 Ian Stewart: The motive for the question was to seek what you have just said, because I have also had difficulty trying to work it out. David, higher education, of which our Chairman is a great advocate, has received massive investment since 1997. Can you say whether these cuts will undo that good work? Will it, for example, force some universities to decrease their UK recruitment for indigenous students and perhaps go for more students from overseas? Will they damage the good work?
Mr Lammy: I think we have got to put this in perspective. We saw a decline in the unit of resource, Ian, as you will remember, on new UK figures of 40% between 1991 and 1997. What we are effectively talking about is a less than 5% saving, and within that 5% I think the real argument is about how we minimise the effect on science and research, and I would include teaching within that. That is the endeavour. I certainly do not recognise some of the alarmist statements that have been made.

Q290 Ian Stewart: Do you not accept that some of the more far-reaching statements that may be made are born out of complete uncertainty, not about the current proposals, but whether there may be further cuts to come after the General Election?
Mr Lammy: Yes, as I indicated earlier, I think that there are some vice chancellors who are clearly very worried about the prospect of a Conservative administration and there are other vice chancellors, very, very unusually, confusing their understanding of ancient history, because I did not quite understand the 800 years statement that had been made.

Q291 Ian Stewart: Can I move to the more positive side? Some of our witnesses have asked for help from government. For example, a number of them have said it would be really good if the Government could do something about VAT. Have you articulated that to the Treasury and what progress has been made if you have articulated it?
Mr Lammy: That point has been made. We are looking at it, but I think it is right to say that there is quite a lot that can be done in terms of shared back-office operations and we need to encourage the sector to make those advances because some of the impediment looks to be in competition actually and I want to indicate that where the last 10 years have been very competitive, this next period has to be collaborative. You will understand, Ian, that we are obviously discussing these things within the Treasury. Progress is usually determined by a Budget.

Q292 Ian Stewart: Do we know if it will be in the Budget?
Mr Lammy: I cannot anticipate what the Budget might be.

Q293 Ian Stewart: Can I move to my final point? We know, in line with what Paul Drayson said and what you have said, David, as Higher Education Minister, that hard decisions need to be made, but in an attempt to move things forward positively you have implemented the 10,000 additional student initiative and one of our witnesses, Professor Adrian Smith, has said that this was a fairly hastily contrived move and we thought that was an interesting statement, to say the least. Can you tell us about where the idea came from and what consultation you undertook before announcing it, and is Adrian Smith correct?
Mr Lammy: I think all of last year you will have seen a particular group of universities particularly (and I know that you have had Les Ebdon before you and

he described the move as tremendous) generating quite a lot of noise in the system last year, asking for extra places, so I think there was quite a long process by which government was able to hear and listen, to look at a pattern of figures. We were in the height of the recession and we sought to ameliorate that with just the 10,000.

Q294 Ian Stewart: David, can I interrupt there. Professor Ebdon, in the balance, also called the actions on student support money a "betrayal". It appears to me, hearing the different statements from witnesses, including yourself, that there is a sweet and sour situation here. How is the university sector going to get any stability for planning, which is the key issue for the future?
Mr Lammy: If you look at successive years, actually there has always been unfunded growth in and around the system. There was the year before this one and before that.

Q295 Chairman: 10,000 places.
Mr Lammy: It may not have been as much as that but we were in the height of the recession last year. We had a decision to make, we made it and I think it is a good thing that those young people are effectively in universities in new areas of the economy.

Q296 Ian Stewart: What will happen if universities have to say to applicant students, "No, there is no place for you"? Is that not contradictory to what all the Government strategy has been?
Mr Lammy: There will be more young people at university next year than ever before in our history. University is a competitive process. It has never been the case in this country or any other country that everyone who wanted to go in their first-try application went, and that will be the same this year, as it has been in all of our history.

Q297 Ian Stewart: Is that growth sustainable in the light of these cuts?
Mr Lammy: Absolutely. It has to be managed growth, and that is what we are indicating. For every place around 40% of students are in receipt of some grant; so it is managed growth. We have always been clear about that.
Chairman: You have taken 10,000 places out this year. You put them in last year and you have taken them out this year. That is not managed growth.

Q298 Dr Harris: That is negative growth.
Mr Lammy: When I talk about managed growth, I talk about the costs associated with each student place. We made a determination in the height of the recession last year. I think it was the right determination. We will still see growth this year but, of course, it is not the growth that we would have anticipated before we came into this difficult period.
Chairman: Okay.

Q299 Dr Naysmith: Lord Drayson, Professor Brian Cox told the Committee that "it is accepted clearly in the Obama administration that the way to do it"—and this is the sort of thing we have been talking about this morning—"is to expand the frontiers of human knowledge and thereby we derive the benefits". You yourself said earlier this morning that investment is key to driving growth. At the bottom of all we have been talking about this morning there is a clear strategic choice: do we as a country increase investment in science, and that is the punch line, or do we try and squeeze a few more drops out of what we have got and hope for the best?
Lord Drayson: I think that the Obama administration has truly followed what this administration has been doing for a number of years. If you look at the previous administration, the Bush administration certainly did not see science in the centre of its policy. So there has been a transformation, Professor Cox is absolutely right, in the United States that is hugely welcome, but here in the United Kingdom, under both Prime Minister Blair and Prime Minister Brown, there has been a sustained focus, a transformation in science. That is something which should be maintained. In good times or bad this country's future depends upon it being a science leader. Our health, our wealth and our prosperity depends upon us making the best use of this leadership which we have in science. It is astonishing, I think. We are the most productive nation in science in the G8. We have more Nobel Prize winners than any other country apart from the United States, and so we have something very special that takes place here in the United Kingdom. That has been hard fought after a really quite shocking underinvestment by the previous Conservative administration. That has been put right now. We need to maintain that in the future.

Q300 Dr Naysmith: Are there going to be cuts or not? Are there going to be serious cuts that will affect science funding?
Lord Drayson: What I can say to the Committee is that I am arguing very strongly for the investment in science and innovation, but I can also point to public comments that have been made by the Prime Minister and that have been made by Peter Mandelson many, many times over the past 18 months.

Q301 Dr Naysmith: You said that earlier and you said that from the Prime Minister down everyone was persuaded by the importance of science, yet you are still arguing for future investment. Who you are arguing with?
Lord Drayson: The decisions have yet to be made. We are waiting for decisions coming out of the Budget to be made which will then affect future spending rounds. That is the normal business of government.

Q302 Dr Naysmith: What kind of steps are you taking to try and ensure that the rest of the Government will agree with you and increase our investment in science?
Lord Drayson: Firstly, we are showing that we are putting as much effort as possible into ensuring the efficiency of everything we do. The point that you

make about the shared services problem is an example that we have to show to Treasury and other colleagues that we are putting significant effort into making sure that we are maximising the efficiency of everything that we are doing in the areas for which we are responsible. The fact that we are the most productive in the G8 shows that we are already doing something very special, but we must not be complacent. Also we need to develop a public consensus of the central importance of science to growth, about the importance of scientific literacy generally but also making sure that the talent which we have in this country is properly stretched, exploited and its potential turned into economic jobs and growth. All of these things we are doing and we can point to a pretty effective track record. A number of people have said in some of the debates which we have had, on which Evan has shared a platform, and the Chairman is well aware of the fact, that in this run-up to an Election science is central to what this nation is about and it is being discussed in a way which it never has been before, so truly in this Election we have achieved an important goal which is to make science a central part of the choice that voters make. Do you really believe that science is going to be central to this country's growth? This Government has a clear strategy, a clear plan for doing so. The Opposition have said there are going to be very major cuts in science; I do not agree with that, I do not believe there should be very major cuts in science.

Q303 Dr Harris: That is the official Opposition.
Lord Drayson: The official Opposition of course.
Ian Stewart: There only is one official Opposition.
Chairman: On that very, very positive note of agreement, could we thank you very much indeed, Lord Drayson and David Lammy, for your time with us this morning.

Written evidence

Memorandum submitted by the Department of Health (FC 00)

Investment in Health Research

1. The Department of Health is the largest departmental investor in research and development after the Department for Business Innovation & Skills and the Ministry of Defence. The Department of Health funds R&D through two main routes:

— the National Institute for Health Research (NIHR)—specifically designed to deliver the Government's research strategy *Best Research for Best Health*[1]*; and*

— the DH Policy Research Programme (PRP)—providing the evidence base for policy development and evaluation of policy implementation in health and adult social care.

2. The Department has made unparalleled real terms increases in research funding over the previous and current spending review periods, and this investment will rise to over £1 billion in 2010–11. The achievements made by the NIHR in implementing *Best Research for Best Health* are described in its latest progress report.[2] Since January 2009, more than 300,000 participants have taken part in trials and studies conducted through the NIHR Clinical Research Network, and England has the highest national per capita rate of cancer trial participation in the world.

Ring-fenced research and development budget

3. The Department's budget for the NIHR and the PRP has been ring-fenced since the beginning of the 2007 Comprehensive Spending Review period. In 2010–11, a departmental saving of £62 million will be achieved by transferring responsibility for research activity from other departmental policy budgets to the ring-fenced R&D budget. The research the ring-fenced budget currently funds will continue as planned. Research activity previously funded from other departmental budgets will be managed through the PRP from 2010–11. These changes will help to ensure consistent prioritisation and quality measures with Value for Money across the department's R&D investment.

4. The ring fence has ensured protection of this budget from any front line pressures. The sustained and protected investment through the budget is enabling DH to:

— deliver the vision set out in the Cooksey Report for more effective translation of health research into health and economic benefits in the UK, together with the Medical Research Council (MRC) and other funding partners;

— ensure the availability and efficiency of research infrastructure in the NHS to support clinical trials and studies funded by the Research Councils, medical research charities, industry, and other funders;

— respond rapidly to urgent priorities such as swine flu;

— build longer term research capacity in academic clinical medicine, social care, and other fields; and

— contribute to the funding of vital research in cross-cutting priority areas such as obesity.

5. The NIHR provides extensive NHS infrastructure support for translational and clinical research through its 12 Biomedical Research Centres, 16 Biomedical Research Units, Clinical Research Facilities for Experimental Medicine, and Clinical Research Networks. The NIHR and MRC are developing a joint programme for translational research and are working together on number of research initiatives including the Efficacy and Mechanism Evaluation Programme, Methodology Research Programme, and Patient Research Cohorts under the auspices of the Office for Strategic Co-ordination of Health Research (OSCHR).

6. The purpose of the NIHR Clinical Research Network is to provide a world class health research infrastructure to support clinical trials and other well designed studies funded by both commercial and non-commercial organisations. The Network ensures that patients and healthcare professionals from all parts of England, and from all areas of healthcare, are able to participate in and benefit from clinical research. Its existence improves the quality, speed and co-ordination of clinical research by removing the barriers to research in the NHS.

7. It is crucial for DH to have the research resources, and access to the research capability and capacity, to respond swiftly to urgent evidence needs. Discussions of rapid research commissioning in swine flu began on 4 June 2009, and an open, themed call was launched on 19 June. By 6 August, fourteen NIHR projects were being funded. Approval for 100 hospitals to participate in one study was arranged within five days. Mid-term results from a serological study were published in *The Lancet* on 21 January 2010.

8. A vibrant clinical academic community is essential not only for first class health research but also for innovative world class clinical care. Investment by DH has contributed to a recent increase in total staffing levels. However, there are concerns that 58% of the clinical academic workforce are now aged 46 or over, compared with 53% in 2004. Some specialties such as Pathology have reported declines in staffing levels.

Through NIHR, the Department is investing in large numbers of Academic Clinical Fellowships (ACFs) and Clinical Lectureships (CLs). These provide research exposure and experience for academically gifted medical and dental trainees. NIHR funds over 250 news ACFs and 100 CLs each year.

9. Social care is a research field to which many disciplines contribute (among them social policy, psychology, sociology, economics, demography and management) and is of increasing importance in the context of trends in UK demographic change. Historically there has been under-investment in the field and DH is contributing to work to address this, for example through establishment of the NIHR School for Social Care Research (in operation since February 2009).

10. The Department is the largest UK funder of mental health research and the Government's strategy for mental health[3] sets out planned action in this research field. One of the six topic specific research networks that form part of the NIHR Clinical Research Network is devoted to supporting mental health research. It has already had a significant and positive impact on the numbers of patients being recruited to take part in clinical trials.

11. The Department's ring-fenced R&D budget also enables successful collaboration with other government departments on a wide range of cross-cutting research priorities supporting Public Service Agreements. For example, DH led the development of the cross-government research and surveillance plan for obesity. The NIHR Health Technology Assessment (HTA) and Public Health Research (PHR) programmes recently issued a joint themed call for evaluating interventions in obesity. Both programmes focus on evaluation, with an interest in cost-effectiveness. The HTA programme evaluates interventions in the NHS and the PHR programme evaluates public health interventions delivered in other settings.

Economic Impact of Health Research

12. The vision of Best Research for Best Health is to improve the health and wealth of the nation through research. This is reinforced by the Cooksey Report, that made recommendations to increase the translation of R&D into health and economic benefit for the UK, both in the public and private sectors.

13. Health Technology Assessment identifies how drugs, devices, procedures, care settings, screening, and other interventions can be used to maximise the benefits of investment in health services, and may also identify ineffective products or interventions that can be withdrawn. Examples of recent findings from the NIHR HTA programme, and their implications for NHS costs, are listed in an Appendix.

14. Various approaches have been developed to assess the economic and financial impacts of health research. These are discussed in a report published in 2006.[4] A later study[5] found that £1 spent on public and charitable research in cardiovascular disease yields an estimated net return of 39p per year in perpetuity, comprising 9p from health gains and 30p from gains in Gross Domestic Product (GDP). Investment of £1 in mental health research yields an estimated net return of 7p from health gains and 30p from GDP gains. Other work in this area has been undertaken by researchers at the London School of Economics.[6]

APPENDIX

Examples of recent findings from the NIHR Health Technology Assessment programme and their potential implications for cost to the NHS—prepared by the NIHR Evaluation, Trials and Studies Coordinating Centre

01/14/10 Treatment of severe ankle sprain: a pragmatic randomised controlled trial comparing the clinical effectiveness and cost-effectiveness of three types of mechanical ankle support with tubular bandage. The CAST trial (Cooke) Health Technol Assess, 2009; Vol 13:13 www.hta.ac.uk/1309

Summary of findings—This trial suggests that the most clinically and cost-effective treatment for pain relief and recovery from severe ankle sprain, where patients cannot put any weight through that leg, is a below the knee cast. However neither treatment affected the long-term outcome and so a decision about which brace to apply should incorporate an assessment of likely compliance and acceptability to patients.

Importance to NHS—Ankle injuries are one of the most common injuries seen in UK emergency departments. It has been estimated that one ankle sprain occurs per 10,000 people per day, most of which are due to sport or leisure activities.

A number of new devices have been developed to treat severe ankle sprains and include a foam-padded walking boot and ankle braces. However there is limited research on the effectiveness of these new technologies compared to current treatments, which are the use of tubular bandaging or a below knee plaster cast. The CAST trial compared the clinical and cost-effectiveness of four methods of ankle support for severe ankle sprain.

Cost to the NHS—The cost of treatment to the NHS could rise significantly if newer devices were widely adopted, with the foam padded boot costing about £215, including fitting, and the ankle brace £39.23. Both are more expensive than the standard treatments provided by the NHS, with a below the knee plaster cast costing £16.46 and the tubular bandage £1.44 which was less effective than the plaster cast.

01/38/05 Blood glucose self-monitoring in type 2 diabetes: a randomised controlled trial (DiGEM) (Farmer), Health Technol Assess, 2009; Vol 13:15 www.hta.ac.uk/1330

Summary of findings—This study concluded that the routine use of self-monitoring of blood glucose (SMBG) with or without additional training, was associated with higher costs and lower quality of life in patients with well controlled non-insulin treated type 2 diabetes.

Importance to NHS—With the UK prevalence of type 2 diabetes increasing, with estimates ranging from 3.5% – 5% of the population aged 20–79 years, ways to better manage and improve the long-term outcomes for people with diabetes are important.

Self-monitoring of blood glucose (SMBG) is a technology that is frequently incorporated into self-management interventions for diabetes, but has only been separately evaluated in a limited number of trials. As a result of this lack of evidence, clinical guidelines have differed in advice about the best way to use SMBG. The HTA programme therefore commissioned the DiGEM trial to clarify this clinical uncertainty.

Cost to the NHS—The DiGEM trial found that self-monitoring of blood glucose was significantly more expensive than standardised usual care, by £92 and £84 for the less intensive SMBG.

The current NICE guideline (CG66), published in May 2008 before DiGEM had published its findings, recommends offering self-monitoring of plasma glucose to a person newly diagnosed with type 2 diabetes only as an integral part of his or her self-management education. Although not included in the guidelines consideration, the findings of the trial are noted as potentially important.

The results of the DiGEM trial will therefore help inform the management of people with type 2 diabetes in future and should contribute to a reduction of inappropriate expenditure in this area as well as the provision of ineffective or potentially harmful interventions to patients by the NHS.

02/10/02 A prospective randomised controlled trial and economic modelling of antimicrobial silver dressings versus non-adherent control dressings for venous leg ulcers: The VULCAN trial (Michaels) Health Technol Assess, 2009; Vol 13:56 www.hta.ac.uk/1380

Summary of findings—This study found that there is little to support the use of antimicrobial silver dressings, compared with non-adherent dressings, in the treatment of venous leg ulcers. However, the economic analysis showed a significantly higher cost for those treated with antimicrobial dressings with there being no difference in clinical outcomes.

Importance to the NHS—Venous leg ulcers are a major health problem and result in considerable costs and morbidity for health services. Chronic venous leg ulcers affect more than three per cent of the elderly population in the UK.

Antimicrobial dressings have been widely adopted without positive clinical evidence and the study surveys suggested that silver-donating antimicrobial dressings have become widely used. If this reflects national practice then the implication is that the NHS could be spending several million pounds on dressings each year with no evidence of clinical benefit.

Cost to the NHS—The annual cost to the NHS is estimated at £450 million, mostly for dressing materials and nursing time. The results of this trial show that there is no evidence to justify the use of the more expensive silver dressings in routine venous leg ulcer care, as they offer no real clinical advantage or improvement in quality of life, but are significantly more expensive. These findings could potentially save the NHS millions of pounds.

05/39/06 Methods to identify postnatal depression in primary care: an integrated evidence synthesis and value of information analysis (Hewitt) Health Technol Assess, 2009; Vol 13:36 www.hta.ac.uk/1521

Summary of findings—The study found that the accepted criteria for a postnatal depression screening programme were not currently met. The use of formal identification methods for detecting postnatal depression does not represent value for money for the NHS.

The evidence also suggested that there is a simple, safe, precise and validated identification strategy, that in principle a suitable cut-off level could be defined and that the strategy is acceptable to the population.

Importance to the NHS—Over 11% of women experience major or minor postnatal depression six weeks postnatally. Though clinically and cost-effective treatments are available, less than half of cases of postnatal depression are detected in routine clinical practice. Screening strategies using brief depression questionnaires have been advocated but have attracted substantial controversy and the effectiveness and value for money of these strategies is uncertain.

Importance for clinical decision-making and to patient outcomes—Current guidance from NICE recommends routine screening for postnatal depression in primary care. However the findings of this study suggest that this does not appear to represent value for money for the NHS and both the NICE recommendation and widespread current practice should be reviewed.

Cost to the NHS—Screening for postnatal depression with one of the most widely used questionnaires, the Edinburgh Postnatal Depression Scale, had an incremental cost-effectiveness ratio of £41,103 per quality adjusted life year or QALY (a combined measure of quantity and quality of life) compared with routine care only.

The ratio for all other strategies looked at in this study ranged from £49,928 to £272,463 per QALY compared with routine care only. This is above the conventional NHS cost-effectiveness threshold of £20–30,000 per QALY. In contrast, the strategy of treating post natal depression without using screening as is current practice represented good value for money.

References

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[5] Health Economics Research Group, Office of Health Economics, RAND Europe. *Medical research: what's it worth? Estimating the economic benfits from medical research in the UK*. UK Evaluation Forum, November 2008.

[6] McGuire A, Raikou M. *Inferring the vlaue of medical research to the UK*. Working paper No: 5/2007. LSE Health, January 2007.

Memorandum submitted by Professor Andrew Wallard (FC 01)

1. Background and the Context of My Evidence

1.1 am the Director of the International Bureau of Weights and Measures (BIPM), an intergovernmental organization supported by 54 Member States (which include the UK) and 27 Associates of the General Conference on Weights and Measures. Our job is to work towards world-wide uniformity of measurements, to maintain the international system of units (SI) which is the basis of all measurements, and to coordinate the work of the National Metrology (measurement) Institutes world-wide. We work in measurements for physics and engineering with traditional applications in manufacturing industry and traded products which require measurements to demonstrate conformity with written standards for trade and to avoid technical barriers which might come as a result of non-acceptance of measurement by, for example, regulators. Our responsibilities also extend, increasingly, to measurements needed for chemical metrology, climate change, healthcare, etc. The aim is to put as many national measurements on the same basis and to ensure their traceability to internationally agreed standards. More details are on our web site www.bipm.org

1.2 As a result, I am very familiar with the UK's "national measurement system" and the role of the Government in providing support for research, development and maintenance of national standards as well as for their comparison with those of the UK's trading partners.

1.3 My attention has been drawn to the forthcoming study by the Science and Technology Committee on the impact of spending cuts on SET and scientific research.

2. Scope of The Review

2.1 Whilst I would imagine that the majority of the Committee's attention would focus on academia and Research Councils, I believe it is important to draw your attention to the small, under-rated, but yet hugely economically important topic of measurement standards.

2.2 Through BIS, the UK currently spends some £60 million a year on supporting what is loosely called the "National Measurement System" or NMS. The majority is spent on maintaining the country's national standards of measurement and improving them to meet user needs in commerce and society. Day to day measurements in business, universities, hospitals and every aspect of the nation's life have to be traced to national standards if they are to be accurate, reliable and internationally accepted. Much of the work is at the National Physical Laboratory which, once having established national standards which reflect national needs, goes on to provide calibrations and related services for users in industry, the health service as well as other bodies which require accurate measurements in order to achieve their mission. Some of these additional requirements are mentioned in paragraph 5. National expenditure also includes support given to a number of specialised laboratories, and the United Kingdom Accreditation Service, UKAS, which is responsible for making sure that industrial laboratories do their measurements correctly and that they are nationally traceable. All these laboratories and agencies have a degree of private sector involvement in their management (ranging from fully privatized to being managed under contract to the BIS) and in my view are the epitomes, amongst other such laboratories world-wide, of efficiency and effectiveness. By reputation, the UK is universally acknowledged to be in the "big three", together with USA and Germany. Within BIS,

the National Measurement Office deals with measurement in the regulated sector, traditionally known as "weights and measures". The Office also works to plan the national strategies, and prioritize the NMS work programmes in all the areas of measurement.

3. The Written Submission

There are a number of short points I would like to make to the Committee.

3.1 *Awareness and impact of measurement standards (metrology)*

Most people will never have appreciated that about 6% of GDP depends on making measurements.

3.2 The obvious measurement activity—mature technologies for the most part—which makes up this remarkable statistic are in things like petrol pumps or the day to day dimensional measurements needed to ensure quality and that products fit together wherever the sub-components are made in the world. Don't, though be drawn into a false impression that once standards and their dissemination infrastructures like this are in place, they don't need to be improved routinely. There is always the need to respond to demands for better accuracy or product or process innovation or to new measurements needs even in traditional areas such as dimensional measurements. Just because there is, say a national yard or metre doesn't mean that it can stay as it is without being continually updated and the challenge will, in fact, be for measurements of very small quantities for nanotechnology. The rule of thumb is that uncertainies and accuracies need to be halved every decade to meet what then becomes day to day needs. Developments such as this take time and patience. They are not usually suitable for University research where the normal PhD research project timescales are too short.

3.3 In order to maintain their competitiveness, companies continually have to exploit better measurement to do better in the market place. For example, the Airbus wings can only be made in the UK and fitted together with the fuselage in France because of a very sophisticated measurement technology in the UK. Rolls Royce engines demand the finest measurement tolerances and have continually to be upgraded to improve efficiency and make sure that they compete with General Electric and others.

3.4 Other measurement work covers the relatively esoteric such as creating the next generation of "clocks" for initiatives like the European Galileo programme—as well as maintaining national time scale (the "Pips") and ensuring it is consistent with the world mean. Surrey Satellite Systems were helped to be awarded the recent high prestige Galileo contracts because they can access the best measurements in the word. In other areas, measurement impacts directly on all of us who, for example, need dosimetry treatment for cancer. Metrology ensures that the patient receives the correct dose by calibrating standards in hospitals against UK national standards, which are themselves compared with those in other countries so that if treatment is needed abroad, the patient can be confident that the metrology is correct.

3.5 This is classic "public good" support and fully reflects market failures as no one user organization would take on the responsibility on behalf of all other users. Cuts would raise the very real prospect of damage to a unique and vital element of the nation's infrastructure. Cutting the "here and now" would lead to increases in costs to industry or to companies being forced to try to find a solution to their needs elsewhere. Cutting development work, for which users have already been identified, would mean that there would be no measurement infrastructure or expertise on which to draw. There is a wealth of examples that touch on the day to day economic life of the country: cuts would put all that in peril.

4. The Extent of any Damage from Cuts

4.1 Maintaining current services is a no brainer—it has to be done but where would the UK be without a measurement infrastructure on which to rely for the future? Developing and proving a new standard takes time to create confidence in its accuracy. UK is up with the best, but in this game, as elsewhere, reputations matter and cuts will damage the essential new developments as well as international collaboration.

4.2 Frankly, this could not have come at a potentially more damaging time. The UK has led—no-one doubts this—a major European collaboration programme which has resulted in a cost shared programme. It will, I believe, lead to a sharing out of responsibilities in due course: the UK may, for example, hold the temperature standards for Europe, Germany may be responsible for lighting: France for some electrical measurements. This the first time in the world that such an ambitious and thoughtful programme will be mounted. If there are cuts, then the UK "50%" will not be available and all the hard work of the last 10 years will be jeopardised.

4.3 And every aspect of science relies on measurements—that's what scientists do every day of the week and without an accepted infrastructure that addresses new challenges as well as underpins existing activity, UK scientists would be unable to compare their results with those made elsewhere. Measurement leads innovations: of nearly all the recent science Nobel prizes in physics, the first application is a measurement one or the subject has been developed by metrologists. President Obama's Secretary of State for Energy used to be a leading laser metrologist. Here's what he had to say about measurement and new science:

> *"Accurate measurement is at the heart of physics, and in my experience new physics begins at the next decimal place".*

Under his influence and that of other US Departments of State, huge investments are being made in measurement related topics …climate change, new industries, biosciences and health care and others such as those illustrated in this submission. The USA, despite its own economic difficulties, is not stinting on upping its game.

5. Measurement Underpins all the Current Great Challenges

5.1 Measurement underpins much of what the Government has stated as its key policy objectives, and which are broadly cross-party. For example,

— climate change is moving to measurements based on international standards (I am actually currently collaborating with the World Meteorological Organization to put the international structures in place from which the UK and others will base their measurements). The Deputy Director is a total convert. "How", he said, "can you take decisions when large uncertainties exist in measurements related to climate change" and that (without measurements) "we don't know how to achieve the desired level of accuracy". UK metrologists are just about the best in the world in this area.This is a relatively new area where investments are being made and cuts would weaken, if not loose entirely, an ability to continue to make a world-leading impact and to sustain the UK's reputation in the area, let alone enable the UK'sindustrial and economic interests to be appropriately protected in the ensuing debates. The next step is the measurement element in the carbon economy and traceability in carbon trading which will mean that all operate from the same quality and accuracy of measurement. The economic impact, the sums of money, and the impact on competitiveness and the "level playing field" will be huge

— health, especially the measurements made on, for example, cholesterol or other hospital measurements are coming into the ambit of the NMS as the clinical community realises that only by making accurate, reliable measurements can clinical diagnoses be correctly based. The World Health Organization accepts that biological standards like the activity of insulin have to be traceable to the International system of Units rather than subjective assessments in vivo. This was unheard of five years ago. Once this is done, progress will accelerate and the NMS must respond or the UK drug and pharmaceutical industry will be at a competitive disadvantage. Sports drug testing comes into the same category—and is being developed for the London Olympics with the World Anti Doping Agency;

— trade benefits because there is a system, accepted by countries which represent about 95% of the world trade, that recognises the accuracy of measurements made nationally. There are numerous case studies of savings of many millions of pounds because companies don't have to re-test for exports. In this system, the world's experts get together to assess each others' measurement capabilities and so agree to accept tests and measurements made in the something like 40% of world trade that requires compliance with specification standards; and

— new technologies depend on measurements for knowing what is what. For example, legislation in nanotechnology will, sooner or later, require measurements on, for example, particle size. This is not easy but places like the NPL are world-leaders.

6. Economic Impact

6.1 Unfortunately measurement is largely taken for granted, as the NMS works well and it is very rare that there are errors. The consequence is that metrology lacks the glamour of, and attention given to, particle physics, genome programmes or astronomy. Yet the economic impact of the UK's investment—modest in relation to those in most other developed countries—is enormous in public expenditure terms. There are many many studies, which date from the days of the DTI, and which show that, for example:

— the £60 million investment leads to national economic benefits of about £5 billion;

— a Canadian study found an eight-fold benefit from public investments; and

— a recent European study showed that investments produced a rapid rate of return of 3:1 from investments at the European level.

There are also a number of UK and US studies which demonstrate rates of return of between 10 and 30 to 1.

6.2 These rates of return—even given a degree of professional scepticism from politicians or economists —are amongst the highest from any sort of public investment: the irony is why there is not talk of an increase rather than a decrease in the spending.

6.3 Whatever is said and done, there can be no doubt whatsoever that the return achieved from support of measurement science and technology is demonstrable, immediate, sustained and creates an economic and social impact now. The paradox is that the UK is benefiting from a good level of support in the past. It's not as much as in some other countries, but UK is amongst the top three in this business- although rapidly now challenged by Japan, Korea and China as the Asian economies ramp up this support. All developed and especially developing countries realise that they have to have these infrastructures to trade, protect their environment and to be a player on the world scene. As a response, UNIDO has several hundred million dollars earmarked for investments in measurement infrastructure. I recently met with the Secretary General

and his Deputy Director responsible for sustainable development and who said that " UNIDO doesn't do enough to help developing countries who have no choice to show compliance with measurements if they want to trade in the world". If this is true of the developing world, it is significantly more important for an economy like the UK which is hugely dependent on technically competitive exports.

6.4 The good news is that these are—sustained benefits delivered on a day to day basis, rather than promised for the future. It really is "jam today". These are not wistful academic hopes of a possible application; they are real benefits being ploughed into the economy and sustaining economic development everywhere. So pulling back makes no sense. They would hurt UK industry, slow down innovation in new technologies and mean that the UK would not be able to work in the leading edge groups dealing with the measurements related to the Great Grand Challenges, to our way of life, and to industrial development and growth.

I am very happy to amplify my remarks to the Committee should it so desire.

Professor Andrew Wallard
Director, International Bureau of Weights and Measures

January 2010

Memorandum submitted by Dr Rob W van Nues (FC 02)

AN ECONOMIC IMPACT MEASURE FOR FUNDAMENTAL MOLECULAR BIOLOGY RESEARCH DEFIES ALL LOGIC

My perspective is that from a research associate with more than 20 years laboratory experience. I have some questions to raise and experiences to pass on. The idea of an "economic impact measure" as a valuable tool to direct, stimulate or regulate future research efforts seems ill-conceived. Such a measure is superfluous and will be counterproductive.

1. Fundamental research teaches more skills and trains thinking. I have been working, since the start of my practical undergraduate and doctorate studies, in so-called fundamental research: as a student I made this choice over that of biotechnology (being the more popular direction in our faculty at that time) which was focusing on industrial/applied topics. The reason for this was that in the "fundamental" group I would learn more techniques, which were (a) newly discovered, (b) not easy to make successful and (c) together comprised a fairly complete "toolbox" of up-to-date practical and specialist knowledge hard to attain elsewhere. Furthermore, discussion about mechanisms, how things work in nature were mainstream and more important than just solving problems of how to get a greater yield out of the same amount of substrates. Biotechnological gene-manipulation was all based on knowledge obtained in the more fundamental areas of gene-transcription; protein-localization and transport; and for which industries cooperated with the more fundamental research groups to optimize these findings in their interest, as I witnessed during my doctoral studies.

In subsequent jobs, I have learned every time the most recent techniques developed in my field. And I learned that nature does not lie. To find your way through it, as happens by doing fundamental research, requires creative thinking, a sceptical but positive frame of mind and a lot of experimentation to correct false assumptions/conclusions/predictions. The more we begin to understand the more complex nature reveals itself to be. Applied science does not allow for wandering in the dark, the path is known; only the fastest means of transport has to be found.

FUNDAMENTAL RESEARCH GENERATES APPLICABLE OUTCOMES THAT CANNOT BE PREDICTED

2. During my first post-doc in Edinburgh I studied protein-protein interactions involved in an essential modification of messenger RNAs (without this modification the genetic information contained in these molecules would not be correct, resulting in the synthesis of incorrect or incomplete proteins). This process we studied in baker's yeast, as the process is so fundamental for life that its mechanism in yeast can be directly compared to that in more complex organisms like humans. We published a finding that particular mutations in one of these proteins would prevent the interaction with another one and thereby causing a lethal malfunction of the system. When I had left, it turned out that a group in Sheffield researching an eye-illness found causative mutations in a human gene coding for the counterpart of one of the yeast proteins we had studied. Their mutations were highly similar to the ones we had described. Based on our yeast work they could proceed with their finding and eventually conclude that a similar protein-protein interaction would be disturbed in case of the eye-illness. Thus, our fundamental work had an outcome, although completely unforeseen, that had direct application in a completely different field and for different scientists. (But how do you evaluate the "economic impact" of this if you had known this in advance?).

ADOPTION OF "ECONOMIC IMPACTS" LEADS TO RETROSPECTIVE FUNDING AND LACK OF PROGRESS

3. History of biological science will show that it is in the fundamental research areas that major experimental breakthroughs are made that eventually find widespread use (DNA, restriction enzymes, PCR, antibodies, DNA finger printing, gene-therapy). I wonder whether such development can happen in research that will be able to exactly predicts its outcomes and targets. Such predictability will be needed if one wants

to talk sensibly about (and compare between) 'economic impacts' of different research proposals. Any real fundamental research application, however, can only state what it plans to study but can not predict the outcomes, unless the work has already been done. Therefore, I foresee that this pressure will have an unintended outcome, namely the silent adoption of a system in which scientists apply retrospectively for funding. Still, this will not guarantee experimental breakthroughs required to keep the field developing.

Funding Based on "Economic Impact" is Superfluous

4. Current research into, say, novel antibiotics happen predominantly at universities as part of fundamental research. When findings become applicable, companies are set up and bought over by big pharmaceuticals. This provides a funding stream for these research groups and associated universities which seems quite natural. The "economic impact" measure will argue to preferentially fund this kind of research that, however, has already been successful and is able to recruit external monies. Therefore "economic impact" measures lead to paying groups that can do without such money. Overall, the range of research that can be funded will shrink.

What Will Count as Having "Economic Impact"?

5. Almost everything can be described as having an economic impact (to let me have a job for instance). But, looking at the appointed board of directors of funding bodies, it comes across that only that kind of research will be counted as having "economic impact" that will fit the capitalist model of earning money. A cure for HIV which is affordable for Africans? Not economic feasible according to the major pharmaceutical companies. Development of novel cheap antibiotics that get rid of MRSA and "super-bugs" in hospitals? Idem ditto, all left to universities to find out. I fear that such research will also lose out when "economic impact" measures are introduced.

Only History can Tell whether Research had 'Economic Impact'

6. Scientific findings (see 4) with a genuine economic impact have been judged as such by history, in retrospect, with gaps of decennia between discovery and application. The idea of evaluating "economic impact" in advance as would be the case with grant proposals, would try to bypass this historic filter and can only result in speculation, driven by nepotistic judgements as known from the "Dragon"s den" or "The apprentice". It would be quite cynical that scientific endeavour will be regulated by illogical fortune telling. Speculation of would-be investment bankers replaces scientific argumentation! Why not set up a grant-lottery? That would be more honest, fair and time-saving.

"Economic Impact" Is Not The Only Desirable for an Healthy Society

7. As stated above (see 2) one of the major lessons I learned by doing science is that nature (including our society) does not lie and cannot be made to lie. Predictions can only be accurate in as far as we understand the natural phenomenon involved. This taught me a sceptical outlook and always made me ask questions as: "What if", or "Did you check for this?". In general, such questions should be asked in the case of developments with a large impact on human well-being, on environment, or on heritage left for future generations. This attitude is necessary for a healthy democracy, but often contrary to attitudes of people driven by "economic impact".

"Economic impact" often assumes that we can know everything and can calculate everything (risks, future profits etc.). This assumption has been refuted time after time: look at the banking crises and its effects. The rise of super bugs in exactly those places where we go to get cured! Radioactive waste. Floating islands of plastic in the Pacific. All a result of "fast economic solutions" not hampered by a lack of natural understanding and healthy scepticism!

Scientists and explorers dealing with uncertainty in finding out about the unknown, thus provide a healthy counterbalance to all people who are solely driven by their bank-accounts.

The values of a large proportion of our society will be ignored by focus on "economic impact". Progress can not always be translated into utilatarian valuta. It also comes to the fore in education, literacy, respect, trust, tolerance, knowledge, love of nature, and a healthy environment; ie well-being (as opposed to materialistic welfare). A lot of people care for other values than profit and immediate "economic impact" and who all pay taxes that fund research.

January 2010

Memorandum submitted by Dr Sumedh Anathpindika (FC 03)

1. I take this opportunity to express myself on an issue, crucial to the future of science in Great Britain. I am mindful of the gubernatorial endeavour of achieving excellence in science by having as many British universities as possible, at the forefront of global scientific research. The "research impact evaluation", obviously a part of this policy, aims at promoting and supporting the best research projects. Taking a step further, I may claim that armed with this shrewd policy, the government is aiming to shoot two birds in a

single shot; on the one hand it attempts to achieve its goal of promoting Britain as a hub for scientific excellence and on the other, tighten fiscal allocations towards research in pure sciences. It appears that the progenitors of this ingenious scheme of "impact evaluation" have somehow concluded that science and scientific research is just another game of trickery, where results become available at the click of fingers. I submit, Sir, this is not only a dangerous, but a ludicrous and preposterous hypothesis.

2. Scientific research being peer-reviewed is self-regulatory, and results fundamental in nature cannot simply be evaluated by their possible economic worth; for they may have none, however, they could have ground-breaking applications in engineering. While this could be true to some extent, there are yet other branches of physical sciences, purely theoretical in nature, such as astrophysics that have little economic worth. Clearly, astrophysical research, though borrows and contributes to numerous techniques from several other physical sciences, has little social impact besides satiating human fascination towards the cosmos. Having said this, I must quickly add that the foundations of modern astrophysics, laid in the early part of the 20th century, provided great impetus to developments in physics and engineering. Quantum mechanics, is one of its fruits that drew the curtains on the second World-war, and whose applications now span every aspect of human life; for quantum mechanics, we luxuriate ourselves in various possible ways.

3. We can ill afford a policy that forces out results, such a policy, will only encourage scientific malpractices resulting from the desperation for seeking quick, sensational results. Science cannot ever flourish in the midst of insecurity and several young scientists have quit their academic careers owing to this insecurity. I know of at least half dozen (British) colleagues who, in the last two years, have take such a dramatic step. The situation is paradoxical since, on the one hand government agencies such as the British council has been diligent in promoting British universities as centres of excellence in scientific research, attracting post-graduate students from across the world, while on the other there is hardly any funding for further research. Thus, while the universities are churning out a substantial number of young doctorates, the system is unable to absorb them. Young men and women with doctorates from subjects such as astrophysics are unlikely to be employed by multinational companies for want of other technical skills, and themselves are suffering in the prevailing bad economic climate. Scientists are therefore increasingly pondering about funding and issues alike, much less about scientific issues.

4. While a healthy competition is desirable, cronies cannot be admitted in the field. The present system, I am afraid, encourages formation of large conglomerates where only a handful of senior people dominate and stymie new ideas, divergent with their views, incorrect they may be. Scientific research must be free of such fetters. Britain has an illustrious tradition of scientists and philosophers because of the socio-economic freedom, and governments in the past have been custodians of this freedom. The government of the day, though pledges to uphold that tradition, seems to practice a policy that antagonises the glorious tradition.

5. The need for a review mechanism is undisputed, however, physical and natural sciences must be decoupled from engineering sciences. The criteria of "impact evaluation" must be revised and seen in context with general research in a particular field to which the respective research proposal belongs. It must be realised that advances in engineering cannot be sustained without corresponding research in pure sciences, and so funding in pure sciences must be much more liberal. Currently with just a handful of funding opportunities such as the STFC and schemes patronised by the Royal Society, success rates are simply appalling. For Britain to become a global destination in science and technology, research funding increase substantially, a blanket policy of evaluating research proposals must be given up; research must appear as a viable career option, that it does not at the moment, is a matter of deep regret.

January 2010

Memorandum submitted by Martin Ward (FC 04)

The purpose of academic research is to push back the boundaries of human knowledge. I believe that knowlege is intrinsically valuable, and therefore worth pursuing regardless of any immediate or future material benefits: this is one of the things which distinguishes a civilised society from a savage society.

But for those who disagree: it is impossible to measure the future value of any pure scientific research in any meaningful way. In my own field of Computer Science, Alan Turing's work on computability theory led to the publication of only one highly theoretical paper.

Any "impact assessment" would have declared this work to be worthless. But it eventually led to the code-breaking triumph at Bletchley Park and the development of the computer, but not even he knew that at the time.

In the early 1960's, mathematician Carol Karp investigated the extension of the theory of mathematical logic to expressions and formulae of infinite length. This was a piece of pure mathematics research with, apparently, no possible applications or "impact" whatsoever. Twenty years later, this work turned out to have an application in the mathematical analysis of computer algorithms: this formed the basis for my DPhil thesis on program transformations. This was still a piece of pure research with no immediate application.

But today, this theory forms the basis of the FermaT Program Transformation System: which has been and is being used by many major companies to migrate multi-million line assembler systems running on expensive manframes to more maintainable high level language systems running on PCs and workstations.

The companies involved in these migration projects have included EDS, HBOS, IBM, Microfocus, Royal Bank of Scotland, Tenovis, Tesseract and the USA Social Security Administration and Inland Revenue Services.

January 2010

Memorandum submitted by Dr D Crouch (FC 05)

1. I have worked in academia for 15 years. My field of research is science, focussing specifically on cancer biology. I categorically feel that the impact of the majority of research projects CANNOT be measured in the short term, and should not be used to decide where to make cuts in spending. The feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective and looking to the future, cannot be predicted accurately (see specific examples detailed in paragraph 2 below).

2. Some examples to support this are given below, where the significance and potential of each discovery was not realised until many, many years later. These include:
Penicillin—this discovery was a completely accidental by Alexander Fleming in 1928. However due to difficulty in its production, it wasn't successfully mass produced until 17 years later (1945), and led to the Nobel Prize for Fleming, Florey & Chain in 1945.

Keratins—discovered in 1952, but it wasn't until 39 years later ($\sim$1991) that it was discovered that mutations in the keratins were the cause of many skin fragility disorders. Gene therapy studies were published around 2000.

TAQ polymerase—discovered in 1965. Its potential in molecular biology was not realised until 1980s when Cetus applied it to synthesise DNA (polymerase chain reaction or PCR). It was named molecule of the year in 1989, 24 years after its discovery. Estimate $2 billion in royalties. Nobel Prize awarded in 1993 to Kary Mullis. Developments in PCR are still ongoing today.

Green Fluorescent Protein—discovered in 1960s from jellyfish, but was only first used in 1992 for fluorescent imaging of cells and proteins. This protein has revolutionised how and what questions scientists can ask. This initially was a simple description of a protein in a jellyfish, whose properties were only exploited 32 years later. Developments are ongoing today.

Structure of DNA—crystal structure by Watson and Crick in 1953 was an academic exercise, but which much later helped in the development of wider applications many years later eg Human Genome Project in 2003.

DNA sequencing—discovered in the 1970s by Maxam & Gilbert and Sanger. The wider application of this for forensics, clinical diagnostics, biotechnology industry, and the human genome were not realised until much later.

Restriction enzymes—discovered in 1970 and led to the development of recombinant technology. Nobel prize in 1978.

Recombinant DNA technology/molecular biology—has revolutionised the way scientists work. At the time ($\sim$1970s), there was no concept of the full potential of this, and years of incremental developments have led to an incredibly powerful technology base. This was recognised by a relatively quick patent (1980), but this was still some 8 years after the discovery.

Discovery of x-rays—in 1890s, Rontgen persevered with the development of x-rays. The impact of this in medicine was not realised until later.

3. Projects that have a measurable impact within the limited timeframe of the REF have been supported by many years of background research. The majority of strong solid science does not happen in restricted periods of time.

4. Measuring impact would credit very few research projects which are at a sufficient stage of development, and at the stage of having impact in terms of patenting, drug discovery, therapeutics etc, whilst not crediting the majority of projects whose long term potential is not realised.

5. Research is for the long term. Measuring impact and rewarding small numbers of projects will restrict our long term investment in future research, restrict the projects undertaken and could be detrimental to future scientific developments in the UK.

6. Measuring impact in this way could restrict research that scientists do. Most scientists do research that asks fundamental and important questions, however, it should be understood that major advances in the field are often only realised later or are completely serendipitous (see paragraph 2 for a few examples).

7. Research projects may not have a major impact in their own right at one particular time, however, might contribute to the greater picture eg multiple cohort cancer studies around the world all contribute to the greater scientific picture, but these wouldn't all be done at the same time. So timing of all studies would have to be the same for a project to have impact which is completely unrealistic.

8. The time scale for different research projects differs enormously depending on their complexity and/or novelty ie whether they have been running for many years or just initiated. Hence, projects that can be realised in the short term might have impact, whilst longer term projects would be graded as lower status as they did not realise their impact within the timing of the REF. Also projects that just have been initiated could be graded as low impact.

9. I declare an interest in this.

1 February 2010

Memorandum submitted by Professor Jon Billowes (FC 06)

I am writing as Head of the nuclear physics group, University of Manchester and as Director of Education, Dalton Nuclear Institute. I am involved in nuclear skills education and training. I am course director for the NTEC MSc in Nuclear Science & Technology (a consortium of 12 UK universities), and PI for the Nuclear Industrial Doctorate Centre (involving eight universities). I served on the panel for EPSRC/STFC Review of Nuclear Physics and Nuclear Engineering (2009).

1. I write to draw the Committee's attention to the EPSRC/STFC Review of Nuclear Physics and Nuclear Engineering (2009) chaired by Dr Sue Ion (attached to the email version). This contains a recent analysis of the skills and expertise relevant to future economic impact in nuclear-related areas and on the ability of the scope and volume of the current nuclear physics and nuclear engineering activity to deliver these skills and expertise. A particular comment (made in advance of STFC's most recent 29% cut in nuclear physics funding, announced on 16th December) was that "recent funding cuts had damaged the UK's nuclear physics community and that the size of the community now meant it was extremely vulnerable. It was recognised that financial pressures have an adverse effect on the ability of the nuclear physics community to realise its potential in economic impact areas. It was felt that further funding cuts could be terminal, resulting in the loss of an important skill set which would impact the delivery of Master courses." At a time when every UK nuclear skills analysis emphasizes the critical need for a trained nuclear workforce for the future energy programme (including the report by the Innovation Science & Skills Committee on nuclear engineering—HC 50–1, 27 March 2009), STFC is marching in the opposite direction, with no regard for UK future strategy, by making deep and disproportionate cuts to UK nuclear physics funding.

2. Recent comparative figures (attached to email) about to be released by NuPNET (network of European nuclear physics funding agencies—an ERANET funded by the EU under FP7) show that the UK funding is well behind that of Poland, Romania and Spain. The most recent STFC cut pushes the UK below Bulgaria. The UK neither hosts any major facility for nuclear physics research, nor makes any significant contribution to the overseas laboratories at which the UK research programme is conducted. The UK will now be forced to withdraw from international nuclear physics projects; there will be a cut in PhD studentships (we don't know yet to what level); and an inevitable reduction in post-doctoral opportunities in the UK. Quite apart from the impact a smaller nuclear community will have on nuclear education at undergraduate and Masters level, there will be a significant reduction people with higher-level specialist nuclear skills.

EUROPEAN FUNDING FOR NP (NuPNET)

Country Funding	*(MEuro)*	*Tenured Physicists*	*Total Physicists*	*Tech/Engineers*
Belgium	7.6	38.0	133.0	21.0
Bulgaria	6.8	28.0	52.0	9.0
Czech Republic	5.3	16.0	75.0	12.0
Germany	200.0	330.0	1,100.0	500.0
Spain	21.0	119.0	215.0	15.0
Finland	5.3	24.0	120.0	25.0
France	87.5	351.0	488.0	566.0
Greece	2.3	35.0	55.0	15.0
Hungary	3.1	59.0	87.0	26.0
Italy	64.8	354.0	628.0	295.0
Netherlands	9.7	31.0	78.0	55.0
Poland	14.5	203.0	441.0	109.0
Romania	19.5	213.0	340.0	85.0
UK	11.7	63.0	228.0	31.0

Notes:
Total Physicists = Tenured + Fixed term + PhD students

January 2010

Memorandum submitted by Professor Leslie Ann Goldberg (FC 07)

"What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)"

1. The most important thing for the committee to appreciate is that it is simply not possible to accurately estimate the socioeconomic impact of research in advance. Often, it takes a long time (decades, even centuries) before impacts become apparent. Thus, impact assessments are not reliable.

2. In addition to being unreliable, allocating research funding on the basis of perceived socioeconomic impact is positively harmful.
(2a). It diverts scarce funds from excellent research to less excellent research.
(2b). It drives the best researchers out of the country.
The result of (2a) is fewer top-quality research results, hence (ironically) less socioeconomic impact.
The result of (2b) is that the research that does have economic impact will be done elsewhere, in other countries.

3. There is ample evidence to support these points.

(1) The history of science is full of examples of scientific discoveries which had huge impacts, but for which no impacts were apparent at the time. I work at the intersection of pure mathematics and computer science, and here the examples are ample. Essentially all major mathematical discoveries fit into this category, for example calculus (a necessary foundation for essentially all of engineering), number theory (a necessary foundation for all modern cryptography and computer security), and algorithmics (which underlies all of the internet tools such as Google, which we take for granted). The best models that we have for understanding and influencing economic interactions on the internet come from game theory, a branch of pure mathematics and economics whose fundamental discoveries are the result of curiosity-driven research. The best error-correcting codes that we have for use in scientific applications result from group theory—from decades of curiosity-driven research in discrete mathematics. Such examples exist throughout the sciences. For example, it is well-known that the laser, the x-ray, and semi-conductors, all of which are completely essential for modern technology, all resulted from curiosity-driven research whose applications were not apparent at the time and could not have been predicted at the time. There are examples everywhere you look—the discovery of the electron, the discovery of DNA, the discovery of positrons (a completely curiosity-driven discovery that turns out to be useful for medical technology), the discovery of liquid crystals (well before LCDs were envisaged). None of these discoveries would have been judged to have substantial impact at the time of discovery.

4. Unfortunately, there is also plenty of evidence for statement (2) above. It is self-evident that introducing criteria other than "scientific excellence" into the process of determining which scientific work to fund results in less focus on excellence. More concretely, a recent study at MIT found that innovative research is more likely to stem from funding regimes which are long-term in nature, and which require researchers to give fewer specific aims. In addition to stifling innovative research, the new proposals are likely to drive much of this research from the UK. As a result of the proposals, morale amongst UK scientists has become extremely low. Over 18,000 academics have signed the UCU petition against the "impact" assessment as part of the proposed REF. In a recent UCU poll, a third of the 600 professors polled said they would consider moving to another country if the changes came into effect. I feel sadly confident that this will happen. Other countries are not using perceived economic impact as a criterion for science funding—for example this flawed criterion is entirely absent from the current US National Science Funding processes. Both the US and Germany have recently announced increased funding for scientific research (during a period of cuts here in the UK). British academics are following the issue closely—for example the recent CaSE debate between Lord Drayson, the Conservative Shadow Minister for Science and Innovation and the Liberal Democrat Science Spokesman was oversubscribed. If the ill-advised policies persist, the best-qualified academics will simply leave the country. We have plenty of examples of leading academics who have already done that (Harry Kroto, for example). In my field, many of the brightest British PhDs moved to the US anyway. The current policies may force the rest of us to go with them. (Ironically, I moved from the US to the UK during a period in which the UK was better at supporting fundamental scientific research, but the tables have turned.)

5. I thank the committee for investigating this important issue. More evidence is available at my website http://www.csc.liv.ac.uk/~leslie/impact/impact.html

Declaration of interests: I am a professor in the Computer Science Department at the University of Liverpool.

Memorandum submitted by Professor Phil Allport (FC 08)

COMMENTARY ON STFC: FINANCIAL, STRUCTURAL AND LEADERSHIP ISSUES

1. The problems with STFC fall into 3 categories, each of which individually would represent a major handicap but which together have led to an organisation that is manifestly not fit for purpose. The areas in need of resolution can be broadly identified as financial, structural and governance/leadership. Many of these issues had previously been identified by the House of Commons Select Committee on Innovation, Universities, Science and Skills in its April 2008 report, but we feel that little progress has been made since this very comprehensive analysis was published. We particularly agree with the Committee's conclusions which seem to be as relevant today as they were nearly two years ago. *"STFC's problems have their roots in the size of the CSR07 settlement and the legacy of bringing CCLRC and PPARC together, but they have been exacerbated by a poorly conceived delivery plan, lamentable communication and poor leadership, as well as major senior management misjudgements. Substantial and urgent changes are now needed in the way in which the Council is run in order to restore confidence and to give it the leadership it desperately needs and has so far failed properly to receive. This raises serious questions about the role and performance of the Chief Executive, especially his ability to retain the confidence of the scientific community as well as to carry through the necessary changes outlined here."*

(A) Financial Issues

2. The financial issues date back to the underfunding of STFC at its formation through the shotgun marriage of CCLRC with PPARC. These are also well documented in the Select Committee report, which includes the recommendation *"We believe that the Government should ensure that its original commitment to leave no legacy funding issues from the previous Councils is honoured."* That this issue was never addressed remains at the heart of STFC's financial difficulties.

3. The lack of sufficient resourcing at the formation of STFC, in the relatively affluent times before the current recession, makes the impact of subsequent cuts even more severe. In addition, the increase in the fraction of first PPARC and then STFC's budget devoted to international subscriptions has inexorably squeezed the funding available to do the science which the subscriptions in principle enable. These problems came to a head in the December 2009 announcement of further cuts by STFC Council, cuts which have decimated the programmes of all areas of science in STFC's stewardship. An astonishing number of projects have been terminated, representing a wanton waste of years and sometimes decades of UK investment in cutting-edge science. The problem is certainly exacerbated by allocating resources by project rather than programme, since programme managers would be able to make more nuanced decisions than the current STFC committees. For example, the current advisory panels could more efficiently manage a financial envelope for a field, fitting in small activities which keep future opportunities alive. The crude top-down planning that the current structure necessitates has caused enormous reputational damage to the UK.

4. There are many recent analyses of the financial difficulties within STFC. A good recent critique of STFC's self-congratulation over the recent emasculation of the research areas for which it has been entrusted stewardship can be found in the January 12th 2010 4pm contribution to http://www.newscientist.com/blogs/thesword/. It is entirely disingenuous to blame STFC's problems on the "global financial crisis". Needless to say, the impact of cuts which could total 15 to 20% on top of 25% cuts currently being implemented in, for example, particle physics is devastating to both its programme and morale. The timing is also disastrous, with major facilities at CERN and JPARC (Japan) just starting. Indeed UK involvement in one of the 4 major LHC experiments is to be terminated (ALICE) and the long-term future involvement in LHCb is threatened by non-funding of the LHCb upgrade programme. Furthermore, almost the entire particle astrophysics programme in the UK is to be terminated, negating decades of investment and achievement by UK scientists. Even projects not cancelled are to be cut by 10–15% on top of both explicit and implicit further cuts to the grants line. Across all areas it is difficult to see any glimmer of a long-term science strategy for STFC, with the current plan reading like a staged withdrawal from almost all areas of STFC science. Since low-cost investments that keep alive longer-term aspirations are being cut despite the savings being negligible, the clear implication is that the UK is deliberately planning to exit from the sort of blue skies research currently supported by STFC, a message not lost on UK students thinking about careers in science or overseas scientists thinking of bringing their talents to these shores. And to heap insult on injury, part of the recent STFC cuts involve a 25% reduction on PhD studentships and no new postdoctoral fellowships at all in 2010, at a time when the country is crying out for highly skilled young scientists.

(B) Structural Issues

5. The structural problems arise mostly from STFC's CCLRC + PPARC inheritance. The organisation has signally failed to resolve the conflicting demands of the scientific communities it ought to serve and the needs of the facilities and staff it manages directly. This is made worse by STFC having to tension its grant-giving function to University groups (the PPAN areas) with resourcing its laboratories and facilities (the PALS line).

6. Indeed, its recent decision to transfer up to £25 million to £28 million per year from the PPAN line into the PALS line shows the consequences of such a major conflict of interest which will cripple the research in University areas supported by STFC grants. There are three prima facie problems:

(i) that year-to-year changes in international subscriptions are beyond the control of the UK;

(ii) that the funding of national facilities is currently tensioned against a small subset of the UK science programme and there is a major conflict of interest for an organisation that both runs its own national facilities and subscribes to international ones;

(iii) that no functional forum, with appropriate representation from the major stake-holders, exists in which a national strategy for investment in facilities can be formulated.

7. Our specific proposals to solve these three primary problems are as follows:

(i) Each particular Research Council with the predominant use of an international facility takes responsibility for the corresponding subscription and the volume part of that subscription is transferred to that Research Council budget. Future volume changes in that international subscription should come out of the overall budget of that Research Council, but all other changes, which include currency fluctuations, GDP changes and the inflation compensation built into the international agreements, are dealt with centrally. In year, the non-volume changes for each subscription are compensated centrally at the highest possible level, preferably above RCUK. This proposal follows the suggestion of section 8.9 of the Wakeham review.

(ii) Establish a National Laboratory (physically located over multiple sites) with responsibility for the national centres and facilities, such as ISIS, and for the provision of large-scale engineering and computing facilities for both public and private sectors. Innovation campuses sit naturally inside such an organisation. The National Laboratory should be run by a Director reporting to a stakeholder Board, as in all comparable major laboratories overseas. The National Laboratory should be funded by subscriptions from each Research Council, initially set according to recent usage. These national subscriptions are set by this Board in a process that must strike the right balance between flexibility for the Research Councils and the stability required for running major facilities. The peer-review processes of the contracting Research Council to allocate time on the national facilities are unchanged. A properly constituted National Laboratory, which should include an appropriate level of in-house research activity, would naturally take its place alongside other national laboratories overseas providing reciprocal access to facilities.

(iii) There is a need for a forum where the national strategy for investment in large-scale facilities is discussed, and the choice is made between those facilities that are best provided nationally and those where it is more advantageous to join an international facility or bid to establish one in the UK. It is important that any such body is representative of the UK science community as a whole, and that it is at a sufficiently high level to have the necessary authority. Proposals for new national facilities would come naturally through the Director of the National Laboratory. A separate National Science Facilities Board with representatives from RCUK, the learned societies and representatives of UK Universities, would make recommendations to RCUK about the relative priorities of the various options. A mechanism must be found to couple consideration of operating costs tightly into the decision process.

8. It therefore follows that the residual grant-giving functions of STFC would be best dealt with by a new research council with responsibilities for the international subscriptions relating to astronomy, space science, nuclear and particle physics and the communities they serve. These subjects have many links and the time scales required for planning their programs run into decades, requiring a Research Council with a long strategic-planning horizon. Research grants in the current PPAN areas must reside within the same Research Council that pays the international subscriptions in these areas. Separating these functions would not allow for the tensioning of volume increases or decreases in international subscriptions with exploitation based on peer review. It would therefore be highly undesirable to transfer existing STFC grants in the PPAN areas into EPSRC.

(C) Leadership and Governance

9. The issues of leadership and governance by STFC Council were already highlighted by the Select Committee. The communities that STFC serves have even less confidence now than they had at the time of the last Select Committee report that their science is being appropriately advocated to Government or even discussed in an even-handed way between the different disciplines. The sort of spirited defence of his research council activities in the face of proposed cuts launched by MRC Chief Executive, Sir Leszek Borysiewicz, (The Times, 11th January 2010) is completely lacking in the context of STFC.

10. By contrast, in its 2008 report the Committee raised serious questions about the STFC Chief Executive's ability to retain the confidence of the scientific community. This confidence has long ago evaporated completely, and it is a widely held view that his removal from office is an essential prerequisite to addressing and solving STFC's problems.

11. STFC as presently constituted is also unable to provide coherent leadership for either of the UK National laboratories at Daresbury and Rutherford. The Select Committee recommendation that each laboratory should have scientific leadership in the form of an on-site laboratory director has been ignored by STFC. Such directors would be a natural part of the advisory structure for the overall National Laboratory Director that we advocate above.

12. The greatest problem, however, as stated above, is that the STFC Chief Executive does not enjoy the confidence of any of the communities STFC should serve. STFC is managed by edict and spreadsheet and even when it consults, it either ignores the inputs entirely or fails to iterate proposals with those involved in the consultation. Despite recent efforts to engage more directly with the community, The Council still seems unable to impose good governance on the Executive. The dreadful financial settlements, with the irreparable damage they are doing to subjects where the UK genuinely enjoys international leadership, all point to the need for a new model and a new style of management. This is now long overdue, and vital to rekindle the sort of confidence within the community that the current incumbent is patently unable to provide.

13. In conclusion, STFC has so many deep-seated structural and managerial problems that a new start is desperately required to save the world-leading science that its failed stewardship has placed in jeopardy. We believe that the way forward is clear: strip STFC of its responsibility for national facilities with the concomitant internal conflicts of interest by founding a National Laboratory which would tension the funding for these facilities against ALL the science they serve; properly protect the remnant organisation from changes beyond its control caused by currency fluctuations, inflation compensation etc. in its international subscriptions; and establish new leadership to allow the enormous expertise and potential of UK scientists in astronomy, nuclear physics, particle physics and space science to continue to flourish at the forefront of world science.

Memorandum submitted by Professor Julie Gray (FC 09)

Feasibility of Estimating the Economic Impact of Plant Science Research

1. I have been an active university-based researcher since 1983. I was initially attracted to the Plant Science field by the opportunities arising from plant genetic modification, an area that the UK was a world leader in at the time. Of course, all that has changed. The actions of NGOs and other interest groups effectively chased all commercial GM plant research out of the UK, and the EU, in the late 1980s. Although in my early research career I was co-discoverer on 14 industrially-funded patents (concerning the potential to manipulate fruit ripening and drought tolerance) it is now over twenty years since I have received any industrial funding for my research. I am dependant on Research Council funding as there are virtually no UK commercial interests in this area to approach for funding.

2. In a time when it is imperative that we double crop yields, whilst improving their tolerance to climate change, I believe that an understanding of how plants respond to their environment has never been more important. In addition to Plant Science's critical importance to food sustainability and climate change mitigation, I expect that photosynthetic and growth studies will be key in providing biofuels for the future. However, as the UK currently has such a poor commercial base in crop science research, it would not be meaningful to judge our research outputs in terms of economic impact. I believe that it would be catastrophic to Plant Science research to base any future funding model on economic impact as plant research could never compete favourably with, for example, medically based research areas, with their much larger UK industrial base.

3. Summary: Judging Plant Science research outputs in terms of economic impact is simply not feasible in the UK. Despite the critical importance of global crop productivity there is virtually no commercial activity in crop improvement in the UK. If future research funding is at all dependent on economic impact, UK Plant Science research could be effectively closed down – just when it is most needed.

Professor Julie Gray
Chair in Plant Cell Signalling
University of Sheffield

January 2010

Memorandum submitted by Early Career Cassini Scientists (FC 10)

We, the undersigned, are all early-career scientists at a range of UK institutions, primarily involved in planetary science using the Cassini spacecraft. We have prepared the attached document for submission to the Science and Technology Committee inquiry, detailing the impact the recently announced cuts will have upon our research, careers and opportunities in the UK.

Declaration of Interests

Those of us currently studying for PhDs are supported by the STFC. Those of us employed as research associates are funded by the STFC.

Early Career Cassini Scientists

Imperial College London, Space & Atmospheric Physics Group

Dr Jun Cui, Research Associate

Jack Cutler, PhD Student

Dr Caitriona Jackman, Research Associate

Dr Laurent Lamy, Research Associate

Daniel Went, PhD Student

Dr Laurence Billingham, Research Associate (Earth Science & Engineering Group)

University of Leicester, Department of Physics & Astronomy

David Andrews, PhD Student

Kay Clarke, PhD Student

Stephanie Kellett, PhD Student

Dr Henrik Melin, Research Associate

Dr Jonathan Nichols, Research Associate

Dr Gabrielle Provan, Research Associate

Dr Dean Talboys, Research Associate

Queen Mary University of London

Nathan Allcock, PhD Student

Dr Gareth A Williams, Cassini ISS Operations Programmer

Mullard Space Science Laboratory, University College London

Dr Christopher S Arridge, STFC Postdoctoral Research Fellow

Glynn Collinson, PhD Student

Sheila Kanani, PhD Student

Dr Adam Masters, Research Associate

Anne Wellbrock, PhD Student

University of Oxford, Atmospheric, Oceanic and Planetary Physics Group

Dr Leigh Fletcher, Research Associate

Dr Jane Hurley, Research Associate

Dane Tice, DPhil Student

1. We, the undersigned, are early-career scientists at a range of UK institutions, primarily involved in planetary science using the Cassini spacecraft—a highly successful international interplanetary mission that has been studying Saturn, its moons and local environment, since its arrival in 2004.

2. Worryingly, the recently published STFC Science Programme Prioritisation indicates that a "managed withdrawal" will take place from funding of operational costs for the UK-funded instruments on board the Cassini spacecraft. Furthermore, the report recommends that "support be withdrawn for exploitation grants of those projects not recommended for funding", ultimately leading to the cessation of Cassini-based science in the UK. We feel that the STFC Programme Prioritisation does not accurately reflect the community's views as expressed in the recent Near-Universe Advisory Panel (NUAP) report, to which we contributed extensively. STFC should provide a full explanation of how the community's input contributed to the Programme Prioritisation. It appears to have been ignored.

3. The planned programme of managed withdrawal is by no means unique to those of us involved with the Cassini mission. The current prioritisation process seeks to cut all UK-instrument support for space missions actively making in-situ plasma measurements. While we recognise the external economic pressures faced by the research councils, we believe that the long-term implications of such wide-ranging cuts will be severe, and will have a very real impact both to our research, and to the long-term future of planetary science.

4. As early-career scientists we are deeply concerned about the future of space physics within the UK, and in particular the loss of jobs, skills and training opportunities. The result of STFC's prioritisation process will force UK based early-career scientists abroad, or into leaving the field completely. Meanwhile, current PhD students face the very real possibility that there will be no UK planetary space physics

community for them to join once they have completed their studies, should they wish to continue their research. If we fail to retain our world-leading capabilities within planetary space physics, there will not be a future generation of scientists able to exploit upcoming missions, such as the Bepi-Colombo mission to Mercury and the potential Europa-Jupiter System Mission.

5. The international Cassini scientific investigation is in its prime—a quick search reveals over 2000 scientific papers published by nearly 4000 authors to date at a rate that has increased by 30% year-on-year since the spacecraft's arrival at Saturn.[1] NASA are currently reviewing a proposed extension of the Cassini mission to 2017, and are due to announce their decision on February 8, 2010. Scientists in the UK contributed to one of the discoveries of the decade, by detecting the magnetic signature of plumes of water ice ejected from Saturn's icy moon, Enceladus. It is now recognised that there is a very real possibility that a liquid ocean exists beneath the moon's icy shell, posing the profound question—is there life on Enceladus? This question, and the tools required to answer it, has an excellent ability to inspire lasting interest in the STEM subjects in the public, across all age ranges.

6. The UK is a world leader in space physics. Clearly, this reputation cannot be maintained if the UK's involvement is categorically withdrawn from one of the most successful international scientific missions to another planet thus far. Scientists around the world are relying on the UK's expertise in operating key instruments on board the spacecraft. It seems tragic to turn off healthy world-leading instruments on a £2bn spacecraft, denying both UK and our international collaborators a vital resource in our field. Serious questions must be asked about the value of these decisions that have been made by the STFC Council. The STFC has a Royal Charter to "promote and support high-quality scientific and engineering research"—our view is that this is not currently being achieved.

Memorandum submitted by Christopher Connolly (FC 12)

Please remove the requirement for "impact" in your future assessment of scientific research.

1. Impact is a Poor Driver of Success

Following strong leads to get answers is a reliable and dispassionate (professional) approach with clear value. Moreover, this process is peer-reviewed. Clearly there are urgent issues that need to be promoted by additional resources, but this mustn't replace fundamental research. We have come a long way in the past 50 years thanks to this approach. Scientists are devoted to their quest and subsequently work many additional hours free of charge. They are self-motivated and there is no better driver than this.

What evidence exists that "achieving impact" will be an equally motivating incentive? I very much doubt it will achieve any more than forcing scientists to deliver spin and killing their enthusiasm.

2. Impact is Hard to Measure

In the simplest scenario, a study on a particular disease may provide a vital piece of evidence, without actually curing the disease. How will this be measured by some quantitative value? What with "translational", "Impact", high-throughput and "Multi-disciplinary" there will be no more high quality, detailed research in the future, just vagueness, spin and abstract impact all delivered by the new generation of 'scientific story-telling'.

3. Brain Research

The next frontier is brain research. How can this revolution ever occur without a strong basic understanding of the biology of neurons, glia and networks. How much basic cell biology has underpinned our advances in cancer research? Would this success have been possible without it?

Impact is important and should be an important part of scientific research, but it should not be everything. My personal opinion is that, perhaps, 10% could be directed towards impact, this would maintain one eye on focus and the other on the immediate future.

Please reconsider by circulating a poll/questionnaire of active scientists. "But they're all biased"—No we are not, that's the point.

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[1] Thomson Reuters Web of Science, topic "Cassini", Number of papers published per year, 2004–09 inclusive.

Memorandum submitted by the Royal Society / Royal Academy of Engineering Science Advisory Group for the National Physical Laboratory (NPL) (FC 13)

RESEARCH FUNDING CUTS

I write to you as Chair of the Royal Society/Royal Academy of Engineering Science Advisory Group for the National Physical Laboratory (NPL), in order to make the enclosed plea for the National Physical Laboratory, the UK home of Measurement Science and Technology.

This group is formally part of DBIS and reports annually to the Secretary of State for Business, Innovation and Skills. It is supported by the National Measurement Office (NMO), as part of the National Measurement System (NMS).

This group was established over 13 years ago when NPL became a GOCO and the government asked the Royal Society and the Royal Academy of Engineering to monitor the quality of research at NPL, and to assist in maintaining the high international profile for which NPL was renowned. It consists of six eminent Fellows[2] who advise NMO on the quality of science at NPL and on strategic issues such as NPL's longer-term research capability and whether its reputation for excellence is being maintained.

Although the enclosed may not be exactly in the nature of what you are expecting, the Advisory Group considers its content to be very important for the UK's future academic standing and industrial competitiveness. On that basis, I would ask that your Members consider it seriously.

Ian Shanks

A PLEA FOR THE NATIONAL PHYSICAL LABORATORY, UK HOME OF MEASUREMENT S&T

1. The National Physical Laboratory (NPL) holds the UK Government's formal responsibility for measurement science and technology, a role that began many years ago. It carries this remit proudly, for it ranks equal with the world-class centres in the USA and Germany. Measurement technology underpins much of industry, and NPL's mission is essential if the Government's increased investment in R&D is to have economic impact. The knowledge generated by academia cannot be translated readily into products with the standard and precision required by the customer. The growth in regulation, by both the Government and the EC, makes this bridge vital.

2. Industry moves rapidly today, and so must measurement science. The ultra- precision time measurements needed for advanced telecommunications, and the biotechnology measurement tasks demanded by the pharmaceutical industry are examples of these new major scientific challenges. To ensure that NPL stays in this race, the Government commissioned the Royal Society and the Royal Academy of Engineering to establish a monitoring group who would survey their scientific capability, and report to the relevant Secretary of State, now Lord Mandelson. We now wish to pass our concerns to you.

3. In the past several years we have witnessed NPL's struggle to maintain its reputation, built on stars like Robert Watson-Watt, the inventor of radar, Alan Turing, the father of modern computing, Louis Essen, the creator of the atomic clock, and John Pople, a Nobel prizewinner. The competition is harsh, and gifted scientists will come and stay only if they are confident that the future is bright. The task has not been eased by the higher profile given recently to science by the UK Government, for though the science budget has doubled, NPL has seen no benefit. Generosity for some has caused problems for others and this has tilted the level playing field.

4. Accurate measurements are of universal importance in advancing Science and Technology and setting fundamental standards. This is not solely an academic concern. The skills also underpin product developments. Defining and maintaining such standards and implementing them objectively are the very bedrock of the UK's commercial competitiveness. Our international rivals perhaps see this more clearly than the UK, for both before and during the recession their measurement laboratories have enjoyed excellent funding. In the US this was bolstered last year by a grant of over £500 million plus an 8% increase in their annual funding of £400 million. Compare this with NPL's much more modest annual government grant, which has progressively reduced in real terms to a figure of under £50 million in 2010.

5. At a time of budget cuts there will always be a rash of special cases for exemption. We, the Royal Society/Royal Academy of Engineering Science Advisory Group, ask for more than that. NPL has been a poor relation for many years, and the value it gives to the economy is vastly underrated by the Government.

[2] Ian Shanks FRS FREng FRSE (CHAIR) Formerly Vice President Physical & Engineering Sciences at Unilever and Chief Scientist THORN EMI plc; Visiting Professor of Electronic & Electrical Engineering, University of Glasgow.
Anne Dell CBE FRS FMedSci Professor of Carbohydrate Biochemistry at Imperial College, London.
Lynn Gladden CBE FRS FREng Shell Professor and Head of Department of Chemical Engineering and Biotechnology, University of Cambridge.
Cyril Hilsum CBE FRS FREng Formerly Director of Research, General Electric Company; Visiting Professor of Physics, UCL.
Sir Martin Taylor FRS Past Physical Sciences Secretary of the Royal Society; Professor of Pure Mathematics, University of Manchester.
Peter Wells CBE FRS FREng FMedSci Distinguished Research Professor, School of Engineering, Cardiff University; Visiting Professor, Institute of Biomedical Engineering, Imperial College, London.

We plead for the increase needed to maintain the UK's competitive position internationally, and can give evidence on the multiplication in money created by NPL's measurement science. We ask the Select Committee to support us in this endeavour.

Ian Shanks FRS FREng FRSE
(CHAIR)

Anne Dell CBE FRS FMedSci

Lynn Gladden CBE FRS FREng

Cyril Hilsum CBE FRS FREng

Sir Martin Taylor FRS

Peter Wells CBE FRS FREng FMedSci

Memorandum submitted by TUV NEL (FC 14)

1. Declaration of Interests

1.1 I am a director of TUV NEL Ltd (formerly the National Engineering Laboratory) and as such have interests relating to the National Measurement System (NMS) which is managed by the National Measurement Office (NMO).

1.2 TUV NEL is designated as one of three National Measurement Institutes (NMIs), the others being NPL and LGC.

1.3 In my 25 year career at TUV NEL I have been through the periods of operation within DTI; the operation of NEL as an Executive Agency; the privatisation of NEL and sale to Siemens; and the subsequent change of ownership to TUV. Prior to working at TUV NEL, I spent 4 years in post-graduate engineering research at Southampton University.

1.4 During the course of my career I have had considerable dealings with the energy sector within the UK and globally, as well as with the UK public sector. Much of the experience with the energy sector has been on industry-funded research projects.

2. Scope of Reply

2.1 Comments and observations are largely concerned with the area of scientific and engineering research undertaken by the NMS as this is where the vast majority of my experience has been gained over the years. This falls primarily in the "demand-led" research category described in your email.

3. Pertinent Comments

3.1 The vision and commitment to the delivery of practical engineering and science research is unfortunately woeful in the UK mainly because of the short timelines involved and the political aspects that have been all too evident over the last 20 years.

3.2 The organisation I manage has by its very nature major engineering infrastructure that needs to be actively managed in a way that encourages innovation and modernisation to address the national challenges. Over the years we have had some great successes, but the vision for this has largely come from within. There has been little, if any, encouragement from central government to the active development and support of the engineering capability located at TUV NEL. The infrastructure relies principally on support from the NMS, and this has no more than a 3-year time horizon, and as we are seeing now can be cut at any point. This is no way to manage and plan a unique engineering research resource within the UK.

3.3 When I took over the role I am currently discharging in 1993, the budget for the NMS Flow Programme (NEL's part of the NMS) was some £4.8 million per annum. It now stands at £3 million per annum. Making the comparison based on value today, this is a reduction from £7 million to £3 million per annum on a like-for-like basis. And yet flow metrology is right at the heart of many aspects of industry, business and taxation. The famous saying about "measurement" by Lord Kelvin is very true, but the strategic support within the UK to support measurement research and innovation is effectively being left to die a slow and painful death, either through neglect (no inflationary funding increases) or through more direct cuts as witnessed recently. And now with the prospect of more to come courtesy of the financial sector.

3.4 The flow metrology programme referred to is at the forefront of research into the challenges faced by the change in structure of the energy sector in the UK. Recent cuts within the NMS have had the bizarre effect of eliminating virtually all the support for metrology research in the area of low carbon technology. At a time when there should be vision, support and growth of these capabilities, we have in fact gone backwards. The programme is now faced with choosing which of the challenges in the energy sector to ignore: LNG, carbon capture, complex fluid metrology, low carbon technologies …. To say this is short-sighted as a nation is an understatement, but that is the reality today.

3.5 The questionnaire requested thoughts on impact. This is always difficult to gauge in advance or whilst in progress, but there are three different examples of impact that stand out amongst many I have observed.

3.5.1 During the 1990s the succession of cuts to funding saw all public support removed from the world leading structural test centre at the then NEL. This was a unique facility within the UK and Europe that allowed full-scale structural testing of large engineering components such as aircraft wings, oil platform legs and train carriages. The upkeep of the centre was substantial as large facilities of this type are highly capital intensive. Without the underpinning public funding the centre was closed within 5 years. The free-marketers may argue that this was a good outcome because industry should support such facilities. However, the UK now wishes to invest heavily in offshore structures for wind farms and the UK structural test and research capability that previously existed will not be there to serve the many and varied challenges that this will create. This is a good example of a lack of strategic vision within the public sector that has had major negative impact on the UK economy going forward.

3.5.2 The development of the atomic clock at NPL has spawned many innovations. It is at the heart of mobile phone technology and satellite technology amongst many other applications. Would this research have been funded under the current climate of "demonstrate impact"? A very resounding no is the answer because back in 1955 nobody could have foreseen the innovations that simply measuring time more accurately could have led to. I agree that applied research should be able to identify clear benefits and potential impact, but there is a strong case to diminish these requirements as the research becomes more long-term. It is after all this type of research that made the UK a leader in the scientific world.

3.5.3 At NEL we have spent the last 25-years developing and supporting the implementation of multi-phase flow measurement technology. This is an important aspect of the oil & gas production chain as it has allowed (along with other innovations) the development of deepwater reserves. This research has been underpinned throughout by the NMS through the provision of the necessary facility infrastructure to undertake the research. The impact has been multi-billion GBP. Contrast this with the metrology challenges now facing carbon capture and storage, which is at the same stage that the multi-phase flow research was some 20 years ago. The present funding cuts will mean that the NMS will struggle to provide anything like the same level of response, if any response at all to this challenge. This is where vision, strategy and commitment are needed within BIS and DECC, to support this type of grand-challenge on a long-term basis.

3.6 Competition between research organisations and between departments within government has been encouraged over the last 20 years. Is this a good approach to scientific research? It is a culture that certainly breeds short-termism and often hinders collaboration rather than promotes it. This is most definitely true within the NMS (the 3 NMIs compete albeit on a very unequal basis). It is certainly true also that the TSB, RCs and NMS view each other as competitors when there should be an underlying culture that actively breeds real (and long-term) partnership between these organisations. On balance I would be encouraging government to find ways of reducing competition between research organisations, but in exchange I would be looking for research organisations to be embracing the national challenges more readily than they do at present. There should be much more leadership and vision coming from BIS and DECC.

3.7 The involvement of industry in long-term strategic research programmes must be actively encouraged. Other countries, such as the US, have had very effective alliances between energy companies and the state over many years. The Deepstar and RPSEA projects in the US are good models to consider. Deepstar in particular has been running since the 1980s. This is certainly one method of helping to alleviate public funding shortages while maintaining long-term research. The key in these programmes is a shared vision.

The above points are a fairly wide-ranging set of observations based on 25 years of working in an organisation heavily involved in delivering publicly funded research.

I trust they are of interest to the committee, and would welcome more dialogue if you so wish.

Dr B C Millington
Director, TUV NEL

Memorandum submitted by the Engineering Professors' Council (EPC) (FC 15)

SUMMARY

1. The Engineering Professors' Council (EPC) represents the interests of engineering in higher education. It has over 1600 members in virtually all of the UK universities that teach engineering.

(a) failure to invest in world class facilities implies that it will be impossible to meet the Government's vision as set out in Higher Ambitions and the Science and Innovation Framework;

(b) the quality of UK academic research in engineering is world class;

(c) the investment in UK publically funded engineering research does not reflect the contribution engineering makes to the economy;

(d) a bold, imaginative approach to engineering research is needed if solutions are going to be provided to the global challenges at the same time as ensuring sustainable economic growth.

(e) incremental engineering research is required because that demonstrably achieves impact in the long term;

(f) a new framework needs to be created to develop transformative research that produces engineering solutions to global challenges;

(g) a review of the distribution of funds to HE is needed to ensure that the focus is on the front line activities of generating and disseminating knowledge; and

(h) there should be increased focus on those activities that do not contribute directly to generating and disseminating knowledge in order to achieve the efficiencies needed.

2. EPC would welcome the opportunity to give further details of its views on the means of funding science and scientific research that would deal with the global challenges and achieve the vision of the Government expressed in Higher Ambitions and the Science and Innovation Framework.

THE IMPACT OF SPENDING CUTS ON SCIENCE AND SCIENTIFIC RESEARCH

Response

3. The Engineering Professors' Council (EPC) represents the interests of engineering in higher education. It has over 1600 members in virtually all of the UK universities that teach engineering. They are all either professors or Heads of departments. It has as its mission the promotion of excellence in engineering higher education teaching and research.

4. The EPC are concerned that cuts to core and research funding will impact on the ability of its members to develop engineering solutions needed to deal with the challenging, changing environment and their ability to continue to deliver a world class education for engineers for the future. Further, many members of the EPC are also professional engineers and are concerned that professional institutions' contribution to society through skills and expertise cannot be sustained if the cuts lead to a reduction in engineering graduates and research output. Creating a sustainable future will require an adequate supply of research informed engineers educated to a world class standard; a fact that the Government has recognised.

5. However, EPC accepts that cuts are inevitable because of the dire state of the UK economy. This is at the same time as major investment will be required to cope with climate change, both the need to limit the change to the climate through the development of a low carbon economy and the need to address the impacts of climate change through changes to the built environment and the behaviour of society. This will require a paradigm shift in design of new products and systems including, for example, the development of new materials and smart materials, and changes to manufacturing and operational processes.

6. There are a number of issues that EPC raise related to:

(a) achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation;

(b) whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses; and

(c) the effect of HEFCE cuts on the "unit of funding" for STEM students.

7. There has been an upturn in applications to engineering (in 2009 8.1%) and in the increase in numbers registering for engineering (in 2009 4.6%). Universities, however, are limiting numbers entering engineering programmes because of the reduction in staff, limitations in space and the increasing focus on research. Entry standards have been raised as consequence of increased demand but with limited places. This can only be beneficial as it will lead to an increase in the quality of the graduates. Some of the extra student places announced in July 2009 would have gone to engineering. The increase in the number of students choosing to enter engineering and the increase in entry standards are in line with some of the ambitions of the UK Science and Innovation Framework to create a strong supply of engineers but do not meet the proposal set out in the Higher Ambitions document to remove caps on talent nor with the concerns of the CBI for the need to increase the number of engineering students.

8. Therefore:

(a) there is increasing demand for engineering places;

(b) the number of students entering engineering is increasing but not at sufficient rate to meet the demands of industry and the vision of the Government; and

(c) entry standards have been increased leading to an increase in the quality of graduates which does meet the demand of industry and the vision of Government.

9. EPC and Engineering UK (formerly ETB) have shown that the provision of well founded engineering base for research and teaching is not sustainable which is not in line with the Government's Science and Innovation Framework to produce sustainable and financially robust universities nor with the desire to

produce a world class research base as a component of the UK's innovation infrastructure. Further, the lack of funding has also resulted in a lack of investment in facilities needed to develop the STEM subjects as identified in Higher Ambitions.

10. The potential cuts in funding will further impact on engineering students as there will be a further decline in unit resource per student putting further pressure on engineering facilities. Engineering departments have been successful in attracting overseas students which has helped subsidise the facilities. The Government (Higher Ambitions) is encouraging further investment in postgraduate education but that can only be supported by an investment in world class facilities. Efficiency savings and further cuts in unit of funding will inevitably lead to a decline in resources to support the educational base for professional engineers.

11. The ratio of engineering academics to students has been increasing; the number of academics with practical engineering experience in industry has been in steady decline. Thus, there has been an overall decline in appropriate support to students.

12. Therefore:

(a) UK engineering education is currently inadequately funded;

(b) a further reduction in the unit of funding will impact on the facilities needed to ensure a world class engineering education;

(c) the UK engineering education is dependent on overseas fee income to be sustainable; and

(d) failure to invest in world class facilities implies that it will be impossible to meet the Government's vision as set out in Higher Ambitions and the Science and Innovation Framework.

13. There are a number of issues that EPC raise related to:

(a) the process for deciding where to make cuts in SET spending; and

(b) what evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants).

14. There is increasing evidence (eg EPSRC's Review of Civil Engineering Research, 2010) that much of engineering research is incremental by nature and that incremental approach has impact some of which can only be seen over a prolonged period. This is especially the case in those sectors that are risk averse which engineering is by nature because of the need to protect society from disasters. However, the opportunities and the demand for transformative research have created an exciting era for engineering research. Seeking creative applications for the recent discoveries in natural, biological and mathematical sciences and linking that to the concept of a low carbon, sustainable economy means that engineering is entering a new age of discovery which fits with the Government's and society's need for change. Indeed, this could be the opportunity to help achieve the vision of the Government as set out in the Science and Innovation Framework and the demand of industry as highlighted by the CBI.

15. Historically, and which continues to exist in other countries, publically funded engineering research was undertaken by research organisations. The Government has actively promoted HEIs as being the prime source of publically funded research output. There are some 4,500 academics engaged in engineering research which represents about 9% of the total number of research active academics. The percentage of academics engaged in engineering research does not reflect the contribution engineering makes to the economy and society; that is publically funded engineering academics as a proportion of all academics is significantly less than the proportional contribution engineering makes to GDP. This suggests that engineering research is currently underfunded challenging the vision for a strong and innovative research base. Despite this a review of the RAE 2008 by Engineering UK shows that UK academic research is world class (more than 60% of academics were rated internationally excellent). This issue is not with quality of research but with quantity though cuts in core funding could impact on the quality of the underlying engineering base for research.

16. We are entering an era of unprecedented change in which the global challenges of climate change, food supply, poverty alleviation, migration, water supply, energy supply, natural disasters, security, wealth creation and transport will require engineering solutions. This requires a bold approach to investment which justifies a means of assessing risk and impact but at the same time requires adventure.

17. Therefore:

(a) the quality of UK academic research in engineering is world class;

(b) the investment in UK publically funded engineering research does not reflect the contribution engineering makes to the economy compared to the investment in other disciplines;

(c) a bold, imaginative approach to engineering research is needed if solutions are going to be provided to the global challenges at the same time as ensuring sustainable economic growth.

18. This is not about making cuts but about making wise investments. The dual funding system should ensure a well resourced engineering base that underpins the research (and teaching). Clearly it does not at the moment so any cuts in core funding will impact on that underlying resource. Research funding can be aligned to government/industry/society needs through focused calls or be driven by curiosity. Both have

impact though curiosity driven research is more likely to be long term which makes measuring impact difficult. Focused research often addresses immediate needs but long term impact may be limited because it is about solving problems not delivering solutions. The current structure for research funding may be inappropriate as it naturally tends to safe research because of the necessary reliance on seeking a consensus view of what is required and because of the governance structure of the funding agencies.

19. Therefore:

(a) incremental engineering research is required because that demonstrably achieves impact in the long term; and

(b) a new framework needs to be created to develop transformative research that produces engineering solutions to global challenges. This research is likely to exist at the discipline boundaries. The existing governance and operation of the research funding agencies can facilitate this research but it would be worth investigating whether an alternative structure would be more beneficial to obtain greater impact with reduced funding.

20. There are a number of issues that EPC raise related to:

(a) the implications and effects of the announced STFC budget cuts; and

(b) the scope of the STFC review announced on 16 December and currently underway.

21. Universities have two roles:—to generate and disseminate knowledge. Generating is through scholarship and research; dissemination is through education, training, events, papers and consultations. The implication is that if we are to maintain our world class status then there is a need to consider the function of universities. These autonomous bodies have been driven by initiatives, legislation and codes of practice to such an extent that a significant proportion of funds to HE is not used to or support the generation and dissemination knowledge. The impact of this can be demonstrated by the fact that full economic costing applied to consultancy activities typically amounts to 300% of the cost of academic time. The difference between this rate and the lowered rates typically changed by industry highlights the cost to society of providing a system that delivers the majority of higher skills and research output the UK seeks but within a complex, over engineered framework for HEIs.

22. Therefore:

(a) a review of the distribution of funds to HE is needed to ensure that the focus is on the front line activities of generating and disseminating knowledge; and

(b) there should be increased focus on those activities that do not contribute directly to generating and disseminating knowledge in order to achieve the efficiencies needed.

Professor B G Clarke
President of the Engineering Professors Council

Memorandum submitted by Prospect (FC 16)

INTRODUCTION

1. Prospect is a trade union representing 122,000 scientific, technical, managerial and specialist staff in the Civil Service and related bodies and major companies. Our members are professionals, managers and specialists across a diverse range of areas, including agriculture, defence, energy, environment, communications, heritage, justice and transport.

2. We welcome the opportunity to submit evidence to this inquiry. Our response to the themes identified by the Select Committee is set out in the following paragraphs. Some of these are ongoing issues, of key concern to Prospect members, and require urgent resolution.

The process for deciding where to make cuts in SET spending

3. We would emphasise that there is actually a strong case for increasing expenditure on SET, and note that this sentiment was supported by the Prime Minister in his Romanes Lecture at Oxford in February 2009: "Some say that now is not the time to invest, but the bottom line is that the downturn is no time to slow down our investment in science but to build more vigorously for the future. And so we will not allow science to become a victim of the recession—but rather focus on developing it as a key element of our path to recovery".

4. Whilst Prospect accepts that priorities can and do change, we object to the fact that major decisions have been taken—for example about site closures, transfer of functions and significant cuts in funding streams—with no central knowledge by government of the location, functions or specialist expertise it employs. Hence there is no clarity of what capability is being lost or whether retained capability will be sufficient to cope with future demands. Recent work by Government Skills demonstrates that departments and professions are unable to collectively provide work force data that is accurate enough to facilitate effective work force planning. A number of professions, including science and engineering, have identified work force data as being a key issue for them in making progress against their aspirations.

5. Recent examples of poor decision making include:

6. Closure of the world-renowned 192-hectare Wellesbourne site of Warwick HRI, formerly Horticulture Research International, by the University of Warwick. All research work will be transferred to a new School of Life Sciences on the Warwick main campus from 2012. Thirty per cent of staff will be made redundant, including principal investigators, research and support staff. WHRI employed about 35 academic staff at principal investigator level, together with 175 research and support staff, plus PhD and MSc students. It was ranked as the UK's top university department for agriculture, veterinary and food science in the 2008 Research Assessment Exercise.

7. In Prospect's view, the university's decision was made on the basis of a report that:

— Did not present a coherent case on economic, public health, food security or environmental grounds;

— Took no account of funding sources available from Defra, the Technology Strategy Board or industry;

— Focused on basic research, instead of key disciplines in agricultural science that the Royal Society has recognised as being in urgent need of investment;

— Ignored the translation of research into practice, a key aim of Government and the Biotechnology and Biological Sciences Research Council; and

— Had no policy for engagement with industry or to seek multi-donor funding.

8. Only 11 days notice of the proposals was given to staff via their union, and there was no prior consultation with policy makers or funders (Defra, BBSRC or the Agriculture Development and Horticulture Advisory Board).

9. At the National Physical Laboratory (NPL) discussions are currently underway to alleviate the consequences of proposals for significant funding cuts from the parent Agency—the National Measurement Office (NMO). A likely funding cut of around 10% could not be sustained without job losses and the corresponding loss of scientific capability, with in excess of 40 posts at risk. This would inevitably mean choices about the retention of scientific capability and perhaps decisions that will be regretted in the future when immediate cost pressures ease.

10. This is despite the existence of a significant body of evidence illustrating the impact of measurement science as uniquely practised by NPL. Economists from the Department of Business, Innovation and Skills estimate that every £6 million spent by Government on measurement technology delivers £410 million of economic impact to the UK, so any cuts are correspondingly magnified. In addition the Advisory Group from the Royal Society and Royal Academy of Engineering appointed by the Secretary of State to oversee the quality of science from NPL, although pleased by the work undertaken, has been increasingly concerned that the investment is insufficient to enable NPL to provide a critical mass to have a real impact in emerging areas. Professor Ian Shanks, Chairman of the Advisory Group, said that the potential loss of science capabilities would significantly impact on NPL's ability to meet the challenges of metrology support to data security, health-care, advanced manufacturing, low carbon and environmental issues—topics of central interest to Government where NPL could have a real impact for the benefit of the UK.

11. Helpfully discussions are currently in progress, leading to a Ministerial commitment to review the processes and evidence base that led to the reductions in NPL's funding from NMO and NPL's success in attracting additional funding from other areas that could have mitigated these shortfalls. However, at the time of writing the redundancy process is ongoing and key scientific staff could be lost in a few weeks time. Further Prospect would emphasise that, although we hope that the situation may still be retrieved, in fact there is a clear responsibility on the part of Government to ensure that consultation takes place in an appropriate manner at the time decisions are being discussed and most certainly when economic decision are made that will clearly have an effect on employment.

The decision in the ECJ last year (*Akavan Erityisalojen Keskusliitto AEK ry and ors v Fujitsu Siemens Computers*) made it clear that the obligation on employers to consult arose when there were "strategic decisions" or "changes in activity" that may lead to redundancies. The Government's position stems from decisions made in summer 2009, and our understanding is that the NMO were also aware of the position at this time. Yet, despite this there was no consultation with Prospect until November of 2009, some four months after the decisions were made.

12. We would also like to draw to the Select Committee's attention the risks currently surrounding the proposed redevelopment of the Institute of Animal Health's Pirbright site. Prospect members at both IAH Pirbright and Compton welcomed the decision announced in September 2009 to invest £100 million in the Institute, but there is now concern that pressure on the public finances will mean that there may not be sufficient funds to complete the redevelopment in the timescale required or to the high standard for the laboratories and other facilities needed. This is particularly sensitive given that Pirbright was the source of the 2007 FMD outbreak. Members are concerned that corners may have to be cut or, alternatively, that progressing with this redevelopment at a time of wider budget cuts will place all other Institutes and programmes under strain.

13. Prospect's view is that without effective cross-government scrutiny irrecoverable damage can result to our science base, and it is clear that in the case of NPL real commercial impacts will follow. As long ago as 2006 Prospect published a Charter for Public Science identifying, among other objectives, the need for a clear strategic vision for UK science and a Cabinet Minister with authority and accountability for public sector science—with a similar Ministerial role in the devolved administrations. We therefore very much welcome the Government's decision to establish a Cabinet Sub-Committee on Science and Innovation and we welcome the fact that the Science Minister, Lord Drayson, attends Cabinet meetings. However, more could be done immediately to make sure that Lord Drayson's Cabinet level role includes cross-cutting accountability for public science and is not simply to act as an exponent of science in Cabinet, important though that is.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR Funding) and looking to the future (for Research Council Grants)

14. Laboratory staff and university researchers are scientists, not entrepreneurs. Whilst the economic impact of scientific research is important, to allocate basic research funding based solely upon perceived economic outcomes is counter-productive. Research should be funded according to scientific merit. If the current trend of modelling the UK's SET base as the R&D arm of industry continues, with no "blue sky", curiosity-driven research, we will be unable to compete scientifically with our peers overseas.

The differential effect of cuts on demand-led and research institutions

15. Prospect believes that science and technology have a crucial role to play in identifying high quality and sustainable investment opportunities that would help to lead the economy out of recession. We welcome the fact that recent Government policy statements reflect this priority. However, the same commitment must extend to funding for blue-skies work and pure research and development, which must come from an adequately funded and motivated public sector science base. Public science must provide a measure of stability to preserve the UK's technical capacity through short-term fluctuations in demand. In practice, world-leading UK programmes including research into breast cancer, agri-engineering and animal diseases have been closed. Research on the impacts of climate change, pollution and biodiversity all struggle for funding. The level of core funding for research institutes leaves many of them highly vulnerable to shifts and reductions that owe more to short-term changes in departmental priorities than to the quality of work being undertaken.

The implications and effects of the announced STFC budget cuts

16. Prospect has yet to understand the full implications of the announced cuts. Nevertheless, the impact of the cancellation of projects that have been found to be excellent by international peer review undermines our status as a first rate scientific nation. For example, the New Light Source project would have propelled the UK to the forefront of a revolution taking place in the physical and biological sciences—the ability to study molecular interactions in real time. Instead, this new frontier will be explored by our competitors in the United States and Germany, who have significantly increased their science budgets in response to the financial crisis. There is also the risk of under-utilisation of UK investment in large capital projects only now coming on-stream, for example Diamond Light Source and the next-generation ALICE prototype accelerator at Daresbury. It is too early to assess what, if any, impact there will be on STFC staffing.

The scope of the STFC review announced on 16 December and currently underway

17. Any re-organisation of the functions of STFC must ensure integrity and continuity for the Daresbury and Rutherford laboratories. These institutions are national scientific assets which have been built up over 50 years. The staff who operate and maintain the facilities contained within these labs are unique in terms of their expertise and skills. The STFC review is expected to conclude by the end of February, with the aim of quickly implementing its recommendations. Whilst Prospect has welcomed Lord Drayson's intention to resolve the tensions that inevitably rise from vesting responsibility for international subscriptions and research grants in the same organisation, we are concerned that whatever the outcome, it is already being made clear that there is unlikely to be any more money available.

18. It is demoralising for laboratory staff to suffer cuts to investment in scientific facilities and research whilst large amounts of the laboratory budget are wasted on the poorly conceived and executed outsourcing of ancillary services that is the RCUK Shared Services Centre. Latest information is that the estimated cost of this project has spiralled from £40 million to somewhere between £132–140 million. STFC is responsible for just over 25% of the cost of SSC and so, based on the original costing would have been responsible for £10 million of cost. In practice, STFC is likely to be asked to pay about £35 million—not far short of its £40 million budget deficit.

19. The recent financial crisis has placed immense pressure on STFC's budgets due to their agreed commitments to international subscriptions to facilities such as CERN. The actual cost in pounds sterling is subject to exchange rate fluctuations, and because of the "banking crisis", this further reduces the funds available to support the UK's own national laboratories and universities. Whilst the Government has acknowledged that our economy cannot continue to be based on the provision of financial services, with a vision of science and innovation replacing financial services as our economic foundation, it is clear that the

SET community are quite literally paying for the greed and failings of the financial sector. STFC is an organisation of scientists, not bankers, so STFC should not have to fall victim to these fluctuations once our overseas commitments are agreed.

20. Delivering world-class, cutting-edge SET is hard enough in itself. It does not benefit in any way from the unending pressure on budgets, staff and infrastructure which has repeatedly lead to these highly public and undignified struggles for limited resources, often punctuated by misleading coverage in various news media. This damages staff morale, the public perception of science and its societal value, and makes it harder to encourage new people to enter science, thus ultimately causing massive damage to science itself. It is essential to ensure that sufficient funding is placed into SET budgets; the appropriate structural divisions within the SET community are made; and that there is a stable and capable management structure to create the right environment for true science and innovation to flourish in the UK.

The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

21. Prospect strongly supports the continuation of a ring-fenced Science Budget, though stronger safeguards are needed to ensure that the ring-fence cannot be breached in response to short-term financial pressures. There is overwhelming evidence of the need for a similar ring-fence for departmental SET budgets.

22. The Government's 2009 SET Statistics show that whilst Science Budget expenditure has grown significantly over the last 10 years, with the exception of the Scottish Government SET expenditure by civil departments has fared much worse. Table 1 shows that overall civil departments' SET expenditure fell by 18.2% in real terms over a 10-year period from 1997–98 and of 28.1% between 2006–07 and 2007–08. DEFRA's expenditure on SET fell by 17.5% over the same 10 years and very sharply, by 51.2%, between 2006–07 and 2007–08. The Department for Transport similarly suffered a 53.6% cut in SET expenditure between 1997–08 and 2001–02 which has not been restored. Growth of 20.2% in NHS set expenditure in the 10-year period from 1997–98 masks a 33.8% cut elsewhere in the Department of Health over the same period. A 28% overall cut in MOD's SET expenditure over the 10 years from 1997–98 includes a cut of 12.4% in research expenditure and a cut of 33.1% in development activities. SET real terms expenditure in the Devolved Administrations increased sharply in the five years from 1997–98 to 2001–02, by 82.2% in Scotland and 90.9% in Wales. However, there has been no growth in SET spending in Scotland since 2005–06 and, as a consequence of progressive cuts in Wales since 2001–02, SET expenditure by the Welsh Assembly Government in 2007–08 was 45.5% lower than in was in 1997–98.

Table 1

NET GOVERNMENT EXPENDITURE ON SET BY DEPARTMENTS IN REAL TERMS 1997–98 TO 2007–08

Source	*1997–98*	*2001–02*	*2005–06*	*2006–07*	*2007–08*	*% change 1997–98 to 2001–02*	*% change 2005–06 to 2006–07*	*% change 2006–07 to 2007–08*	*% change 1997–98 to 2007–08*
BBSRC	234	245	331	366	361	4.7	10.6	−1.4	54.3
NERC	199	201	384	361	353	1.0	−6.0	−2.2	77.4
STFC[1]	244	558	430	421	535	128.7	−2.1	27.1	119.3
Total science budget	1,656	1,955	2,954	3,006	3,467	18.1	1.8	15.3	109.4
Total HE funding councils SET	1,285	1,688	1,984	2,085	2,181	31.4	5.1	4.6	69.7
Total science & engineering base SET	2,941	3,643	4,938	5,092	5,648	23.9	3.1	10.9	92.0
DEFRA[2]	177	260	296	299	146	46.9	1.0	−51.2	−17.5
DFT[3]	192	89	90	89	89	−53.6	−1.1	0.0	−53.6
Dept Health	573	578	646	673	689	0.9	4.2	2.4	20.2
Dept Health excluding NHS	74	68	46	50	49	−8.1	8.7	−2.0	−33.8
BERR[4]	427	420	308	265	1	−1.6	−14.0	−99.6	−99.8
Scottish Government[5]	90	164	215	214	214	82.2	−0.5	0.0	137.8
Welsh Assembly Government[6]	22	42	34	10	12	90.9	−70.6	20.0	−45.5
Total civil depts	1,685	2,035	2,021	1,918	1,379	20.8	−5.1	−28.1	−18.2
MOD research	702	638	615	632	615	−9.1	2.8	−2.7	−12.4
MOD development	2,178	1,719	1,976	1,492	1,457	−21.1	−24.5	−2.3	−33.1
Total defence	2,879	2,356	2,582	2,124	2,072	−18.2	−17.7	−2.4	−28.0
Grand total	7,927	8,481	9,926	9,510	9,455	7.0	−4.2	−0.6	19.3
Grand total excluding NHS	7,428	7,972	9,326	8,887	8,815	7.3	−4.7	−0.8	18.7

Notes:
[1] Formerly PPARC & CCLRC; [2] Formerly MAFF; [3] Formerly DETR; [4] Formerly DTI;
[5] Formerly Scottish Executive; [6] Formerly Welsh Office.

Source: 2009 SET Statistics Table 2.2.

23. Furthermore, as shown in Table 2, it is of concern that the most recent information about departmental expenditure on R&D, shows some significant shortfalls when compared with CSR expenditure plans for 2007–08. Again there are significant shortfalls in expenditure by civil departments including DEFRA, the Health and Safety Commission, Department for International Development and the Welsh Assembly Government. There is also a substantial cut in MOD expenditure on development.

Table 2

(£ million)	*CSR Plan*	*Actual*	*Actual—Plan*	*% Change*
BBSRC	354	358	4	1.1
NERC	369	339	−30	−8.1
STFC	437	531	94	21.5
Total science budget R&D	3,186	3,412	226	7.1
Total HE Funding Councils R&D	2,075	2,164	89	4.3
Total science & engineering base R&D	5,261	5,576	315	6.0
DEFRA	195	134	−61	−31.3
DFT	59	60	1	1.7
Dept Health	696	689	−7	−1.0
Dept of Health excluding NHS	44	49	5	11.4,%
HSC	15	12	−3	−20.0,%
Home Office	46	41	−5	−10.9,%
DFID	240	129	−111	−46.3
Scottish Government	133	133	0	0.0
Welsh Assembly Government	34	12	−22	−64.7
Total civil depts R&D	1,667	1,253	−414	−24.8
MOD research	607	615	8	1.3
MOD development	1,954	1,457	−497	−25.4
Total defence	2,561	2,072	−489	−19.1
Grand total	9,825	9,258	−567	−5.8
Grand total excluding NHS	9,173	8,618	−555	−6.1

Source: Campaign for Science and Engineering

24. The longer-term trends are also confirmed in Table 3 which shows the contribution of the Science Budget, civil departments and the MOD to total government expenditure on SET. Science Budget and HE funding councils" SET contributions have grown, but departmental expenditure now accounts for a smaller share—both in relation to civil and defence applications. Allocations to Higher Education Institutions continue to account for around half of all research council expenditure, mainly through payment of grants. Expenditure on research councils" own establishments accounts for around one quarter of total expenditure, though with a growing share for facilities rather than institutes. Administration costs remain at a modest 5%.

Table 3

Source	*1997–98*	*2007–08*	*% change 1997–08 to 2007–08*
Total science budget	22.1	38.1	16
Total HE funding councils SET	17.1	24	6.9
Total science & engineering base SET	39.2	62.1	22.9
DEFRA2	2.4	1.6	−0.8
DFT3	2.6	1	−1.6
Dept Health	7.6	7.6	0
Dept Health excluding NHS	0.9	0.6	−0.3
Scottish Government5	1.2	2.4	1.2
Welsh Assembly Government6	0.3	0.1	−0.2
Total civil depts	22.5	15.2	−7.3
MOD research	9.4	6.8	−2.6
MOD development	29.0	16.0	−13.0
Total defence	37.1	22.8	−14.3

Source: 2009 SET Statistics Table 2.5

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–14: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation.

25. Experience of the recession may to some extent have diminished the attractiveness of the financial services sector as an employment destination for STEM graduates. However, we are concerned about the implications of recent government announcements for the numbers and quality of science graduates and the research output of the UK university sector. We are also concerned that there is little to incentivise talented STEM graduates to pursue a career in government science. R&D employment in research councils has fallen by 9.1% over the 10 years since 1997–98. By comparison employment in civil departments has fallen by 34.8% and in the Ministry of Defence by 55.1% Continuing pressures on SET budgets and on individual terms and conditions will only reinforce existing negative perceptions.

Supplementary memorandum submitted by Prospect (FC 16a)

I am writing now to ask that you draw the Select Committee's attention to notification on 5 February of 70 proposed redundancies in Institute of Biological, Environmental and Rural Sciences.

The letter from the University of Aberystwyth initiating the formal redundancy consultation procedure makes clear that the proposed redundancies are attributable in part to "an expected reduction in public funding of at least 15% over the next three years" coupled with "increased competition in all areas of research funding".

We would emphasise that these proposed cuts arise less than two years after the transfer of the Institute of Grassland and Environmental Research to the University. In our view, this situation also highlights the fragility of the "independence" governance model espoused by the Biotechnology and Biological Sciences Research Council. It follows hard on the heels of the decision by the University of Warwick to close the Kirton Research Centre and to downsize and merge Warwick HRI—as outlined in our main evidence—and is in addition to the University's decision to close Bronydd Mawr facility in 2009.

Sue Ferns
Head of Research and Specialist Services

February 2010

Memorandum submitted by Lancaster University (FC 17)

We append below our response to the specific questions. We need to declare our interest in these questions as recipients of funding from HEFCE and the research councils, including STFC.

The process for deciding where to make cuts in SET spending

1. It is not clear whether this refers to national or institutional cuts but HEFCE do not fund at specific subject level so decisions are made at the local level. In an environment of decreasing funding our internal funding systems at Lancaster permit a level of buffering that allows strategic considerations and interventions when required. With a decrease in government funding the viability of departments then becomes increasingly dependent on the number and quality of students attracted and the ability to attract international students.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

2. The request to consider the potential impact of a research project and how this would be achieved at the application stage (ie as now done for RCUK grants) is reasonable. Research in the UK has well documented major impacts on the economy and society so it is sensible to ensure that these are achieved and articulated. While the impact questions have been bedding in, there has been a concern about the predictability of impact and how the information is used in the evaluation process. We are now getting indications (eg from EPSRC) that it is valid to label research as "fundamental with no obvious application identifiable at this stage" but that, when appropriate, a strong impact development plan will give an advantage when judged alongside a proposal of equal research quality but with an inferior strategy to achieve impact. If both of these elements are maintained in practice then it does allow a research portfolio that has a balance of aims and a continued emphasis on research excellence which has to be at the heart of the assessment process.

3. Success rates for applications to research councils are now dangerously low. It should be recognised that not only will this reduce the amount of current research it will severely limit the realisation of the impact of previously funded research. Therefore it is vital that Government maintains it's commitment to continue to increase funding for science.

4. The inclusion of impact in the REF is also reasonable so that the massive impact of excellent research is fully captured and valued. There are technical details that need to be clarified by the current pilot project and HEFCE need to be prepared to reduce the contribution of the impact component (perhaps to 15%) if the practicalities of measurement still look problematic. This is not to undermine the significance of the inclusion of impact rather it recognises that a higher proportion would allocate substantial amounts of government funding on the basis of unreliable criteria. We would also identify the following key issues with impact in the REF:

5. The link between impact and high quality research must be maintained in the REF. This is not the means by which overall interaction with external organisations is assessed; it is the impact of the research that is central to this process.

6. The proposed number of case studies needs to be in the range of 1 for every 10 staff so that there is the flexibility needed for a research unit to maintain a portfolio of blue skies research.

7. The final funding formula (that HEFCE never discuss until after an exercise) must be based on the overall distribution in the results and not based on the sub profiles for outputs, impact and environment. To split the funding would remove the key link between the excellence of the research and the impact.

The differential effect of cuts on demand-led and research institutions

8. This classification nomenclature for Universities is not helpful. Research intensive Universities like Lancaster respond to market demands in both the teaching and research that we do. We suspect that it is largely research intensive universities that now teach the laboratory intensive SET subjects that are already under pressure (see below) so in this respect a reduction in SET teaching funding will tend to affect the quality of the teaching to a greater degree in research intensive universities.

The implications and effects of the announced STFC budget cuts

9. The instability in STFC in the last couple of years has caused disruption and an inability to plan which is bad for research programmes. It is also bad for international reputation. Putting two councils together does not seem to be working—especially if costs on facilities/international investments impact on the ability to fund science.

10. The loss of end of year flexibility seems to have put an enormous addition pressure on the research councils so that they are less able to respond to fluctuations in demand. This should be revisited.

11. There will always be competing claims for funding but the focus on ESA, for example, can be seen as political/policy as much as science and the ability to make balanced scientific judgements is damaged in such cases.

12. The process behind decisions about international programmes the UK should engage with needs to be revised. For example, could there be a conflict within STFC between supporting national facilities and subscribing to international projects?

13. Issues about exchange rates should not be allowed to damage major funding. Why can't exchange rate fluctuations (up or down) be handled outside the research councils?

The scope of the STFC review announced on 16 December and currently underway

14. As STFC themselves recognise, the implementation of the proposals from their review has the potential to seriously destabilise some top quality physics departments. While we clearly recognise that disciplines cannot be stagnant, some of the proposed changes in priority will not often be implementable at individual University level, especially since the range of potential funding sources is very limited for much of STFC-type activity. Indeed, we would ask whether the availability of other funding sources was considered as part of the prioritisation process. For example, it is probable that the ESA activity is more likely to be fundable in other ways compared with particle physics. We have little doubt that the UK will lose some high quality scientists as a result of these changes.

15. Other results of the review, such as the reduction in support of postgraduate students, are not consistent with national strategies and priorities. The research councils are expected to take the national lead in these areas so the implications of reduced support could be severe.

The operation and definition of the science budget ring-fence and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

16. The level of SET ring fence is probably about right currently but there is a risk that the absence of a research ring fence in HEFCE and other government departments could have serious consequences for the whole research agenda, including SET. For HEFCE it is important that the absolute level of research funding available is not degraded.

17. Reduction of research funding in some government departments, eg MoD, will have a particularly detrimental effect on SET.

18. This has an added importance in some SET areas because of the impact of the financial crisis on funding available from charities.

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

19. There has been good progress in science A levels. More students are now available to do science and applications in many SET areas seem to be on an upward trend. It is now important that Universities offer good SET courses that lead to a range of good job opportunities.

20. It is possible that a decline in the financial sector will have a beneficial effect on SET recruitment but we await evidence for this.

21. We do have a concern that we are not yet seeing these feed through into postgraduate degrees and this needs to be watched carefully.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses

22. Lancaster University did not take up the offer of a proportion of the 10,000 extra student places so we cannot comment directly the question within our own institution.

23. The reason we did not take up these places was that it was effectively reducing the unit of resource for those areas that recruited students and this would reduce the viability of our teaching activity, especially in SET subjects (see below).

24. We would suggest that in addressing this question the committee should consider the quality of the SET departments that took the extra numbers and not just be concerned with student numbers.

The effect of HEFCE cuts on the "unit of funding" for STEM students

25 The current unit of funding for SET subjects is already at a dangerously low level. We would suggest that in recent years it has been increasingly difficult to maintain the technical support base for SET teaching, to maintain teaching equipment at the level required and to maintain practical class size levels at sensible levels. Thus any cut in this resource would have an immediate detrimental effect on the quality of the education received by the students and would undoubtedly increase the risk that UK SET graduates are not competitive from a global perspective.

Memorandum submitted by Eric Clarke (FC 18)

1. I am writing to express my dismay at the prospect that a measure of "impact" will be a contributing factor in the proposed REF, and my implacable opposition to such a development.

2. My own field of research is the psychology of music, a subject that embraces science and technology, and the arts and humanities. It has a history of well over 150 years of "modern" research, and roots that go back to the writings of Greek antiquity, and in the last three decades has demonstrated highly significant, and previously unprecedented growth. Music is significant part of every known human culture, and has an enormous cultural, economic, and "health and well-being" significance globally.

3. A number of extremely prominent scientists (among them Antonio Damasio, Gerald Edelman, Steven Mithen) have argued that music is as defining of "what it means to be human" as any other single human accomplishment.

4. The scientific community now has a better understanding of the nature of this defining human capacity than at any other time in history, but this has been achieved by means of patient, careful work, distributed over a wide and extremely heterogeneous spectrum of scholarly outputs, and in places that in some cases were overlooked for years or decades. The short timescale, and crude measures, of so-called "impact" are completely inappropriate as a proposed means to assess the importance of that work, and furthermore create artificial incentives to undertake kinds of research, and styles of publication and dissemination, that are anathema to serious research and the development of understanding in the field.

5. Let me illustrate the extremely suspect, and at times inverse, relationship between scientific importance, and so-called "impact" in the field of the psychology of music with two examples from my field. The publication in the Nature in 1993 of a report by Rauscher, Shaw and Ky (Rauscher, F, Shaw, G, Ky, K (1993). Music and spatial task performance. Nature, 365 611) that purported to show an increase in spatial IQ after listening to a particular work for two pianos by W. A. Mozart (K. 448) sparked huge press coverage, international exposure, and in 1998 the announcement by the then governor of the state of Georgia that more than $100,000 every year would be included in the state budget to provide the mother of every child born in the state with a tape or CD of classical music to "make their children smarter". The apparent "impact" of this research (in terms of citations, economic consequences, policy, educational strategy) could hardly be more dramatic. This is without doubt the single most prominent piece of research in the psychology of music in terms of "impact" in the last two decades. And yet, after controversy, claim and counter-claim (including the claim by Rauscher in 1997—before the announcement by the governor of Georgia—that the spatial performance of rats was also increased after listening to the same music by Mozart—see Rauscher, F H, Robinson, K D, & Jens, J (1997, June). "Spatial performance as a function of early music exposure in rats (Rattus norvegicus)"), and eventually more thoughtful and careful work, this research is now regarded by almost the whole psychology of music community as deeply flawed, nave and simplistic, and of negligible research significance.

6. By contrast, the work of Christopher Longuet-Higgins in the UK, who was in his extraordinary career a professor of theoretical physics, theoretical chemistry, and artificial intelligence (and the originator of the term Cognitive Science), and a Royal Society research professor, made lasting and hugely significant

contributions to research in the psychology of music which received scant recognition in his own lifetime (he was eventually honoured with an honorary doctorate in Music by the University of Sheffield for his contributions to the field six years before his death), and would have failed even to register in terms of "impact". His earliest, and arguably foundational work, is reported in two small-scale but astonishingly far-sighted papers (4 pages and 9 pages respectively) entitled "Letter to a musical friend" and "Second letter to a musical friend" (hardly titles that would attract the attention of an "impact" search engine!) in the less than internationally prominent journal (it no longer exists) Music Review in 1962. These papers, which are still cited nearly 50 years later (see eg Chew, E (2008)) as the roots of such diverse developments as theories of tonal cognition, and automatic music retrieval systems, were of ground-breaking importance at the time, retained their research importance over four decades, and remain seminal publications in the field.

7. I urge the research community not to be misled into believing that so-called "impact" should have anything to do with the assessment of research.

Eric Clarke
Heather Professor of Music
University of Oxford

Memorandum submitted by the University of Sussex (FC 19)

1. This response is structured to address the questions asked by the Science and Technology Committee in their call for evidence (No 11 (09–10) 13 January 2010).

2. *The process for deciding where to make cuts in SET spending*

3. The process should be focused on identifying priorities for funding in the first instance. The outcome will automatically identify low priority areas. Work currently underway by the Natural Environment Research Council to identify training needs for UK Ph.D. graduate level skills could be used as a pointer here.

4. An important part of identifying need will be to balance (a) fields within SET of significant potential in terms of fundamental advances with (b) the need in some areas to maintain international competitiveness and (c) the contribution in other areas to economic growth and stability.

5. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (QR funding) and looking to the future (for Research Council grants)?*

6. A range of studies have been completed, for example by the HEFCE and RCUK, into the economic impact of QR. There are important differences between the two bodies. The HEFCE report is based on returns from HEIs and demonstrate impact from past activity. RCUK information is principally based on projected impact noted in research grant proposals. Information collected at these levels is likely to be more useful than returns from individual HEIs because of differences across the sector.

7. *The differential effect of cuts on demand-led and research institutions*

8. The value for money (£ for £) in terms of international research excellence is higher in the UK than elsewhere in the world. Any significant cut to funding has the potential to undermine this international competitiveness. The diversity of UK HEIs is significant, as reflected by varying institutional missions. Those which are research-led, in particular Russell Group and '94 Group universities rely heavily on QR (HEFCE) and RCUK funding. These parts of the sector in particular are therefore highly vulnerable to reductions in funding if one aim of Government is to maintain the international research profile of the UK via its HEIs.

9. *The implications and effects of the announced STFC budget cuts*

10. The impact is potentially significant but more so in some areas of fundamental science than others. STFC cuts are due, in some significant part, to uncontrolled impacts on available resource (eg exchange rates). Some areas of STFC science will be protected and the impact of budget cuts will be small. There are other areas which are likely to be undermined. These sit principally within university departments and the consequence of this will be reduced subject sustainability in a number of HEIs. One implication of this is likely to be the risk of closure of some physics departments. Another may be an out-migration of staff to countries where research funding is available.

11. *The scope of the STFC review announced on 16 December and currently under way*

12. There is a lack of evidence that the STFC is planning strategically or that identifiable future impacts on budgets are being built in to either financial forecasts or science programmes. These issues must be addressed in the review. Many of the current problems have arisen due to the impact of large (subscription) international projects on nationally-centred research agendas. Some separation / budget ring-fencing or similar is required to address this issue and remove the undermining of key research areas.

13. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the HEFCE research budget and departmental research budgets*

14. On the one hand the science ring-fence does go some way toward protecting an important part of the academy but the converse is disproportionate cuts in other subject areas, which again risk the undermining of national capability. There would be advantage in ring-fencing the HEFCE research budget but in parallel with this should be a more effective setting of national priorities in the medium to long term. This should be one in parallel with RCUK agendas as part of recognising the importance of the dual-support system.

15. *Whether the Government is achieving its objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEP) graduates to achieve its overall ambitions for UK science and innovation*

16. There are early signs of growth in undergraduate application numbers in STEM but this is stronger in some subject areas than others. There are still barriers to growth such as the need for a more integrated approach to the plethora of Government programmes to encourage prospective undergraduates into STEM areas and the need to improve early-years science teaching to school students.

17. *Whether the extra student support which the Government announced on 20 July 2009 for 10,000 higher education places delivered students in science, technology, engineering and mathematics courses; and the effects of HEFCE cuts on the 'unit of funding' for STEM students*

18. The announcement came too late to have any significant influence on STEM.

19. If there is an overall reduction in the "T" unit of resource one possible outcome is that numbers are moved from high cost laboratory disciplines into lower cost classroom based subjects, within the tolerance band, thereby saving costs. Another negative outcome would be accepting high-fee overseas students on to courses in preference to home/EU students due to the additional income received from the former.

20. *Declaration of interests*

21. The University of Sussex receives funding from the STFC for research in a number of areas. The University benefits from income (eg HEFCE) earned as a result of teaching and research in a range of STEM subjects. The University also receives money from the HEFCE Strategic Development Fund as part of the SEPNet consortium.

Memorandum submitted by LHCb experiment CERN, Geneva (FC 20)

IMPACT OF THE STFC SPENDING CUTS OF THe LHCb EXPERIMENT AND LHCb UPGRADE

1. Introduction

We are writing to the UK House of Commons Science and Technology as the Spokesperson and Physics Coordinator of the LHCb Collaboration at CERN, Geneva. LHCb is one of the four main experiments at the Large Hadron Collider with 726 collaborators from 54 research groups in 15 different countries including 10 UK research groups. As we are sure you are aware, the LHC programme is just starting after decades of preparations and investment, with LHCb offering a unique scientific programme based at this new world leading facility. We are writing to offer some observations on the impact of the recent spending cuts on science and scientific research by the Science and Technology Facilities Council (STFC). We focus on the effect of these cuts on the present LHCb project and, in particular, on the next phase of this programme, the upgraded LHCb experiment.

2. Background and Physics Motivation

We know our present description of fundamental physics, the so-called Standard Model, to be incomplete. There are compelling reasons to believe that evidence of a higher theory, or "New Physics", will emerge at the energies probed by the LHC accelerator at CERN. One way in which to discover this New Physics will be to observe new particles directly produced in the LHC collisions. This is the approach adopted by the ATLAS and CMS experiments.

An alternative and complementary approach is to detect the "virtual" presence of New Physics in the decay of Standard Model particles. Very precise measurements of rare processes involving, in particular, B-mesons are exceedingly sensitive to perturbations due to New Physics effects, which subtly alter the predictions from those of the Standard Model. This approach is termed "flavour physics" and has an established record of discovery in fundamental science, for example demonstrating the existence of the charm quark, and the third generation of bottom and top quarks, several years before their direct observation.

LHCb is a flavour physics experiment and was approved *in order to widen the discovery potential of the LHC*, giving the project many additional attributes to those provided by the direct observation capabilities of ATLAS and CMS.

3. Status and Prospects

The LHC delivered its first colliding beams before Christmas of last year. With the limited data collected it has proved possible to study the performance of all components of the LHCb detector. In all cases the results are highly satisfactory, giving confidence that when the LHC restarts next month, LHCb will immediately embark on its core physics programme. In contrast with the main studies planned at ATLAS and CMS, the measurements to be made at LHCb do not require that the accelerator reach its full design energy or luminosity. *Thus there are good reasons to expect that the first important discoveries at the LHC will be made by LHCb.*

4. The Role of the UK and Cuts to Physics Exploitation

UK physicists were founding members of LHCb, and now represent the single largest national group on the experiment. The spokesperson, the physics coordinator, and several past and present sub-detector project leaders are all UK physicists. The UK has played a particularly prominent role in defining and preparing the LHCb physics programme. It is with great regret, therefore, to observe that the last couple of years have seen severe spending cuts to LHCb within the UK. These cuts have caused great pain to all participating UK institutes and have put at risk the effectiveness of several groups in contributing to the experiment.

5. Our Greatest Concern — Threat to the LHCb Upgrade

Despite these cuts, we welcome the continued UK support for the LHCb project. Of much greater concern is the recent STFC decision not to allocate any funds to the LHCb upgrade and to cancel the peer review process for this project before this process had even begun.

It is not sufficient to discover New Physics; rather its nature must be understood. It is certain that measurements in the flavour sector will have a pivotal role in distinguishing between the various competing theories which will arise to explain any New Physics discovery. Although some of this work will begin with the present LHCb experiment, the history of particle physics tells us that it will be essential to plan for an upgraded detector with significantly enhanced precision. Conceptual designs and R&D activities for such an upgraded LHCb are already well advanced, again with very significant UK input.

The announcement of STFC to deny any funds to the LHCb upgrade before even undertaking the appropriate peer review of the project is, in our mind, disastrous, and indeed *endangers the project as a whole*. It must be emphasised that the studies which are foreseen at this next-generation experiment are *not accessible* to the ATLAS and CMS detectors, in particular when they are configured to run at very high luminosity. The LHC is a unique facility, and as well as seeking for evidence of direct production of particles at the highest energies, we also have a responsibility to exploit fully the flavour-physics potential of the accelerator. *Not to do so would significantly diminish the breadth of the project and represent a major waste of scientific opportunity and of the investment in the whole LHC complex*.

6. Conclusions

We hope these comments are useful. We urge the Select Committee to make recommendations for the future funding of fundamental science, which will allow the UK to maintain its world-leading reputation in flavour-physics, and in particular to ensure that this vital area is given full support throughout the life-cycle of the LHC. Not to do so, sends a disastrously negative signal to prospective UK scientists and international partners about the UK's commitment to fundamental physics.

Professor Andrei Golutvin
(Imperial College London)
LHCb Spokesperson

Dr Guy Wilkinson
(University of Oxford)
LHCb Physics Coordinator

Memorandum submitted by the National Physical Laboratory (FC 21)

Independent studies have demonstrated that the National Physical Laboratory (NPL) has a huge benefit to the economy of the UK—some £2 billion per annum. It also impacts significantly on the quality of life of the UK's citizens: for example, nearly 200,000 people a year receive radiotherapy treatment that relies on accurate measurement of dose as determined by NPL. However, whilst measurement science contributes hugely to the UK, much of this work goes on in the background. We are not sure if the importance of this work and its economic impact is always appreciated, particularly by those charged with making funding

decisions on science research. In particular, NPL has recently faced a significant reduction in its core funding, at a time when its counterparts in the USA, France and Germany have received major increases. This would jeopardise NPL's status as one of the leading National Measurement Institutes and ultimately impact on the UK economy.

1. The National Physical Laboratory (NPL) is one of the UK's leading science and research facilities. It is a world-leading centre of excellence in developing and applying the most accurate standards, science and technology. NPL contains a National Measurement Institute developing and maintaining the national measurement standards and supporting infrastructures required to ensure quality of life and economic benefits. NPL is BIS's largest directly-owned science asset with world leading experts in important areas such as materials, the environment, healthcare, advanced manufacturing and knowledge transfer that enable UK business to stay internationally competitive.

2. Estimating the economic impact of research and the process for deciding cuts. BIS, NMO and NPL have carried out studies to evaluate the economic impact of the research programmes delivered by NPL. These studies have:

(i) developed economic models to estimate economic impact from research. These predict that an additional £6m of investment in measurement research programmes would bring at least £400 million of benefit to GDP;

(ii) surveyed users of the services NPL provides to obtain their estimate of the added value they deliver; These found that in one year innovative business using our services increased their profitability by more than £700 million; and

(iii) used case studies to estimate the return on investment of particular research projects. These found returns on investment from measurement research projects of between 10 and 30 times.

All these studies support the view that the £50 million a year government investment in the National Measurement System research programmes provides a benefit of greater than £2 billion per annum to the UK economy. However, we have concerns that this evidence does not always reach those making decisions about cuts, which sometimes seem to be uniformly applied rather than evidence-based. This is of particular concern at this difficult time for the economy when our major competitors in the global market, including Germany, France and US have announced significant increases in funding for our sister organisations overseas (in the US, the equivalent laboratory, the National Institute for Standards and Technology (NIST), had an additional $600 million support in 2009–10).

3. Ring-fencing budgets. The ring-fence as currently operated excludes research organisations like NPL from receiving any direct funding. It has also made it very difficult to align research funding through the Research Councils and the NMO. NPL has been successful in working collaboratively with universities, but the research is mostly funded through uncoordinated programmes. We believe there would be significant benefits for the UK to enable national laboratories like NPL to be funded for joint research with universities from inside the ring-fence. This would make more efficient use of national facilities and would bring NPL's expertise for the delivery of economic impact from research into the academic community.

We can see some merit in a ring-fence for departmental research budgets, but first it would be necessary to have a greater understanding of these budgets. We have recently tried to quantify government research programmes delivered by other national laboratories like NPL, and found it very difficult. It is even difficult to obtain a definitive list of these laboratories and their roles. We believe there would be many benefits to government by looking at the national laboratories together and we are already seeing benefits for the four national laboratories which Serco supports for the government, NPL, AWE, NNL and Dstl, by taking this approach.

4. Achieving Science and Innovation Investment Framework objectives. The forerunner of this Framework, the Innovation Report of 1999, identified a number of bodies, including the NPL, as National Innovation Assets. In recognition of the importance of NPL to the innovation ecosystem, the predecessor of BIS established two new National Measurement System programmes, Measurement for Innovators and Measurement for Emerging Technologies (MET). Despite high hopes at the time, no additional budget was found for these new programmes, and budgets for existing programmes were reduced. Since that time the NMS budget has been further reduced, and now BIS has announced the closure of the Measurement for Innovators programme, despite the high demand from industry and the measurable impact the programme has achieved. The budget for the successor to the MET programme is also under severe pressure as the National Measurement Office that is responsible for the National Measurement System programme budget has understandably asked for essential UK NMS infrastructure to be given priority.

Memorandum submitted by the Head of School of Optometry (FC 22)

1. The recent announcement by STFC to postpone the NLS (New Light Source) project, halt the Photon Science Research Institute and to withdraw from XFEL Hamburg will have serious negative repercussions for UK science in the rapidly emerging area of Free Electron Laser (FEL) research.

2. The decision on the NLS is regrettable and the difficult financial background is the overwhelming factor motivating this postponement of what will, inevitably be a high cost, high return project. Nevertheless, there can be little question that sooner or later the UK will need to build a FEL, or it will be frozen out from future developments over a vast landscape of light source enabled science and technology. This new class of device promises profound scientific benefit. Moreover there is a large potential for wide ranging economic and societal impact, for instance, through advances in science relating to current high profile topics such as energy science, protein structure determination, biomedical imaging and nanotechnology. Whilst, economically, this may not be the correct moment to move rapidly in building the NLS, it is absolutely imperative that the UK continues to maintain a strong presence in both FEL technology and in the exploitation of FELs for new science complementing research with laser and Synchrotron sources.

3. In the course of the last few years, FELs have emerged as an exceptionally exciting tool for new science providing unique capabilities for imaging the processes at work in nature, and in man-made technology, at the very fast timescales at which these often occur. New results (eg from FLASH — the first short wavelength FEL in Hamburg) are already revealing remarkable results on biological imaging, X-ray interaction physics, and the science of measuring ultrafast interactions in chemical and physical systems. In April, scientists at the LCLS light source (Stanford, USA) saw the first spectacular evidence of hard X-ray lasing and the first experiments are now taking place there. There is likely to be profound impact from these new light sources in biomedical imaging, drug design, fast electronics and magnetics, industrial catalysis, and in artificial light harvesting. Despite the costs, most advanced industrial nations are now pressing ahead with the development of such light sources on their own soil, and/or are becoming partners of the major international project, XFEL.

4. In the meantime, other machines in Japan, Germany and Italy are progressing rapidly towards first light and a number of other projects are moving toward a formal go ahead (eg Max IV in Sweden, SwissFEL in Switzerland, the Shanghai FEL and South Korean FEL). The partners of the XFEL are China, Denmark, France, Germany, Greece, Hungary, Italy, Poland, Russia, Slovakia, Spain, Sweden and Switzerland. Thus, at the very time when UK researchers are starting to establish a strong international presence at the facilities so far available, the future prospects are looking bleak without a stronger UK national commitment. It is vital for the UK to develop an international strategy in FEL science and technology to ensure that the UK remains a key player in a field that promises profound impact across the sciences.

5. The decision of a UK withdrawal from XFEL does not appear to have sufficiently taken into account the resulting dire repercussions on our international reputation. The minimal planned contribution of £30 million over a five year period would have allowed UK engagement with the £1 billion project and would have been exceptionally good value for money. XFEL is the most advanced, and capable, of the current generation of X-ray free electron lasers, with impact that will cut across all areas of science. UK scientists need access to this facility if they are to be able to exploit these new capabilities and develop the expertise to remain a potent force in the many advanced research areas that will be opened for the first time. It is a tragedy if the door to access is to be closed, as none of the alternatives (including LCLS in Stanford) have comparable capability. UK science and possible future UK-based light sources will be seriously damaged by losing access to XFEL. Likewise, the decision to withdraw support from the Photon Science Research Institute, which has promoted the use of the international FEL projects by UK-based research groups, will irreparably damage UK competiveness in FEL science.

6. As the World embarks on this all-important new era of science, it is vitally important to maintain UK momentum in FEL science. The highest priority in the short term must be devoted to establishing strong UK participation in FEL research at the existing international facilities (FLASH, LCLS, XFEL from 2015), as well as at other developing FEL projects in Europe and Japan. If the UK cannot afford to build a FEL of her own, she certainly cannot afford not to play a major part in FEL science.

7. Three main points must be addressed in order to maintain the credible profile of UK's involvement in FEL science built over the last years.

(i) Every effort should be made to maintain a dialogue with XFEL so that the UK users will not be excluded from this world leading facility in the future. The UK partnership with XFEL is a key issue to maintaining international credibility as stakeholders of FEL science and technology.

(ii) Broad support must be provided by the RCUK to allow access to international facilities. Scholarships and bursaries must be maintained to ensure the healthy growing of the research community.

(iii) The future UK's accelerator strategy must incorporate development of FEL sources. This will ensure the technological development for future exploitation.

We believe that, unless these measures are promptly implemented, UK science and its potential will be severely hampered for decades to come.

Memorandum submitted by the Wellcome Trust (FC 23)

1. The Wellcome Trust is the largest charity in the UK. It funds innovative biomedical research, in the UK and internationally, spending over £600 million each year to support the brightest scientists with the best ideas. The Wellcome Trust supports public debate about biomedical research and its impact on health and wellbeing.

2. The Trust welcomes the opportunity to respond to this consultation. Given the short timeframe, and the breadth of issues the Committee has identified, our response is necessarily brief. We would be happy to participate in subsequent evidence sessions if the Committee requires further information on any of these issues.

3. The Wellcome Trust is opposed to cuts to public spending on science, engineering and technology (SET). Such cuts are not consistent with the evidence that exists for the substantial economic benefits that result from investment in research. The report "*Medical Research: what is it worth",*[3] estimated that every pound invested in UK cardiovascular disease research between 1975–92 produced an ongoing stream of benefits equivalent to earning £0.39 per year in perpetuity. The report also illustrated the substantial time lag between research expenditure and the realisation of benefits, suggesting that investment in research requires a stable, long-term commitment.

4. We also note that, while the UK is discussing cuts to spending, other nations have responded to the economic crisis by substantially increasing their investment in SET. The American Recovery and Reinvestment Act of 2009 made a $10 billion commitment to scientific research, facilities and instrumentation, including $2 billion for biomedical research within the National Institutes of Health, $3 billion for the National Science Foundation and $1.9 billion for basic research in the physical sciences. Germany, France, Australia, South Korea and Canada are other nations that have committed to substantial increases in science budgets as part of their recession response packages. If the UK wants to safeguard its leading position in global science we should be seeking to increase, not reduce, our investment.

5. Cuts to SET spending are also not consistent with the UK public's strong support for scientific research. A 2009 Wellcome Trust survey that investigated adults' and young people's awareness, knowledge and attitudes regarding biomedical science found that 95% of adults and 93% of young people thought that "medical research should be supported and encouraged, even if a lot of public money would need to be invested."

6. If spending cuts are seen to be necessary in spite of the strong arguments for maintaining and increasing investment, the Trust suggests that the following set of principles should be used to guide decision-making:

- Take a long-term view: The process for deciding where to make cuts in SET spending must be based on a long-term strategy that recognises the inter-dependencies between research, innovation and education. The Trust considers that the long-term approach taken in the *Science and Innovation Investment Framework 2004–2014* has played a major role in the success of British science over the last decade, and we would urge Government not to abandon this long-term approach in the face of short-term economic constraints.
- Retain a diversity of funding mechanisms: The Wellcome Trust strongly supports the continuation of the dual support system for university research, which recognises that HEFCE and Research Council funding are provided for different purposes and require different allocation mechanisms. If cuts to SET spending are necessary, it is important that these do not disproportionately impact on one part of the dual support system.
- Support partnerships with other funders: Partnerships between Government and third parties, including charities, will be very important in maintaining levels of SET funding through the recession. Charities have contributed over £4 billion to the UK research base over the past five years. The Charity Research Support Fund is an important component of the dual support system that ensures that charities can continue to play a major role as funders of medical research in UK universities. Government must commit to provide adequate funding to the CRSF over the longer-term.
- Support a mix of applied research and research that has yet to be applied: The Trust has significant reservations about the feasibility of HEFCE's recent proposals for measuring the economic impact of research within the Research Excellence Framework. We support attempts to improve understanding of the broader of impacts of research, but there are substantial risks associated with using impact as a tool to prioritise research funding. Such an approach is likely to skew the existing balance of funding towards research with clear short-term application, at the expense of fundamental research which may lead to important applications in the future.

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[3] Health Economics Research Group, Office of Health Economics, RAND Europe (2008) http://www.brunel.ac.uk/385/other/TAP825EconomicBenefitsReportFULLWeb.pdf

— Focus on core priorities: At funding agency level, the Trust's view is that deep, narrow cuts are likely to be less damaging than broad shallow cuts. Budget cuts should be managed by focusing funding on core priorities (and potentially funding a smaller number of grants overall), rather than reducing the size and scope of individual grants.

— Develop and sustain national research infrastructure: Over the past decade the Government has made significant commitments to major research infrastructure. Some of these have been made in partnership with other funders — such as the Diamond Light Source, where the Wellcome Trust provided 14% of the project costs. To ensure long-term sustainability of such facilities it is essential that operational funding requirements are considered alongside capital funding commitments. We welcome the development of the Large Facilities Road Map, which has enabled the Government to become more strategic with investment in capital funding, considering competing priorities across all disciplines.

7. In relation to STFC, the Trust welcomes the recent reprioritisation exercise, and the review of structural issues that is currently underway. This should assist in managing some of the tensions associated with combining research grant-making and support for large scientific facilities within a single funding agency. Funding models for large scientific facilities must enable funders to separate issues of longer-term planning for facilities and their use from shorter-term budgetary cycles.

8. The Trust would also like to highlight the important opportunity presented by the UK Centre for Medical Research and Innovation (UKCMRI)—a partnership of four of the world's most influential and respected scientific research organisations: Cancer Research UK, the Medical Research Council, UCL (University College London) and the Wellcome Trust. As a flagship programme for four funders and one that will greatly enhance national capability, UKCMRI should be considered a national priority.

9. Finally, we would like to emphasise the importance of transparency and openness in relation to potential cuts in spending. The recently announced spending cuts have created significant anxiety in the scientific community, exacerbated by a lack of clarity about the full extent of cuts and where these are likely to fall. Adopting a transparent and consultative decision-making process, and providing clear information about the decisions that have been made, will be an important factor in maintaining the confidence of the UK science community through this difficult period.

Memorandum submitted by Professor Sean J Freeman (FC 24)

Evidence Relating to Cuts in Area of Nuclear Physics and Treatment of Smaller Areas of Scientific Excellence in the STFC Processes

1. Nuclear physics research in UK universities, including the nuclear physics group at Daresbury Laboratory, is primarily a curiosity-driven science, asking fundamental questions such as the nature of the atomic nucleus and radioactivity and how chemical elements are manufactured in stars. The much wider field of applied nuclear science has the commonly known application of nuclear power, but many others in areas such as health/medicine and material engineering. Nuclear physicists in UK universities play an important role in nuclear skills education underpinning these activities at undergraduate, masters and postgraduate levels, as well as participating in applied nuclear activities themselves. Without funding for the fundamental science programme provided by STFC, it is likely that this community will dwindle, scientific output will fall and the important side benefits and wider impact will disappear.

2. UK Nuclear physics is rated highly in international circles. For example, the International Review of UK Physics and Astronomy Research 2005 indicates that: "… UK nuclear physics research is first class, has high international prominence, and has improved since the 2000 review" The full report can be found at the following URL:

http://www.iop.org/activity/policy/Projects/International_Review/

The high quality of UK NP is also illustrated by the large number of UK nuclear physicists holding leading positions in international projects, on international scientific and technical coordination committees, and on programme advisory committees who advise on the specific experimental proposals to use international facilities.[4]

3. Nuclear physics funding was done under the auspices of the Engineering and Physical Science Research Council (EPSRC) until 2007, when it was transferred to the newly created Science and Technology Facilities Council (STFC). Before the transfer it received approximately £10 million per year, a relatively large fraction of the EPSRC physics budget. However, under EPSRC process, it was very difficult to commit funding on a medium-term period, 5–10 years, which is necessary, if the UK NP community were to continue to make impact in large European projects. The funding of nuclear physics was therefore switched to STFC on its creation.

[4] More detailed information could be compiled if felt useful.

4. The 2007 STFC crisis had already led to a 25% cut in the uncommitted funds for NP, in common with the other STFC science areas. The recent cuts announced in December were additional to this. In total, the amount of money for NP has been reduced from approximately £10 million per year when leaving EPSRC to £6 million per year for future years.

5. The current round of STFC cuts announced Dec 2009, using numbers from STFC for the whole programme including subscriptions, are: nuclear physics 29%, particle physics 4%, astronomy 10% and space science 6%. Nuclear physics appears to have suffered more than other areas.

6. The numbers of UK academics in these science areas differ greatly: nuclear physics approximately 55, particle physics approximately 250, astronomy and space science approximately 450. In other countries, the numbers are better balanced.

7. The prioritisation process, by which these cuts have been decided, has been done with little NP expertise on the relevant higher-level STFC committees. Input has been solicited from the science communities via Advisory Panels, but they are not directly involved in the decision making process, as is suggested by their name. The population of the higher committees in STFC, that have actually taken decisions on tensioning the programme, include few nuclear physicists. Participation from the different science areas appears to be largely in proportion to the size of the academic community.

On STFC Council, their Science Board and their Particle Physics, Astronomy and Nuclear Physics (PPAN) Committee, there are only two people with nuclear physics expertise, one in each of the latter groups. It is noted that, due to conflict of interest, these experts must leave the room when nuclear physics is discussed and decisions are taken. The other areas of STFC science, particle physics, astronomy and space science, with much greater participation, do not experience the same issues.

Concerns about the levels of nuclear physics expertise on STFC higher-level committees were raised with STFC officials at town meetings on nuclear physics around the time of STFC's creation.

It is noted that the organisation, process and procedures used in STFC are largely those of the Particle Physics and Astronomy Research Council (PPARC), which was subsumed within STFC on its creation. No changes were made to accommodate properly smaller scientific areas of excellence.

8. The prioritisation process did not take independent expert advice. All members of PPAN, for example, have potential vested interests in the outcome of the process and may have difficulties in taking a wider view. [Science Board has one non-UK member from particle physics, but from CERN where a large amount of STFC money is spent. It may be difficult to assume independence in this situation.] STFC Council accepted the advice of these committees without change.

Independent advice is readily obtained from international scientists, without conflict of interest, and there are many individuals who could have been used in such a process. This might be considered particularly important when dealing with a small area of scientific excellence, where representation of the relevant expertise is difficult.

It is noted that the lower-level STFC grant panels, who deal with the peer review and prioritisation of individual university grant applications, do all include at least one international member. It is strange that such policy is not used in the higher committees in STFC, especially when there are major consequences to the decisions made.

9. Without independent expert advice, and when there is a shortage of expertise, peer-review processes can develop problems. Here I do not wish to call into doubt the integrity of anyone serving on STFC committees; I have the utmost respect for all involved at personal and scientific levels who are involved with such difficult decisions. However, there are unintended pathological outcomes that arise from a peer-review setup such as this.

There is a natural tendency for reviewers to look at areas outside their own expertise conservatively. People are reluctant to score highly areas they do not fully understand. Similarly do not rate very badly either, however, scientific excellence tends to be missed due to the lack of expertise. As a result the smaller subjects will tend to cluster in the middle of any ranking. This is understandable, but fatal in the current financial environment of STFC.

A robust process should acknowledge and overcome such flaws, but the STFC process appears not have any corrective measures imposed in it. No truly independent experts are called on, for example, from the international community. For smaller areas of scientific excellence, where expertise is not available due to committee composition and conflicts of interest, this presents great difficulties. I believe these effects have contributed to the disproportionate cuts imposed on UK nuclear physics.

10. To illustrate international concern over the cuts in nuclear physics funding, note the following letter sent to the Times newspaper by senior US researchers. They note: "The UK nuclear science effort is simply world class". The full letter can be found at:

http://www.timesonline.co.uk/tol/comment/letters/article6962052.ece

11. To illustrate the significance of these cuts to NP internationally, even *before* the recent announcement, UK NP was not funded at a similar level to other EU countries. The following table shows funding levels and personnel in NP in different countries. The *total physicists* includes tenured academics, fixed-term researchers and PhD students. *The numbers are correct at the end of 2006, so prior to both sets of reductions in funding by STFC and are sourced from NuPNET, a grouping of the relevant European research agencies.*

Country	*Funding (MEuro)*	*Tenured Physicists*	*Total Physicists*	*Technicians & Engineers*
Belgium	7.6	38	133	21
Bulgaria	6.8	28	52	9
Czech Republic	5.3	16	75	12
Germany	200.0	330	1100	500
Spain	21.0	119	215	15
Finland	5.3	24	120	25
France	87.5	351	488	566
Greece	2.3	35	55	15
Hungary	3.1	59	87	26
Italy	64.8	354	628	295
Netherlands	9.7	31	78	55
Poland	14.5	203	441	109
Romania	19.5	213	340	85
UK	11.7	63	228	31

12. The 2009 Review of Nuclear Physics and Nuclear Engineering Report on the *training* aspects provided by nuclear physics, (regrettably the panel did not feel they were equipped to review the scientific aspects of nuclear physics) illustrates the importance of the academic nuclear physics community in applied nuclear physics research and in providing essential training in the area of nuclear science, a well known skills gap for UK PLC. They also indicated the risks for the UK community with levels of research funding, even before the recent cuts:

> "The panel acknowledged that recent funding cuts had damaged the UK's Nuclear Physics community, and that the size of the community now meant that it was extremely vulnerable. It was recognised that financial pressures have an adverse effect on the ability of the Nuclear Physics community to realise its potential in economic impact areas. It was felt that further funding cuts could be terminal, resulting in the loss of an important skill set which would impact the delivery of Masters courses."

STFC Science Board appear not to have supported this view, but the quoted reasoning, for example, in a response to a letter sent to Lord Drayson[5] may indicate that the real meaning of the Review's comment was misinterpreted:

> "In particular, the Science Board considered the suggestion in the Review that any further reductions in nuclear physics support by STFC might leave its programme subcritical. The Science Board did not support this view, since projects concerned are all international collaborations and work largely independent of each other, meaning that withdrawing from some does not adversely effect the other."

I must admit to not fully understanding this response, but it appears to ignore the point made about the health and critical mass of the UK nuclear physics community in undertaking excellent international scientific projects, as well as the associated impact noted under Paragraph 1 above.

The full report can be found at the following URL: http://www.epsrc.ac.uk/ResearchFunding/Programmes/PhysSci/RC/Review.htm

13. The consequences of these cuts is likely to begin with a reduction in the number of academic nuclear physicists, with a movement to positions in countries with more favourable funding climates and better research opportunities. PhD graduates are also likely to be attracted abroad to postdoctoral positions. With no UK jobs to bring them home, their expertise will be lost to the UK. Beyond associated reduction in UK fundamental scientific output, there are wider risks and consequences correlated with the reduction in academic staffing.

The undergraduate curriculum in nuclear physics could be limited to the bare minimum, with a notable loss in the availability of nuclear physics as a practical subject at UG level where higher-level expertise is necessary. In addition, 70–90 MSc students per year are trained by the nuclear physics research group through Masters level programmes run at Birmingham, Liverpool, Manchester and Surrey by nuclear physicists and these courses would be in danger of disappearing.

[5] Letter sent by Lord Drayson dated 22 January in response to communication by Sean J Freeman sent on 7 January 2010 (copy available on request).

There could be a loss of the expertise to apply nuclear physics technological advances to areas such as medical imaging, homeland security, radioactive waste management and decommissioning of nuclear sites. For example, improvements in gamma ray detection derived from the nuclear physics research programme are now being applied to improves imaging for brain and cardiac uses, detection of special nuclear materials and the assay of nuclear waste.

14. There is considerable concern in the scientific community as a whole that these cuts are really just the beginning. Despite comments from STFC staff in the press arguing that this round of cuts is due to the current economic crisis, in fact they stem from the Comprehensive Spending Review in 2007 and the poor performance of STFC in the Science Budget Allocation exercise. The effect of the current economic crisis is yet to come and there is great concern that these areas of the physical sciences will suffer yet again when cuts in public spending filter through, unless the Science Budget is kept constant in real terms.

15. The scope of nuclear physicists to undertake applied nuclear physics research is currently limited by research council structure and process. Fundamental nuclear physics programmes are supported by STFC. Research council funding for activities in applied nuclear physics such as reactor technology and nuclear data, medical and homeland security applications, still falls within the remit of EPSRC—and some applied research simply falls in the gap between the two councils. There are some nuclear physics academics, whose primary *reason d'etre* is curiosity-driven science, who also run successful programmes of applied research, but there is untapped potential for such blending of effort. Such initiatives are actually inhibited by current funding arrangements splitting funding sources across councils.

16. There is scope for academic nuclear physicists to increase the volume of MSc training in nuclear skills, and also in bespoke continuing professional development (CPD) courses for industry. This appears to be a missed opportunity in helping to address the skills gap in nuclear science. It would be useful if this were picked up and promoted in some way by a relevant body.

Declaration of Interests

(i) Professor of Nuclear Physics at the University of Manchester.

(ii) STFC Nuclear Physics Grants Panel Chairman (Peer-review committee advising STFC on individual university grant proposals).

Professor Sean J Freeman

26 January 2010

Memorandum submitted by the Faculty of Mathematical and Physics Sciences UCL (FC 25)

Impact of STFC Cuts on UCL Faculty of Mathematical and Physical Sciences

1. This submission is an addition to a more general submission sent centrally from UCL. Here we summarise the effects of the continuing crisis in STFC on the faculty of Mathematical and Physics Sciences in particular.

Specifics of the Latest Round of Cuts

2. Cuts in PhD studentships probably translates to one or two studentships per year over the college. Not financially very significant, but serious for the groups concerned ($\sim$15% cut).

3. Fellowship success rates can be expected to reduce pro rata by a similar amount. The abolition of the PDRA fellowship round after the proposals had been submitted looked calculated to anger and demoralise the brightest of this year's cohort on what was for most their first ever grant application.

4. We expect our large rolling grants in Particle & Astrophysics/Space to be cut by at least 15% depending on how the cuts are implemented. This will be several £100k/yr income lost. This is likely mean a loss of engineering and support capability (redundancies for skilled staff) as well as a reduction in post doc opportunities. Smaller responsive-mode grants will also be hit, especially in Astronomy.

5. Regarding specific projects, our outstanding science programme is vindicated, in that our major projects are generally highly ranked. However, even the highest ranked projects are suffering cuts and whether they remain viable in some cases is in doubt.

6. There is very little breadth left in the STFC programme areas. Initiating any new project is going to be very tough.

7. There will be (currently unquantifiable) damage to retention and recruitment (foreign students and researchers) due to UK cutting science while most of our competitors (US, France, Germany…) invest for the future.

General

8. STFC has continued to oversee the destruction of much of the UK's reputation as a good place to do science, and also a significant transfer of resource from universities to industry and the central labs. Perhaps the most worrying aspects are:

9. The fact that STFC was underfunded and failing has been known for nearly two years, but there has been no political will to fix it (though at least Lord Drayson recently acknowledged the problem).

10. The perception is that the inspirational science under STFC's responsibility is neglected or disfavoured by the government.

11. We also note with concern a continued pressure across the research funding base to spend on projects in industry even when this is not obviously the best science value for money.

12. The cumulative effect is the perception amongst those considering a career in science that the UK does not have the required ambition or vision to support them. There is still no real strategy as to how the UK invests in and exploits facilities (UK and elsewhere). Unless rapidly rectified, this will adversely affect UCL's recruitment and retention of students, postdocs, technical staff and academics across a swathe of physical sciences.

Dean Prof R Catlow FRS
Vice-dean (research)

Prof J M Butterworth
Faculty of Mathematical Physics Sciences
University College London

January 2010

Memorandum submitted by the Royal Astronomical Society (FC 26)

1. The RAS welcomes the opportunity to provide input to the Committee's inquiry. Our Fellows who work in the astronomy and space science research communities have been greatly affected by recent spending cuts and shifts in spending priorities, particularly at the Science and Technology Facilities Council (STFC). A separate submission to the Committee will come from the British Geophysical Association (BGA), which represents those RAS Fellows who work in the area of Solid Earth Geophysics.

2. This submission has been assembled following extensive discussion within the RAS, the Astronomy Forum (representing university astronomy groups around the UK) and with the Institute of Physics.

The process for deciding where to make cuts in SET spending

3. The Society does not wish to comment on the overall balance of the SET budget nor express a preference for one part of its Fellows' work over another. We support a balanced portfolio of investment, with sufficient resources to allow internationally competitive curiosity-driven research (including astronomy and space science) to flourish.

4. For any future cuts, we strongly support a decision making process that is open and transparent across the different levels of Government, with the reasoning behind strategies adopted in the public domain.

5. Within the Research Councils, the RAS believes that investment should follow scientific priorities established by broad consultation with the research community. For example, in the most recent round of cuts, there is a concern that STFC did not follow the advice of its scientific Panels covering the astronomy area. The Council supported a number of less favoured projects and did not seek to prioritise investment in people, both actions that are contrary to Panel advice.

The feasibility or effectiveness of estimating the economic impact of research

6. The RAS concurs with the premise that scientific researchers should facilitate the exploitation of their work by society and industry. In astronomy and space science, there are many examples of this taking place, for example in imaging techniques in medicine, in the Terahertz imaging scanners now being introduced at UK airports and in signal processing in telecommunications.

7. However, the Society strongly opposes the introduction of 'economic impact' in the assessment of research, both retrospectively (via the proposed Research Excellence Framework or REF) and in applications for future funding. Our opposition is based both on the lack of feasibility of this approach and the distortions it is likely to introduce to research funding.

8. In our science, researchers are rarely able to predict the impact of their research at the outset or during the first few years. Impacts that do arise are often a consequence of many years (or even several decades) of further work and extremely difficult to attribute to the original research. For example, the development of Wi-Fi from radio astronomy took more than 30 years and relied on contributions from other disciplines.

9. We find implausible the proposals contained in the REF for a new 'approach' to be developed to tackle this time lag and it is certainly hard to see how this will give due credit to the many different contributors to a resulting impact.

10. With very few exceptions, it is then almost impossible to trace the ultimate economic impact that follows from a new product or technique back to a single original piece of research.

The implications and effects of the STFC budget cuts

11. The RAS believes that the STFC budget cuts are very damaging to UK research in astronomy and space science. This is contrary to the stated Government policy of attracting students into STEM subjects, given the evidence that astronomy, cosmology and particle physics attract students to study undergraduate physics degrees, where applications increased by 19% between 2002–07. The number of UK astronomy academics increased by 13% between 2003–04 and 2007–08, following the average 14% growth in academic numbers nationally over this time frame.

12. The cuts themselves are described in detail in the STFC investment strategy announced in December 2009. They result from a combination of factors: (a) the £80 million shortfall in the STFC settlement resulting from the 2007 Comprehensive Spending Review (CSR07); (b) the inability to withdraw prematurely from long term, international commitments without severe financial penalties; (c) forward budget planning made on the assumption of flat cash settlements in future spending rounds. The initial CSR07 announcement was particularly ill-timed for STFC since this new organisation lacked community input to prioritisation via advisory panels. Delays in the establishment of such panels prevented the outcome of a scientific prioritisation exercise until now, accruing £46 million in loans over 2008–09 and 2009–10, which have to be repaid in 2010–11.

13. Further financial pressures have arisen from the decline in the Net National Income (NNI) of the UK, calculated on the basis of GDP and exchange rate. With a weaker pound, subscription levels for international organisations including ESO and ESA have increased sharply. So far, these potentially crippling costs to STFC have been reimbursed by DIUS/BIS to the value of £17 million (for the financial year 2008–09), £42 million (2009–10) and an anticipated £60 million in 2010–11, but this has inevitably led to financial tensions within RCUK, including a contribution of £14 million to STFC from other Research Councils for 2010–11.

14. This combination of factors has nevertheless resulted in a devastating impact upon STFC science including (a) a 25% reduction in the volume of exploitation grants over CSR07; (b) major cuts to the current and future scientific facilities required by STFC's scientific user base, with UK-led programmes lacking formal agreements with international partners hardest hit and (c) the inability to maximise the return from major subscriptions or national facilities. On the latter point, in the Particle Physics Astronomy and Nuclear physics (PPAN) area the current ratio of STFC investment between facilities and exploitation grants is around 3:1, which many researchers believe to be too low for that exploitation to be effective. However, the current strategy is that funding for astronomy Post-Doctoral Research Assistants (PDRAs) will reduce even further, with a planned reduction towards 60 PDRAs/yr, 45% below the 2007–08 level of around 110/ PDRAs/yr, leading to a yet greater imbalance between astronomy facility provision and exploitation grants.

15. The chair of the STFC Astronomy Grants Panel (AGP) believes that these savings could mean that 70% of UK astronomy rolling grants (those extending over a five year period) to research groups in universities will no longer be viable as they will lack a critical mass of postdoctoral researchers. This loss will make it almost impossible for them to compete with their peers both in the UK and overseas.

16. Such a profound shift will remove the ability of virtually every research group to provide leadership in international projects. This in turn could threaten the viability of many physics departments around the UK that have a significant fraction of their work funded by STFC. The combination of cuts to previously announced STFC research grants and the general outlook for STFC supported science in Universities will inevitably lead to a rapid decline in academics within these areas, unless confidence can be rapidly restored through greater stability in funding.

17. STFC has also announced a 25% cut to the education and training budget for 2010–11, a reduction in the number of postgraduate studentship awards and cancellation of the 2010 postdoctoral fellowship round at late notice. It will become more difficult to receive postgraduate training and far harder to take the first step on the ladder of an academic career, further accelerating an exodus of the brightest young scientists overseas, a process which had started before these latest announcements. Urgent changes need to be made to offer hope of a future within the UK to current STFC-funded postgraduates and PDRAs.

18. In terms of facilities, these savings include UK withdrawal from a swathe of ground-based research projects and observatories, including the Auger Cosmic Ray Observatory in Argentina, the Atacama Large Millimeter Array (ALMA) regional centre, the Joint Institute for Very Long Baseline Interferometry in Europe (JIVE), the UK Infrared Telescope (UKIRT) in Hawaii, the Gemini Observatory in Hawaii and Chile and potentially the Isaac Newton Group (ING) in La Palma in the Canary Islands.

19. One dramatic consequence of the cuts to ground-based facilities is that after 2012 UK astronomers may no longer have access to any optical telescopes in the northern hemisphere, effectively denying British researchers the opportunity to observe the sky above their heads.

20. Support will no longer be available for researchers working on data from the ongoing and highly successful space missions Cassini (studying Saturn and its moons), Cluster (studying the Earth's magnetosphere), the Solar and Heliospheric Observatory (SOHO), Venus Express and the X-ray observatory XMM. In all these cases UK scientists were involved in designing instruments for and held key roles in planning the missions.

21. STFC has also planned for a further £16m in savings from the budget for ground-based astronomy and a further £28m from space-based astronomy research. These savings partly result from the proposed shift of £24m from the (PPAN) area to the Physics and Life Sciences (PALS) area.

22. At present the UK has enormous strength in astronomy and space science. It is one of the few scientific areas where we are genuinely world-leading, with the number of citations of scientific papers second only to the United States. This reputation helps attract the best talent from overseas and also has the effect of encouraging young people to careers in science and engineering. In UK universities, many academics working in other more "applied" areas of physics and engineering state that they were drawn into science by their enthusiasm for "blue skies" subjects like astronomy (examples are outlined in the RAS submission to the RCUK review of physics in 2008 led by Professor Bill Wakeham).

23. Given the scale of the proposed cuts, the Society believes that if they are implemented UK astronomers will lose their leading position and that this change would likely be irreversible. It will also remove the technical base (for example in instrument development) that forms the heart of knowledge exchange activities in this area as well as much of the motivation for scientists to engage in outreach activities.

The scope of the STFC review

24. The RAS welcomes and has actively engaged with the review of STFC announced by the Science Minister on 16 December 2009. Our proposals for the Science Minister are set out in the following paragraphs.

25. Firstly, we acknowledge and welcome the positive action taken by DIUS and then BIS since 2008 to mitigate the detrimental effect of increases in international subscription costs. We also recognise the efforts made by STFC management to better engage with the research community (at least via the RAS) in the period since their CSR07 settlement and the welcome consultation exercises that have followed.

26. Nevertheless, the Society believes that structural issues remain whilst the risk associated with international subscriptions are largely the responsibility of the Research Council. Their fluctuations are essentially beyond the control of STFC, yet major subscriptions now amount tõ 50% of STFC's near-cash allocation in 2009–10.

27. To provide a permanent, rather than ad hoc solution we believe that the Government should move the risk associated with changes in NNI to the level of BIS or HM Treasury, which would allow far greater certainty in forward planning. This compensation should ultimately be cost neutral, as in many years BIS would also benefit from positive movements in exchange rates (and hence NNI).

28. The Society accepts that international subscriptions to which STFC's user communities are the sole users should be tensioned against other components of their programmes, except for ESA subscriptions or bilateral agreements which are in the wider UK strategic interest.

29. The STFC structure grew out of the merger of the Particle Physics and Astronomy Research Council (PPARC) with the Council for the Central Laboratory of the Research Councils (CCLRC). STFC is now responsible for and has active involvement in both the science exploitation and the facilities provision on the PPAN side but only the facilities in the PALS area. Consequently only the PPAN part of the UK science programme is tensioned against the PALS facilities, which serve communities funded by the other Research Councils and are effectively "national laboratories". The merger was justified on the basis that the previous arrangement ran the risk that the UK did not fully exploit its investment in large scientific facilities. To date, underfunding has led to STFC failing in this regard.

30. We therefore urge the Government and RCUK to treat the PPAN and PALS areas of STFC separately, at least for financial purposes. STFC would benefit from a more transparent division between science and multi-disciplinary national facilities if those were considered by separate Boards. Future science budget allocations and associated technology development in the PPAN area could then be made explicitly for this new Science Board which would gain a more executive role. Costs for the Facilities Board would be

met at the time of the next CSR by those Research Councils requiring the use of the national facilities, in proportion to their proposed use. Membership of this Board would then need to have representation from across RCUK.

31. The RAS believes that this would remove the direct tensioning between national facilities and the PPAN research community, although the national facilities would still need to be tensioned against their own user communities from different research areas. However, future STFC science budget allocations could still be distorted by the "non-cash" costs associated with the depreciation of capital assets like Diamond and ISIS included in Treasury accounting rules. A standalone National Laboratory, located on multiple sites and reporting to a stakeholder board, could provide large-scale engineering and computing facilities for both the public and private sectors. The Innovation Campuses would also sit naturally inside an organisation of this type. The Astronomy Technology Centre should remain within STFC, since its primary role is the development of instrumentation for ground-based astronomy facilities with UK involvement.

32. If the new approach is adopted, the RAS believes that this will stabilise the STFC research grants line, provided that subscriptions to major international organisations are stabilised, although it is recognised that increases in these costs may be imposed on the UK through majority voting amongst international partners. At the very least, these revisions would create a more transparent decision making process, where changes to the Council budget would translate more seamlessly into research activity.

33. We also believe that these solutions are preferable to shifting the grants line into another Research Council, thereby fragmenting the responsibilities for UK research in astronomy. PPAN research is characterised by long lead times, sometimes a decade or more, supported by the "Rolling Grants" model which better ensures continuity of funding over project lifetimes and has been instrumental in allowing the UK to take its world-leading position in astronomy and space science. This model is not used in for example, EPSRC, where research projects are more impact-led and expected to deliver results on a much shorter timescale.

34. One other aspect of astronomy and space science funding so far not covered by the review of STFC is the role of the new freestanding Space Agency.

35. The RAS welcomes the creation of the Agency, with the view that its leadership could be far more effective than the present BNSC partnership. Our proviso is that additional costs associated with the Agency should not be met at the expense of the science research budget. Since the Ministerial announcement last December, we also remain unclear as to the shape of the Space Agency and the areas it will be responsible for. We therefore request the Government to publish its proposed Agency model in the near future and to work with the scientific community to devise an appropriate structure for the new organisation.

The operation and definition of the science budget ring-fence

36. The RAS welcomes the public commitment of the Science Minister to retain the science budget ring-fence. We note however that the additional costs arising from the impact of NNI fluctuations discussed above are at present funded by shifting resources within the ring fence, making it less effective at protecting research funding than might be assumed.

Government objectives set out in the "Science and Engineering Investment Framework 2004–14"

37. The Society notes the ambitious vision for Science set out when the Framework was published in 2004. With the planned contraction of research in astronomy and space science, that vision will be harder to realise.

38. With Governments of other nations like the United States and Germany committed to increasing investment in science, the UK's world ranking as second to the US for research excellence is unlikely to be sustained. It is also hard to see how the UK will continue to be an attractive destination for researchers from other countries if the reputation of our science is so diminished.

39. In 2004 the Framework set out the ambition that Research Council's programmes should be more strongly influenced by and delivered in partnership with end users of research. Although matters have improved greatly since 2007, there is still well-founded concern in the astronomy and space science community that STFC is not responding to scientific recommendations in the way that it should.

40. One final note concerns the provision of science teachers in schools and the "step change" in their numbers sought by the Framework. Despite welcome efforts made to improve recruitment in the form of bursaries and other incentives, 50% of secondary schools in inner London have no physics graduates teaching science. This has long-term and well documented implications for the supply of future graduates in physics and astronomy and we urge the Government to look again at policy in this area.

Memorandum submitted by senior academics from the Department of Physics and Astronomy, University of Sheffield (FC 27)

We wish to write to you following your request for input to the 'Impact of Spending Cuts on Science and Scientific Research' inquiry as senior academics from the Department of Physics and Astronomy, University of Sheffield. We would like to express our concerns about the impact of the recently announced STFC prioritisation exercise, together with our opinion on necessary structural changes to ensure that fundamental physics within the UK can be better supported.

Professor Paul Crowther (astrophysics)

Professor Neil Spooner (particle astrophysics experiment)

Professor Dan Tovey (particle physics experiment)

Professor Clive Tadhunter (astrophysics)

Declaration of Interests

We are each in receipt of STFC-funded research grants, plus various PPARC/STFC committee and panel membership, including both Particle Physics Grants Panel (2008–-present), STFC Particle Physics Advisory Panel (2009–present) for Prof D. Tovey.

1. We welcome the opportunity to provide input to the Committee's inquiry, and thank members of the Committee for their continuing scrutiny of issues relating to the Science and Technology Facilities Council (STFC).

2. Four of the eight scientific highlights of the past decade selected by the BBC in December 2009[6] were from disciplines funded by the STFC, namely the quest for dark matter, particle physics at CERN, the discovery of extra-solar planets and the search for life elsewhere within our Solar System.

3. STFC-funded research within our department is involved with three of these subject areas, namely Particle Physics, Particle Astrophysics and Astrophysics. We currently educate around 130 physics undergraduates a year. Our department was rated joint 4th (with Imperial, UCL and Glasgow) among Russell Group Universities in the 2008 Research Assessment Exercise. In common with other UK physics departments we are now facing the loss of many skilled staff in the next few years, most likely to our competitor nations.

4. STFC-funded subjects are known to attract students to physics degrees, for which applications increased by 19% between 2002 and 2007 nationally.[7] According to RCUK, the number of physics academics within the UK increased by 14% between 2003–04 and 2007–08, while the number of astronomy academics submitted for the PPARC/STFC studentship quota exercise increased by 13% over this timeframe. These statistics mimic a 14% growth of the entire UK academic community spanning all disciplines,[8] and contradict claims made by STFC's Chief Executive during the 2008 Science Budget Allocations inquiry by your predecessor Committee.[9]

5. Current Government policy is to increase the number of Science, Technology, Engineering and Mathematics (STEM) students. However, such aims are undermined by ongoing cuts to subjects for which the STFC is the sole custodian within the UK. STFC senior management have claimed that cuts arise from the economic downturn,[10] yet they predate the financial crisis, stemming instead solely from the Comprehensive Spending Review 2007 (CSR 07) which has remained ring-fenced to date.

The Implications and Effects of the STFC Budget Cuts

6. The STFC grew out of the merger of the Particle Physics and Astronomy Research Council (PPARC) with the Council for the Central Laboratory of the Research Councils (CCLRC). STFC has responsibility for the science exploitation of the Particle Physics, Astronomy and Nuclear Physics (PPAN) but also national facilities for all Physics and Life Sciences (PALS). Consequently only the PPAN part of the UK science programme is tensioned against national facilities, which serve communities funded by the other Research Councils.

7. The merger was justified on the basis that the previous arrangement ran the risk that the UK did not fully exploit its investment in large scientific facilities.[11] It is our view that a combination of the conflict of interests resulting from the poor structure above, a funding shortfall built in at the formation of STFC and inept senior management decisions have led to STFC wholly failing in this regard to date.

8. The savage budgetary cuts announced by STFC in December 2009, amounting to more than 35% (greater than anything in the Thatcher era) are very damaging not just to the health of UK research in astronomy, space science, particle physics and nuclear physics, but to undergraduate Physics education at

6 http://news.bbc.co.uk/1/hi/sci/tech/8435246.stm
7 http://www.dius.gov.uk/research_and_analysis/media/publications/D/DIUS_RR_08_21
8 http://www.rcuk.ac.uk/news/2009/091217.htm
9 http://www.publications.parliament.uk/pa/cm200708/cmselect/cmdius/215/8022706.htm (Q341)
10 http://www.newscientist.com/blogs/thesword/2010/01/uk-facilities-cuts-fair-and-ba.html
11 http://www.berr.gov.uk/files/file36094.doc

Universities as well. They result from a combination of factors: (a) the £80 million shortfall in the STFC settlement resulting from CSR07; (b) the inability to withdraw prematurely from long-term, international commitments (eg Gemini Observatory) without severe financial penalties and reputational damage for future international collaborations; (c) forward budget planning made on the assumption of flat-cash settlements in future spending rounds.

9. The initial CSR07 announcement was particularly ill-timed for STFC since this new organisation lacked community input to prioritisation via advisory panels, since advisory panels to the Science Committee of PPARC had been disbanded. Delays of two years in the establishment of new advisory panels to PPAN prevented the outcome of a robust scientific prioritisation exercise until late 2009, accruing £46 million in loans over 2008–09 and 2009–10, which have to be repaid in 2010–11.

10. Further financial pressures have arisen from the decline in the Net National Income (NNI) of the UK, calculated on the basis of GDP and exchange rate. With a weaker pound, subscription levels for international organisations have increased sharply, especially the European Space Agency (ESA). So far, these potentially crippling costs to STFC have been reimbursed by DIUS/BIS to the value of £17 million (2008–09), £42 million (2009–10) and ~£60 million anticipated for 2010–11, but this has inevitably led to financial tensions within RCUK, including a contribution of £14 million to STFC from other Research Councils for 2010–11.

11. This combination of factors has nevertheless resulted in a devastating impact upon STFC science within university departments. Over 30 project of high international standing are to be cut and we face: (a) a further 25% reduction in the volume of exploitation grants over CSR07; (b) major cuts to the current and future scientific facilities required by STFC's scientific user base; (c) the inability to maximise the return from major subscriptions or national facilities.

12. UK-led scientific projects have often been hardest hit since they lack the penalty agreements with international partners regarding cancellation/withdrawal. For example, CLOVER was cancelled by STFC in April 2009 within sight of its deployment[12] and the UK-based world renown Dark Matter research and Boulby facility now face withdrawal of all STFC support.

13. The current ratio of investment across the PPAN area between facilities and exploitation grants is ~3:1.We feel that there is a strong imbalance between facility provision and research grants, in the sense that greater benefit would result from an increase in scientific exploitation. This view was shared by the 2006 International Panel on Physics and Astronomy.[13] However, STFC's Chief Executive has taken the opposite stance as recently as January 2010, ie that the balance remains too great towards exploitation.[14] The vision instilled at STFC from the Chief Executive's role as Director of the Mullard Space Science Laboratory appears to be a desire to leave scientific exploitation to others (ie "build it, launch it, forget about it").

14. The December 2009 announcements outline no further cuts to exploitation grants during CSR 07 plus a 10% volume reduction thereafter. However, for astronomy/space science, the medium-term reality looks to be far worse, with a volume reduction of 32.5% below 2007–08 levels according to the chairman of the Astronomy Grants Panel (AGP).[14] The figure of particle physics is similarly bad. Notable is proposed withdrawal from many pump-priming projects that are vital to UK leadership in the future of the subject, such as the UK's neutrino programme in Japan. The current strategy in astronomy/space science is that PDRA funding is planned to reduce towards 60 PDRA's/yr over the next few years, a decline of 45% with respect to the 2007–08 level of ~110/PDRA's/yr.

15. Such a profound shift will inevitably lead to a yet greater imbalance between facility provision and exploitation grants, disproportionately affecting junior staff, with many long-term rolling grants becoming unviable. This will remove the ability of virtually every research group to provide leadership in international projects. In addition, plans are made on the basis of optimistic flat-cash settlements in future spending rounds, so that the actual cuts may yet be far worse.

16. The combination of unprecedented cuts to previously announced STFC research grants and the general outlook for STFC supported science in Universities will inevitably lead to a rapid decline in academics, postdoctoral staff and postgraduate students within Physics department, unless confidence can be rapidly restored through greater stability in funding. In turn, this will threaten the viability of many physics departments, rapidly reduce the numbers of students entering University to study physics, and impact on the quality of education received by those who remain.

17. The planned reduction in standard and rolling grant awards will not only leave a majority of STFC's academic community without postdoctoral support, but also represent the loss of equipment and travel grants, which are generally tied to Research Council grant awards. This will further impact heavily on the UK's success at holding leadership in international programmes. New, supposedly transparent arrangements for PhD studentship allocations imposed upon STFC's Education, Training and Careers Committee require that academic staff are in receipt of STFC grant funding to be eligible for studentship quotas. Therefore, the effects of future low grant success rates will affect junior academic staff the hardest, severely hindering their research career progression.

[12] http://www.astro.cf.ac.uk/research/instr/projects/clover/?page=status
[13] http://www.iop.org/activity/policy/Projects/International_Review/index.html
[14] http://www.ras.org.uk/images/stories/ras_pdfs/Astronomy_Forum/ASTRONOMY%20FORUM%20Jan%202010.pdf

18. STFC has also announced a 25% cut to the education and training budget for 2010–11, reducing in the number of postgraduate studentship awards and cancellation of the 2010 postdoctoral fellowship round at late notice (after the application process was completed). It will become more difficult to receive postgraduate training and far harder to take the first step on the ladder of an academic career, further accelerating an exodus of the brightest young scientists overseas, a process that had started before these latest announcements. Urgent changes need to be made to offer hope of a future within the UK to current STFC-funded postgraduates and PDRA's.

19. One dramatic consequence of the cuts to ground-based facilities is that after 2012 UK astronomers may no longer have access to any optical telescopes in the northern hemisphere, effectively denying British researchers the opportunity to observe the sky above their heads. The curtailment in new European programmes like the Cherenkov Telescope Array and the EURECA dark matter search, will essentially end UK involvement in Particle Astrophysics as a field, entirely opposite to the trend in our competitor countries. The inability to provide instrument technology funding in Universities for future particle physics will end carefully established UK leadership in future neutrino programmes like FJNE and threatens future development of the Large Hadron Collider.

20. At present the UK has enormous strength in astronomy, space science, particle physics and particle astrophysics. It is one of the few scientific areas where we are genuinely world-leading, with the number of citations of scientific papers second only to the United States in several areas. This reputation helps attract the best talent from overseas and also has the effect of encouraging young people to careers in science and engineering. This situation is rapidly being reversed.

21. Given the scale of the proposed cuts, we believe that if they are implemented the UK will lose its leading position and that this change would likely be irreversible. It will also remove the technical base (for example in instrument development) that forms the heart of knowledge exchange activities in this area as well as much of the motivation for scientists to engage in outreach activities.

The Scope of the STFC Review

22. We welcome the review of STFC announced by the Science Minister on 16 December 2009 and endorse the submissions to the review set out by the Institute of Physics, plus particle physics and astronomy communities, to which we have provided input. However, it was necessary for such input to be carried out on a very short timescale, and in the vacuum of specific details regarding the new UK space agency.

23. There is a widespread perception that astronomy/space science receives a disproportionate share of the STFC near-cash allocation, a view bolstered by the prominence given to space exploration during CSR 07 negotiations.[15] However, such costs are dominated by the ESA subscription, which distorts the overall balance of resources within STFC yet are largely beyond the control of its scientific community. Over the past decade, Government policy has served to increase the share (with associated risks thereof) of the civil ESA budget that is paid from Research Council, in particular the STFC. The fraction of the UK's civil space activities for which STFC and its predecessor organisation has responsibility has increased from 25% in 2000–01 to 44% in 2008–09.[16]

24. The only optional ESA subscription in which STFC has involvement is the Aurora space exploration programme. Despite warnings about the long-term financial impact of participation in Aurora by your predecessor Committee,[17] the STFC has been reluctant to reduce expenditure in this area, contrary to input from the scientific community set out in the Near Universe Advisory Panel report to PPAN, summarised in a presentation to the Astronomy Forum in January 2010.[18] If the primary beneficiary of Aurora membership to the UK is industry, it would be appropriate for its cost to be met by the UK space agency, rather than Research Councils.

25. If the new approach set out by our communities for a new research council were adopted, the STFC research grants line would then be stabilised, providing subscriptions to major international organisations do not increase in real terms. However, it is recognised that increases may be imposed on the UK through majority voting amongst international partners. At the very least, proposed revisions would create a more transparent decision making process, where changes to the Council budget would translate more seamlessly into research activity.

26. Overall we also believe that these solutions are preferable to shifting the grants line into another existing Research Council, thereby fragmenting the responsibilities for UK research in our fields. Some aspects of PPAN research are characterised by long lead times, sometimes a decade or more, supported by the "Rolling Grants" model which better ensures continuity of funding over project lifetimes and builds the necessary skilled staff. This has been instrumental in allowing the UK to take its world-leading position. This model is not used in for example, EPSRC, where research projects are more impact-led and expected to deliver results on a much shorter timescale. The latter does offer attractions to responsive-mode funding for some activities, including computational studies in which the UK excels, requiring an appropriate balance between the two models.

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[15] http://www.physics.ox.ac.uk/users/peachk/STFoIC/CSR07%20Bilateral%20v10.ppt
[16] http://www.bnsc.gov.uk/About%20BNSC/How%20we%20are%20funded/8012.aspx
[17] http://www.publications.parliament.uk/pa/cm200506/cmselect/cmsctech/808/6011802.htm (Q.13)
[18] http://pacrowther.staff.shef.ac.uk/NUAP15Jan10.pdf

27. Additional costs associated with the new UK Space Agency should not be met at the expense of the science research budget.

28. Finally, recommendations set out by the community are based upon the desire by the Science Minister to implement STFC structural changes that do not require legislation ahead of the next general election. In the longer term, it is hoped that a better solution can be achieved. If a National Laboratory sited at Harwell and Daresbury were established, the remaining science components of STFC together with technology development specific to PPAN science (eg UK Astronomy Technology Centre) could be refocused upon the delivery of University-led scientific excellence via the inclusion of research within its title as the Science and Technology Research Council, after proper consultation with its user community. In the longer term, if Government strategy wished for improved cross-disciplinary links, a single science research council might be established, along the lines of the U.S. National Science Foundation or former UK Science Research Council.

Memorandum submitted by UK Nuclear Physics Research Groups (FC 28)

1. Nuclear Physics Research is an important part of any balanced science research programme. The importance of nuclear physics research has been recognised in recent years by major investments in new facilities in Europe, USA, Canada and Japan. The UK does not have any facilities and has not made an investment in any of the international nuclear physics facilities. UK Nuclear Physics is recognised as being on very high quality. This was recognised by the most recent (2005) International review of UK Research in Physics and Astronomy (http://www.iop.org/activity/policy/Projects/International_Review/). The review concluded that "UK nuclear physics research is first class and has high international prominence". It further stated that "the potential for this research is outstanding" and that that was a need for "stable long term funding".

2. The STFC budget cuts will hit Nuclear Physics research in the UK particularly hard. The cuts in the Nuclear Physics budgets were much bigger than in the other fields where STFC funds grants. The figures in the table below are taken from the STFC announcement.

Subject area	*5 year funds (£M)*	*Subscription (£M)*	*Grant Funding (£M)*	*Cut (£M)*	*Cut (%)*
Nuclear Physics	30	0	30	12	29
Astronomy	267	113	154	29	10
Space Science	639	480	159	42	6
Particle Physics	690	460	230	32	4.4

The cut in Nuclear Physics is disproportionate.

3. When Nuclear Physics research moved from EPSRC in 2007 the budget for Nuclear Physics waš £10M p.a. plus studentships/fellowships. This is already very low compared to European and other international comparators. This can be seen in evidence compiled by NuPeCC (http://www.nupecc.org/pub/survey2006.pdf), OECD (http://www.oecd.org/sti/gsf) and recent data from NUPNET (a grouping on EU funding agencies). The NUPNET data (which have been supplied by STFC who are a member) are shown in the table below and are based on 2007 figures:

Country	*Funding (MEuro)*
Belgium	7.6
Bulgaria	6.8
Czech Republic	5.3
Germany	200.0
Spain	21.0
Finland	5.3
France	87.5
Greece	2.3
Hungary	3.1
Italy	64.8
Netherlands	9.7
Poland	14.5
Romania	19.5
UK	11.7
UK (2010–)	6.8

Since these data were compiled STFC have cut the Nuclear Physics programme twice to an annual value of ~£6 million per annum, this is shown in the table as 6.8 Meuros. The number of academic staff in UK Universities carrying out Nuclear Physics research is ~55. This number cannot be sustained with this level of funding and will reduce significantly in the next few years to the point where the numbers are below the critical mass needed to carry out research at the highest international level.

4. The peer review process used by STFC to reach these decisions is in our view flawed. Funding for nuclear physics research is decided following recommendations from the PPAN (Particle Physics, Astronomy and Nuclear Physics) Committee, Science Board and Council. Members of all these groups are appointed by STFC. The main peer review committee is PPAN whose members are all researchers in Particle Physics, Astronomy, Space Science and Nuclear Physics. There are no independent members and no international members. The number of people on the committee reflects the size of each area both in terms of numbers of researchers and spend. Of the eleven members one is from nuclear physics, the others are split between particle physics, astronomy and space science. When the committee are discussing the allocation of a reduced budget every member will naturally protect their own area. The result of this process protects the larger groups and is essentially a majority vote system. PPAN produce a single list in order to determine the priorities, there was not attempt to look at how the various areas compared. The PPAN recommendations were discussed by Science Board and Council, but were accepted in the belief that they were the result of a rigorous peer review.

5. The Royal Charter under which STFC operates includes the following:

> To promote and support, by any means, high-quality basic, strategic and applied research and related post-graduate training in astronomy, particle physics, space science and nuclear physics and research in any other field which makes use of scientific facilities where access is provided, arranged or otherwise made available by the Council, having regard to the objects of the other research councils.

This specifically includes nuclear physics. There is no evidence that STFC through its Council have done this for nuclear physics. There has been very little promotion of the subject and its funding has been reduced severely in a period of around three years since STFC was established. The cuts in Nuclear Physics are much greater than other areas and STFC are moving funding to different areas in the portfolio they inherited from PPARC. STFC have made no effort to change their structures and practices to reflect the addition of nuclear physics to the PPARC portfolio. This has severely compromised the STFC's ability to prioritise across disciplines without showing the natural biases of its panel members. Given this situation the funding in different areas should be scaled to the 2007 figures until a robust prioritisation mechanism can be agreed by all interested parties.

6. The loss of academic nuclear physics in UK Universities will follow from these STFC cuts unless funding is restored to a minimum of the £10 million per annum transferred from EPSRC to STFC. This will have an impact in a number of areas including:

- The undergraduate curriculum and the availability of nuclear physics as a practical subject and for final year projects.
- The recruitment and training of young people for the nuclear industries through MSc and PhD degrees. Currently the UK nuclear physics research community trains about 20 PhD students per year, 25% of whom take jobs directly in the nuclear industries. In addition 70-90 MSc students per year are trained by the nuclear physics research group through Masters level programmes run at Birmingham, Liverpool, Manchester and Surrey.
- The loss of the expertise to apply nuclear physics technological advances to areas such as medical imaging, homeland security and radioactive waste decommissioning. For example improvements in gamma ray detection derived from the nuclear physics research programme (the AGATA spectrometer) as now being applied to improve SPECT imaging for brain and cardiac uses, detection of special nuclear materials and the assay of nuclear waste on sites such as Sellafield.

It is unlikely much of this will survive without the base of UK academic nuclear physics researchers in Universities that is funded by STFC.

7. Following the Wakeham review RCUK commissioned a review of Nuclear Physics and Engineering in the UK. This was carried out by STFC and EPSRC and the committee was chaired by Dame Sue Ion. The report is now published at: (http://www.stfc.ac.uk/SciProg/NP/NPEngReview.aspx)

The review agrees with what has been said above. This review was available during the later stages of the prioritisation process that STFC announced the results of in December 2009. There is little evidence that any of the STFC committees took any notice of its recommendations. STFC and EPSRC are currently preparing a response to this report, but have already cut nuclear physics funding further before this has been completed.

Review of STFC

8. STFC currently funds International subscriptions, National Facilities and grants for Particle Physics, Astronomy, Space Science and Nuclear Physics. It is essentially a merger of PPARC and CCLRC. It has been in crisis since it was formed in 2007. The funding of International subscriptions and National Facilities is causing unacceptable reductions in the amounts of funds available for grants. The various functions should be separated.

9. A National Laboratory, based on multiple sites, should be established to run the National facilities. The funding for the various facilities operated (eg DIAMOND, ISIS etc.) should come from the Research Councils who wish to use the facilities. Funding should be agreed between the Research Councils and the National Laboratory on a three year rolling basis. A new strategic body should be establishing including independent and international members to determine the establishment of future new facilities and the development of current facilities.

10. International subscriptions should be the responsibility of the Research Council that makes the major use of the facility. That research council would then tension exploitation of the facility against the size of the subscription. The subscriptions to ESRF and ILL should be the responsibility of EPSRC. The major subscriptions for CERN, ESA and ESO would remain with STFC (in a slimmed down form) or go to the new space agency as appropriate. Any changes due to currency fluctuations should be the responsibility of government.

11. The process of awarding grants for Particle Physics, Astronomy, Space Science and Nuclear Physics needs reform to ensure that the amount available to grants does not reduce due to outside factors. Nuclear Physics being much smaller than the other three area is not served well by the mechanisms currently employed by the PPAN committee of STFC. Nuclear Physics research needs a funding mechanism that allows for both long term commitments to facilities and projects (through rolling grants, project grants and facility investment) and for shorter term exploitation grants. The STFC systems allows for all this. The peer review system however would have to changed to avoid disadvantaging smaller groups such as nuclear physics. This can be done by ensuring that the peer review process and the committees making the decisions are not dominated by groupings from big science areas. The system used by EPSRC for example for their physical sciences grants follows this approach.

12. For Nuclear Physics grants there are two options for the future. The first would see Nuclear Physics remaining within STFC. If the recommendations above are followed then the current STFC would end up very close to the old PPARC Research Council which is relatively small compared to others. If this is the case Nuclear Physics can only survive if the changes described above to the peer review process are implemented. The second option would see Nuclear Physics grants (including at least £10 million per year plus studentships) transferred to a modified EPSRC Research Council. The current EPSRC process would have to be changed to account for the long term commitments needed, including rolling grants and facility investments.

Declaration of Interests

This submission has been prepared by Prof Paul Nolan on behalf of all the UK Nuclear Physics research groups at:

University of Birmingham
Brighton University
University of Edinburgh
University of Glasgow
University of Liverpool
University of Manchester
University of Surrey
University of York
University of the West of Scotland

Memorandum submitted by the UK Space Academic Network (SPAN) (FC 29)

As Chairman of the UK Space Academic Network (SPAN) I am submitting the attached evidence on behalf of the group.

SPAN members are based in about 20 UK University and Institute research groups that cover a broad range of the Space disciplines including Astronomy, Climate and Earth Science, Fundamental, Planetary and Solar System Physics.

1. Introduction

1.1 This submission is made by the Space Academic Network (SPAN), representing about 20 UK University- and Institute-based research groups that cover a broad range of Space disciplines including Astronomy, Climate and Earth Science, Fundamental, Planetary and Solar System Physics.

1.2 Given the limited time available for consultation prior to this submission, the content will concentrate on the impact of the recently announced STFC budget cuts on the Space Sciences supported by that Council and the structure of the STFC in relation to the on-going support of the space-based disciplines. However,

the research councils are important funders across our remit. In particular, we welcome the way NERC's strategy emphasises the important role observations play in environmental prediction, and thus the central role played by Earth observation in NERC's programme. We also welcome the establishment of the National Centre for Earth Observation, funding UK Universities Earth observation research from NERC. Continuation of a vibrant UK environmental science programme thus depends on continuing funding by NERC of Earth observation science at at least the level of today, as well as an ability to play a full part in ESA by maintaining the UK subscription, and subscribing to new programmes such as GMES.

1.3 The DBIS 2009 International Comparator Performance of the UK Research Base makes clear how well the UK performs in almost all areas. The UK is first internationally in environmental sciences, where Earth observation is critical to performance, and in physical sciences the UK is fourth internationally in citations. In the area represented by SPAN, the space-based physical science performance is better, with total high quality refereed publications being second only to the USA. DBIS in their comparisons note that three nations, China, Germany and the US, are forming a separate group in performance above the next, European cluster led by the UK. It is important to maintain and grow those areas where the UK is well in the top group. This success is built on the academic excellence of its Universities and Research Laboratories which drives the technological innovations and projects from which the key observational data can be obtained. UK access to space has been primarily through its participation in the European Space Agency, where it plays a leading role in mission design, instrumentation, and exploitation. These endeavours are supported by STFC through a combination of project and responsive-mode research grants.

1.4 The UK space industry grew by 9% per annum between 1999 and 2007 to reach annual revenues of £5.9 billion—this growth is continuing unabated through the current recession. Space science and Earth observation have both direct and indirect impacts on this UK space industry. Space science at Universities and Institutes provides technical challenges and spin-offs, positions UK industry to win high-profile ESA contracts and trains the high-tech workforce needed by industry for the whole range of endeavours in which it is involved. The importance of the space industry for the UK economy has recently been emphasised by the Government's establishment of the Space Innovation and Growth Team (SIGT) which will shortly present its proposals for a 20 year plan to grow the UK space sector.

1.5 Space science has also a demonstrated and important role in the inspiration of younger generations to pursue courses at school and university level in STEM subjects critical for the UK economy. It features prominently in media portrayals of science to the public from detailed Horizon expositions of the frontiers of science to regular spreads in the Metro newspaper highlighting the latest space missions and results.

1.6 Our European competitor countries, with active space programmes and industries, invest in national programmes that supplement the large and relatively infrequent ESA science missions with targeted smaller projects. Such projects often develop and demonstrate the technology that will in the future be commercialised or deployed on larger missions. Recently the UK Government has decided that to secure the UK competitive position in the space sector requires a move from the loose partnership arrangement of the British National Space Centre to a full national Executive Space Agency. SPAN welcomes this move and sees it as an extremely important step for the UK.

2. Impact of Recent STFC Budget Cuts

2.1 Against the above strongly positive background, the STFC is proposing severe cuts in the space sector, which would withdraw the UK from a number of currently operational flagship missions eg Cassini, Cluster, Venus Express, XMM, that are heavily and productively exploited by a wide scientific community. In addition their output has demonstrated inspirational value and they attract regular press coverage. Although financial stringencies are necessary, the money saved by withdrawing from key operational missions amounts to no more than £5 million per annum. While regular and systematic reviewing of the scientific productivity of operating missions, such as is routinely carried out by ESA and NASA, is essential, the present cuts appear to be uncritically based more on the age of the projects than on their scientific productivity. In addition they are in fields for which the next generation of missions is not yet under construction.

2.2 The premature withdrawal from mission operation schedules that the UK voted in favour of within the national delegations at ESA's Science Programme Committee would cause the UK to be branded as an untrustworthy partner. This in turn would severely hinder UK influence and success in competing for future activities.

2.3 Perhaps even more worryingly, the level of responsive mode research funding being projected by STFC for the next year is being cut. As a consequence, it appears likely that 70% of the grants to those universities and research laboratories engaged in the design and construction of space instrumentation will shrink below the threshold of viability. The medium to long term impacts of such a collapse in funding are even more serious than the failure to capitalise on previous investments described in 2.1 above. The closure of whole areas of space science and the accompanying dispersal of technical expertise accumulated over several decades, threatens to relegate the UK to a minor role in space instrumentation and exploitation of the observations for which the UK has already paid. This seems utterly at odds with the formation of a national space agency and a vision for continued growth in one the UK's most successful industrial sectors.

2.4 Should the above collapse in funding occur, the academic sector would be unable to play a useful role in the recently proposed STFC Gateway and Space Innovation Centres at the Harwell Campus. Such an outcome would substantially reduce the value of these centres in promoting valuable knowledge exchange between the academic and industrial sectors.

2.5 The recent formation of a UK space agency provides an unparalleled opportunity for both industry and academia to exploit our research and our involvement in ESA for maximum advantage. The space programmes of our major European competitors eg France, Germany, Italy, have clearly demonstrated the importance of conducting small bi- or multi-lateral programmes at comparatively modest cost with NASA, other European nations or with Japan and Russia. There are now many new opportunities with emerging space nations, and China looks like a particularly attractive partner from both the industrial and academic viewpoints. Small missions conducted outside ESA allow the rapid development and demonstration of new technologies and the exploitation of new scientific discoveries. A careful choice of innovative small missions can in turn enable the UK to play leadership roles in the infrequent but major ESA opportunities. This is particularly true in the important climate and environmental science sectors. We should be looking to build our investments and not shrink them in these sectors. The serious damage to the academic sector that will result from the proposed budget cuts will gravely weaken both the space science community and its ability to continue its support of UK industry in one of the few major growth sectors in the economy.

3. The Structure of the STFC and the Future Support of Scientific Research in Space

3.1 With hindsight it has become apparent that the creation of the STFC led to the need to fund an important portfolio of basic sciences being awkwardly tensioned against the operational and capital costs of national facilities that are designed to serve the needs of the whole research base and not just STFC scientists. In order to address this imbalance:

— different funding streams should be identified and managed separately for these two areas; and

— asset depreciation costs should similarly be dealt with separately.

3.2 The issue of foreign currency fluctuations and their effect on international subscriptions has long been a source of considerable difficulty for research council budgeting. In particular the STFC international subscriptions total has risen by close to 30% in the two year period from 2007 to 2009 largely as a result of changes in exchange rate. Similar changes are seen in NERC's subscriptions. Rate changes—in both directions—have a disproportionately large impact on the annual budgeting process:

— BIS or the Treasury should accept the risks of rate fluctuations given that the outcome is likely to be cost neutral in the medium to long term; and

— since other issues e.g national GDP and juste retour, are involved in setting the ESA mandatory programme subscription, negotiation of the necessary international agreements, both for ESA and for future bilateral programmes, should be handled by the newly formed UK Executive Space Agency with STFC involvement. This is also true for NERC's subscriptions, which are not mandatory and where national political decisions play an even larger role.

3.3 The measures outlined in 3.1 and 3.2 above would bring an element of stability to the STFC research grants budget line and to NERC's national funding. As has been indicated in section 2, the recently announced STFC budget cuts will, if implemented, have a disastrous impact on ongoing space missions and on grants related to space activities in general. Given the national importance of the space sector, every effort should be made to ensure the continuing effective exploitation of the ESA subscription and with the arrival of the national space agency, to support a modest national bi- or multi-lateral programme in which the needs of both the industrial and academic sectors can be served.

3.4 Urgent discussions are needed to establish the working interface between the STFC, NERC and the new space agency. Here the review and funding of underpinning research programmes should remain with STFC and NERC while support of specific mission-related programmes and the related post-launch operations could be organized and managed by the agency as is presently the case in many successful European nations. It is important that the details of these arrangements should be worked out and, given the long-term nature of space programmes and the associated international commitments, implemented against the background of a stable budgetary environment.

3.5 The rolling grant mechanism currently operated by the STFC is well matched to the long gestation periods associated with the development of new techniques and to the long-term exploitation of observational data acquired with both space- and ground-based facilities. It is echoed in the National Capability funding to NERC's National Centre for Earth Observation. Funding in this area needs to reflect the long-term nature of the satellite programmes being driven by the science, and the need to keep teams of experts together to exploit the observations successfully. The funding should not be subject to large fluctuations on very short notice. In addition the STFC, NERC and their predecessor research councils have built up significant expertise in the assessment and support of space-related research programmes, and this needs to be maintained with the creation of the new space agency.

4. Conclusions

4.1 Space is important for a growing number of areas eg climate, communication, navigation, space weather, and has a proven record for inspiring the public in general and the young in particular to become interested in the fields of environmental and physical science.

4.2 The related industrial sector is one of the UK's major growth areas. The Government sponsored SIGT will shortly publish plans for a 20 year development programme in the sector while the recent establishment of the UK Executive Space Agency will allow UK space interests—both industrial and scientific, to be effectively promoted on the world stage.

4.3 Against this strongly positive background, the recently announced cuts in STFC funding will have a negative impact both by curtailing UK involvement in ongoing ESA missions for which we have already supported continuation at the ESA level, and in the longer term by withdrawing funds from a range of underpinning activities in universities and research institutes. This will in turn weaken the nation's ability to provide experienced manpower for an industrial sector that will shortly begin a 20 year growth phase based on its previous successes.

4.4 The need for the STFC to fund both large national facilities and a range of physical science research programmes that make little use of them has led to budgetary instability within the Council. In addition programme planning has been made difficult by the impact of unfavourable movement in exchange rates on international subscriptions. It is suggested that these problems be addressed urgently.

4.5 We welcome the establishment of the National Centre for Earth Observation by NERC, which recognises the long-term nature of the funding required to work successfully in this area of science.

4.6 The STFC's mechanisms for assessing and funding research are well matched to the needs of the space field. However it is important that the relationship between the Council, and of NERC, and the newly formed UK Space Agency be defined as soon as possible so that the community can continue to compete effectively internationally.

January 2010

Memorandum submitted by UK Cassini Project Scientists (FC 30)

Subject: Impact of the STFC Prioritisation Decisions on UK Planetary Research—with Particular Reference to UK Involvement in the Cassini Space Mission to the Saturn System

1. The signatories of this submission are senior academics at leading UK universities who are currently deeply involved in various aspects of the NASA-ESA Cassini space mission to investigate the planet Saturn and its environment. Members of this group currently operate instruments on the spacecraft that were designed and built in the UK with funding from the PPARC former research council, implement new observing programmes on instruments operated by wider international consortia, and undertake scientific research with the resulting data, including modelling and basic theory. UK research groups have been centrally involved in the instrumentation, planning, and science exploitation of the Cassini mission since its inception in the 1990s, winning their places as investigators on the mission against strong international competition.

2. Cassini was placed into orbit around Saturn in July 2004, since when it has undertaken a highly successful programme of observations of the planetary atmosphere, the rings and moons, and the outer planetary environment including the magnetic field and charged particle radiation belts. It has undoubtedly been the highest-profile planetary mission of recent years. UK investigators have played a major role in a number of high-profile discoveries using Cassini data, such as the water ice volcanoes of the moon Enceladus, suggesting the existence of liquid oceans under the icy lunar crust, and the plasma measurements in Titan's upper atmosphere that have revealed a world with unexpectedly rich chemistry in a pre-biotic atmosphere. Several hundred research publications have appeared to date featuring UK authors, including many high-profile papers in Science and Nature. The spacecraft and its instruments continue to be in an excellent state of health, such that NASA is expected to announce a further mission extension in early February 2010, leading to an eventual spectacular end-of-mission phase in 2017.

3. Against this strongly positive background, in December 2009 the STFC, as part of its prioritisation exercise, announced its intention to withdraw support for Cassini research at a point that in essence represents the middle of the mission. Support is to be withdrawn in the first instance from research groups operating instruments on the spacecraft, some of these being key to major international interdisciplinary research areas, but with evident implications for on-going related science exploitation. It is astonishing that as the formation of a UK Space Agency is announced, the UK would let down one of their major international partners, NASA, in such a way. The decision was taken despite positive recommendations on the importance of this research area, and the Cassini mission in particular, that followed the community consultation conducted by the STFC's Near-Universe Advisory Panel (NUAP) leading up to the STFC prioritisation. Community consultation is of little significance if its results are simply ignored.

4. The STFC decision, if allowed to stand, has a number of potentially serious consequences.

(i) The consequence for the international Cassini mission going forward are hard to foresee clearly at this point, but it is evident that UK withdrawal will lead to a serious loss of technical and scientific expertise to the project. The implications for the on-going operation of UK-led instruments on the spacecraft, knowledge and understanding of which lie within the UK teams that built them, is potentially catastrophic.

(ii) UK researchers will inevitably be sidelined from their expected central roles in the major discoveries to be anticipated during the remainder of the mission to 2017. One such area results from the high-profile final phase leading to Saturn impact and end of mission in 2017, when unique very close-up observations will be made of the properties of the planet and its ring system.

(iii) The decision to terminate Cassini research will have major negative impact on the UK planetary science community, which is all the more serious because the planned STFC withdrawal is not only from Cassini, but from all related on-going space science programmes, including the ESA Cluster and Venus Express missions. These decisions were taken by STFC on a project-by-project basis with no strategic view of the overall consequences, which will be the destruction of UK planetary research with the exception of the Mars Aurora programme.

(iv) The STFC decisions will clearly damage the reputation of the UK as a reliable project partner, and will blight prospects for future leadership involvements in the next generation of exploratory missions, such as the proposed ESA Cosmic Vision Europa-Jupiter System Mission. Indeed, if some "core" of on-going research in these fields is not retained, the scientific and technical basis for future proposed major involvements will simply not appear credible. Expertise in broad aspects of planetary science has been built in the UK with much effort over the past two decades, such that we are now well-established as a high-profile international player. Once destroyed, the lost ground will not easily be recovered.

(v) Withdrawal will substantially diminish the outcome of the rather large UK investment in support of this mission, the science that has come from it, and the future science which could result. It will decimate our pool of young researchers who will leave the UK in order to do space science. We fully endorse the comments in the parallel evidence submitted to the Committee by the Early Career Cassini Scientists. The usual positive impact of missions of this kind in inspiring future generations of scientists will instead be reversed by the negative consequences of STFC decision-making.

5. As a consequence of these considerations we strongly argue that these decisions must be revisited within the STFC to consider their negative impact on UK planetary science, contrary to the advice provided by their own NUAP advisory panel. The need to retain some "core" programme in planetary exploration must be recognised, which might reasonably focus on Cassini given the planned longevity of the programme, bridging towards the next NASA/ESA mission in this area.

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Principal Investigator, Cassini Magnetic Field Investigation
Institute of Physics Chree Medal (2007), Royal Society Hughes Medal (2008)

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Memorandum submitted by Professor Susan Cooper (FC 32)

Impact

1. There is a wide range of science from very abstract to applied. Impact is more immediate and direct for applied science so it is more feasible to give evidence of it. But it is abstract research that is more likely to lead to entirely new ideas which later lead to completely new and unexpected applications with a much larger impact. Since the time lag is long and the path can be indirect, this impact is much harder to demonstrate. Too much emphasis on demonstrating impact is therefore liable to favour applied over abstract research and be detrimental in the long term.

2. Since all universities are feeling significant financial stress, universities and individuals feel a lot of pressure to concentrate their research in areas that "tick all the boxes" in order to maximise funding. The 25% of funding to be allocated according to "impact" in the REF is extremely important when we are all on the edge financially. The resulting pressure can therefore be felt much more strongly than the explicit 25%.

3. A more balanced way to encourage applied research without discouraging abstract research would be to allow the peer review of research outputs in the REF (or of a research proposal for Research Council funding) to give an output the top rating either for its abstract research quality OR for its impact as applied research, without requiring elements of both to get the top rating.

4. In principle the separate profiles in the REF could allow separate rewards for research excellence and impact, but we all know that great emphasis is put on the reputational reward based on the combined score. This generates pressure for every university to try to do everything rather than to play to its strengths. Even worse, the REF consultation paper (paragraph 72) says a unit can only get the highest score for impact if it has "achieved impact across the full range of activities and contexts appropriate to its field of activity". If we are each required to do everything, we will do nothing well and the effort will be inefficient. Government has said that it wants to support diversity in HEI, but requiring that a HEI excel in both initial research and application in order to get a top overall grade perversely punishes diversity rather than supporting it.

5. The path from initial research breakthrough to eventual impact can be long and complicated. There is no reason to assume the process is more efficient if the whole path is travelled by people within the same institution. However the REF consultation paper (paragraph 68) does not allow an institution to earn impact credit for research it has initially done but which is exploited by another institution, nor apparently for the reverse. The research which eventually has the largest impact may take the longest to do so because it requires a total paradigm shift and may be excluded by the proposed 10–15 year window. These issues cause perverse incentives against developing applications of research initiated in another HEI, never mind in another country, or long ago, and thus reduces the UK's capacity for gaining economic and other benefit from research wherever, whenever and by whoever it was initially performed. This problem would disappear if work to get impact from research were allowed to gain credit on its own merits.

Funding Levels

6. Building up a high-quality research activity takes time and is very difficult to do with unreliable funding. Once experienced staff are lost their expertise cannot quickly be developed again. "Boom and bust" funding is therefore very inefficient. It is also devastating to young people whose careers are cut off if their project is terminated before they can get the results they need to move on to the next step in their career.

7. The UK needs to develop a long-term vision of its level of research funding and to try to hold it there.

8. A research "ring fence" is therefore very welcome but the desired effect of constancy has not been apparent in PPARC and STFC—it has felt more like a series of short periods of hope dashed by new crises. Besides the ongoing problem of the cost of the international subscriptions, this boom/bust may have been partly due to the strategy followed by the leaders of PPARC who felt they needed to emphasise a catchy new project in each CSR in order to maximise the funding it received from the government. When the new project was approved it wasn't at a sufficient level, so strong cuts were required in other projects on a time scale much shorter than their natural project lifetime, while the new project needed to try to build up at an unrealistic rate. Both the 'boom' and the 'bust' were inefficient. (STFC has been so much worse it just doesn't bear talking about.) A ring fence of the total is therefore not sufficient—we also need an understanding on the part of the government and its agencies that repeated short-term shifts of research priorities are unproductive. That certainly doesn't mean new priorities should never be introduced but that they need to come with an appropriately long-term vision.

Declaration of Interests

9. I am an academic employed at a UK university and involved in particle physics (STFC funding).

Memorandum submitted by the British Geophysical Association (FC 33)

1. The British Geophysical Association (BGA) is a joint association of the Royal Astronomical Society and the Geological Society of London and represents members of either Society whose specialisation is geophysics, ie the application of physics to the study of the Earth and its planetary environment. UK geophysicists are employed in university research and teaching, petroleum exploration and exploitation, civil engineering, environmental consultancy, and government service. The UK is a world leader in both pure and applied geophysical research, and many UK geophysicists take part in, or lead, international research consortia.

2. Geophysics is a broad area of study and includes topics vital to the well-being of society, for instance the diverse causes of sea level change; earthquake and volcano monitoring and prediction; the geomagnetic field and near-Earth space environment used by satellites; detecting and extracting subsurface oil and gas accumulations; and predicting and monitoring subsurface engineering for oil and mineral extraction, waste disposal and carbon dioxide (CO_2) capture and storage.

3. Data for geophysical research are often expensive to obtain, eg seismic exploration data collected by dedicated ships using specialist equipment refined by many years of research. Their value is seldom restricted to the immediate purpose for which they were obtained, for instance, marine seismic data obtained for oil exploration are now being used to map ocean currents, and decades-long records of the Earth's magnetic field are used in the prediction of geomagnetic disturbances and "space weather" that affect satellites. Some of these uses could not have been predicted when the original data were obtained. The BGA's concern is that funding cuts might cause:

4. (a) Cessation or interruption of UK involvement in international projects to collect and maintain long timespans of geophysical data, eg the Ocean Drilling Program's unique collection of seafloor rock and sediment cores, which contain a record of past climate change, but must be stored in a controlled environment to avoid degradation. UK scientists would then be denied access to the resources and would have no input into the future of these programmes.

5. (b) Lack of support for archiving and curating geophysical data, including borehole cores, continuous seismometer records, meteorological and geomagnetic readings, and oceanographic data, causing the resources put into their collection and curation so far to be wasted;

6. (c) Loss of UK expertise in instrument design, geophysical data collection, processing, interpretation and preservation. UK students and professionals in these areas will seek to pursue them abroad, or lose their expertise, and aspiring geophysicists be deterred from entering the profession. This would be particularly deleterious to the UK economy, which is already experiencing a shortage of geophysicists in the oil industry and can anticipate needs for geophysical skills in nuclear waste disposal, carbon capture and storage, and geothermal energy exploitation. Geophysics is a "hard science" requiring an early choice of specialisation in maths and physics by secondary-school pupils. Deterring pupils now is likely to cause a worsening skill shortage in 5–10 years' time.

7. The geophysical data described above have to be collected continuously and routinely, and often respond to slowly-varying phenomena with periods longer than the five-year parliamentary cycle, for instance the 11-year sunspot cycle, and (ill-defined) cycles of up to thousands of years between mega-earthquakes at plate boundaries such as the Sumatra-Andaman arc, the Caribbean, and Japan. Planetary data, for instance from Mars, which are valuable in predicting environmental change on Earth, have additionally both long spaceship design and flight times and, for outer planets, longer orbital periods and hence longer data collection times before useful seasonal cycles can be observed. The BGA criticised on these grounds the Higher Education Funding Council for England (HEFCE) proposed use of inevitably short-term "impact" to measure eligibility for funding in the proposed Research Excellence Framework (REF), by which the "research" element of HEFCE funding will be decided.

8. We are also concerned that "impact" and "significance" of geophysical research might be assessed by (a) non-specialists, and (b) biased panels of specialists. Non-specialists' judgements are both subjective and unverifiable, and should not contribute to assessment of research excellence. Specialists need to be drawn from an international pool, because of the global nature of geophysics. Bias will arise because the oil and resource extraction industries are highly motivated to send their specialist employees to be panel members, while geoscience research has impacts on the poorest people in the most environmentally vulnerable areas of the Earth, whose interests risk not being represented, or even assessed.

9. The BGA also submitted a response to the Committee's consultation on the regulation of geo-engineering to mitigate climate change. The gist of our response was that geo-engineering project proposals should be assessed by means of reality-based geophysical modelling of their likely effects. To achieve this, geophysical data sets are needed as input to the modelling, and skilled geophysical modellers are required. Cuts to the UK geophysics base endanger both these, the data as described above, but particularly the skills, which have to be developed through a specialist research degree and years of experience in a research environment. The probable disastrous effects of runaway climate change and the desperate measures, such as deep cuts in CO_2 emission, being proposed to prevent it, will lead to future geo-engineering project proposals. Without geophysical research, these expensive projects might either lead to disaster or be ruled out as too risky and their possible benefits lost.

10. The study of the Earth is an interdisciplinary science, so geophysical research cannot be considered completely in isolation from research in other areas. Cuts in those areas might have unintended deleterious effects. For instance, geophysical modelling often requires large computing power and storage, so the recent threat by the Japanese government to their scientific supercomputer project is thus indirectly a threat to geophysical research. Interaction of the Earth with the biosphere has been increasingly recognised as an important driver of Earth systems, so for instance sampling, genetically analysing and cultivating organisms from seafloor hot chemical springs, carried out as part of the Ocean Drilling Program, might have a bearing on proposed geothermal-energy systems. Fundamental physics, for instance the interaction of neutrinos with the Earth's interior, could open the way for novel geophysical imaging based on particle accelerator science and engineering. Finally, the Haiti earthquake is a disaster for reasons couched in global-scale economics, sociology and politics, which led to so many poor people in ill-constructed dwellings being vulnerable, as much as in the geophysics of plate tectonics in the Caribbean. It is difficult to predict the effect on geophysics of cuts in other branches of knowledge, but such prediction should be attempted by appropriately qualified scientists when cuts are proposed.

11. In summary, the consequences of cuts driven by the short-term addressing of the economic crisis would be profound and damaging in the long term to geophysical research, which in turn underpins the political decisions required to maintain Earth systems in a condition to support comfortable human existence. UK geophysicists are so deeply involved in the global scientific effort to understand and, possibly, control the environment and resources that cuts made by the UK alone cannot be regarded as insignificant to global geophysical science.

January 2010

Memorandum submitted by from LGC (FC 34)

1. LGC recognises the unique role of Government in science, education, research and technology and the positive impact this has on the health of the economy and the well-being and protection of our citizens. We also recognise the strength of Government in providing policy, direction and resources but understand that the level of the latter will inevitably need to reduce in the short to medium term in order to address the deficit in public finances. However, as a technology based company that services Government and innovative industrial sectors and that has strong interfaces with academia, LGC urges that:

- The levels of cut-backs are kept to a minimum to preserve the UK science community's international standing and to ensure that sufficient support is given to areas that will underpin industrial growth and development and enhance the UK position as a leading innovative and manufacturing economy. Science can act as one of the major mechanisms to bridge the gap left by the financial crisis, by way of its contribution to health and public protection and the economy.
- Any cuts that need to be made are restricted to areas where they can be mitigated by efficiency savings or are achieved by providing greater focus on activities that will have the greatest impact on public and environmental protection and in creating the wealth that is necessary for sustainable growth.

2. We have sub-divided our input to provide feedback within the main areas of Government intervention in science, namely: education; research funding; infrastructure; and policy and regulation setting and enforcement. This feedback is provided from a private sector perspective, where the natural competitive landscape and efficiency pressures have led to an understanding of how best to deliver more impact with reducing resources. We believe that there is increasing scope for the private sector to work in partnership with Government to direct and deliver science and to achieve our national objectives efficiently.

3. Education

3.1 Government plays a vital role in delivering an appropriate skill base to meet the requirements of industry and to maintain the UK's leading academic edge. As an employer of over 600 UK science graduates we value an education system that attracts our leading intellectual capital to study the sciences and that develops an appropriate number and quality of individuals with strong understanding of core disciplines (chemistry, physics, biology, biochemistry and mathematics) and of research. At the same time, the system must enable others to concentrate on the practical skills that will equip them to contribute within an industrial setting. We do not support the drive to pull higher numbers of individuals in to higher education purely for the sake of so doing. For example, we observe increasing numbers of courses and students taking degree qualifications in niche subjects like forensic science. Yet, as one of the UK's leading forensic laboratory service providers we rarely find it beneficial to recruit from this base. Employers require a more solid grounding in the STEM subjects; these are seen to be essential building blocks to developing understanding, alongside the equally essential development of critical thinking, problem solving/analytical skills.

3.2 We do see opportunities for the UK to be more streamlined in delivering an effective skill base and hope that the momentum for this will come from fundamental reviews of the scientific education system. We also believe that education and training is a fertile area for greater public/private partnership. LGC

continually appraises its links with universities to ensure delivery of the kind of graduates that best fit our requirements, especially where there is a slant towards specialisation. For example, LGC is actively discussing graduate level provision for a new Forensic science course with Oxford University, and established a MSc course in Analytical Chemistry with Kingston University to support the scarcity of good graduates with practical skills in mass spectrometry

4. Research Funding

4.1 The funding and commissioning of scientific research at both fundamental and applied levels and the associated monitoring and governance of this spending is a critical role of Government.

4.2 The UK needs to continue to support blue sky research and to take a long term view on associated benefits. There are many examples over history where the outputs of fundamental research have led on to unpredicted industrial application. Any cuts in this domain should in our view be restricted in line with considerations of end-focus. The UK needs to recognise that it can no longer afford to stay at the leading edge of all areas of research and emphasis needs to be given to science that is most relevant to the direction of UK industry and to topics of national and international concern. A more detailed and holistic UK national science and technology strategy is needed to underpin these decisions. We question the value of the practice of developing detailed metrics to define the benefits of fundamental research. In our view this creates unnecessary and unproductive work within academia and instead the priority should be given to ensuring that related endeavours are truly world class, thereby providing long term benefit to the UK.

4.3 Metrics are more relevant for applied research where input from industry is essential in defining direction. Where metrics are used we would urge for consistency in how these are measured. There is a role for Government in providing better guidance in defining ways for quantifying returns on investment that enable meaningful comparisons of different areas of scientific research and of associated funding schemes. In these difficult economic times we need to be highly efficient in the way that we define, direct, manage and monitor research funds—the private sector could provide increased support to achieve this aim. For example, LGC is already working with the Department of Health to deliver cost-effective research programme management from a commercial scientific organisation that understands how to run large projects and how to facilitate our leading scientists to contribute to areas that Government prioritises.

5. Infrastructure

5.1 Effective science requires access to advanced infrastructure and hence we support the maintenance of critical national assets such as those funded through the Science and Technology Facilities Council. UK infrastructure should consist of the best in facilities and world class people and both of these require continuous investment in order to remain competitive and attract and retain leading talent. Cuts in this area can be highly damaging and difficult to repair and we advocate the need to target budget reductions to areas that are not considered core to UK science and business strategy.

5.2 Metrology is an example of an area where cuts to capability could result in irreparable damage to UK competitiveness. This capability is funded by the Department of Business Innovation and Skills through the National Measurement Office (NMO), and outputs have been shown by independent evaluation to provide significant payback to the economy. Measurement is a core enabling science for wide sectors of UK industry and the National Measurement System (NMS) that is supported by the NMO plays a critical role in maintaining related standards and quality. The UK is a recognised leader in this field largely through the work of the National Physical Laboratory (Government owned) but also of LGC and TÜV NEL (private sector businesses). However, cutbacks in this area have already begun to compromise the ability of these laboratories to retain the skills and to develop new project areas that will deliver world-class science. Further reductions in funding would certainly impact on the capacity to retain international leadership, particularly when other countries like the US, Korea and China are increasing related investments. We suspect that this scenario is common to other areas of critical infrastructure which might also now be threatened with financial cutbacks.

5.3 The NMS is also an excellent example of where the private sector is taking a very active role in providing and managing UK infrastructure. We believe that the private sector should play a greater role in running public sector science laboratories and suggest that this route is explored when looking for improved productivity and related financial savings.

6. Policy and Regulation

6.1 Finally, Government requires good science to set and enforce policy and regulations and to undertake surveillance and monitoring of critical areas of human well-being including food, environment, health and medicines.

6.2 Research and enforcement activity in policy and regulation is currently largely delivered by public sector laboratories. However, we believe that the private sector could contribute to a much greater extent than it currently does in these areas. For example, the management and development of public sector facilities through outsourcing or under Government Owned–Contractor Operated arrangements could provide cost benefits to the UK and these could be appropriate even in sensitive areas of science and policy. Indeed we can point to demonstrable models where critical regulatory and legislative activities are run within

LGC and where the UK is leveraging benefits. These benefits include activities being hosted within a well-equipped facility run by experienced technical and business managers, without compromising Government's ability to control priorities and agendas. At the same time, the high level of independence and quality required of associated scientific work is maintained.

6.3 Regulatory enforcement and surveillance is often a mandatory obligation on UK Government as a member state of the EU and is also vital in building public confidence, protecting our society from potential threats and in reducing longer term impacts on environmental and human health. LGC can demonstrate how opening up the provision of this surveillance to competition has led to improved service levels and driven down costs to the taxpayer.

Our view is that there is the potential for further benefit to be derived by increasing private sector involvement in these processes and ensuring the operation of fair market principles.

7. We welcome this opportunity to input into this important inquiry and we would be value the opportunity to provide greater detail and explanation of our responses.

Declaration of Interest

LGC provides a wide range of measurement services to the UK public and private sector and is the designated UK National Measurement Institute (NMI) for chemical and biological metrology. As an NMI, LGC engages extensively with the UK academic and industrial sectors.

David Richardson
Chief Executive, LGC

January 2010

Memorandum submitted by the British Heart Foundation (FC 35)

1. Introduction

1.1 The British Heart Foundation (BHF) is the nation's heart charity and we welcome the opportunity to submit written evidence to this inquiry. The BHF is the largest funder of cardiovascular research in the UK and an active member of the Association of Medical Research Charities (AMRC). Between April 2008 and March 2009 we invested over £145 in cardiovascular research every minute—a total annual investment of over £78 million. We fund more than half of all university-based cardiovascular research in the UK, with BHF-funded researchers and projects at centres in over 30 cities across the UK.

1.2 Our research portfolio extends from fundamental laboratory-based molecular, biological and genetic studies to large-scale clinical trials of novel and existing preventive and therapeutic interventions. We support research through infrastructure awards for buildings and equipment, project and programme grants for research staff and consumables and, most importantly, research training and career posts for basic and clinical scientists, from PhD students through to research professors.

2. General Comments

2.1 It is clear that the next government will need to make decisions about where to make cuts in public spending in light of the current economic climate. We believe that where this occurs, it is essential that the effects on medical research within the UK are kept to a minimum. Medical research is fundamental to the UK economy, in terms of the societal and economic benefits that result from the investment made, as an employer of the UK workforce and as part of the UK's competitiveness internationally.

2.2 Research has a crucial role in improving standards in healthcare, with the potential to provide innovative approaches to prevention and treatment and achieve step changes in the quality of care.

2.3 We believe that there are three key areas that must be reinforced in order to maintain and strengthen medical research in the UK:

- sufficient support for charity-funded research must be provided by the Higher Education Funding Councils (HEFCs);
- the UK research environment must be sufficiently facilitative for both basic and clinical research; and
- academic research careers must be sufficiently supported to ensure future sustainability of the UK research base.

3. Deciding Where to Make Cuts in Science Spending

3.1 There have been substantial developments in both diagnosis and medical treatment that have steadily increased survival for those with heart and circulatory disease. Some of the most ground-breaking and important achievements in heart health research over the past 49 years have been made thanks to work supported by the BHF. The charity sector as a whole also makes an enormous contribution to medical

research. The Association of Medical Research Charities (AMRC) estimates that 70% of all funding from its members goes to higher education institutions, and medical charities as a whole fund approximately 14% of all university research. We believe that any decisions on science funding should take this significant contribution into account.

3.2 The Government currently allocates public funds for research through the dual support system, providing two clear streams of funding to both the HEFCs and the research councils. In England, as part of the quality-related (QR) grant provided to universities through the Higher Education Funding Council for England (HEFCE), a separate element has been provided since 2006 in the form of the Charity Research Support Fund (CRSF). Similar streams of funding are also in place in other nations of the UK. The CRSF aims to cover the gap in the full economic costs incurred from charity-funded research, and as a result helps charities such as the BHF to assist universities in attracting researchers of the highest calibre, and conduct research of the highest quality.

3.3 In 2004 the Government made a commitment to the financial sustainability of research, working together with all funders towards fully funding research in UK universities. Progress has been made, with a report earlier this year showing that almost all measures of sustainability amongst higher education institutions have improved in recent years.[19]

3.4 However, a pressing concern is the uncertainty surrounding the adequacy of the current level of funding of the CRSF, and the future of the fund beyond 2010–11. The uncertainty over both of these issues impacts on the confidence of researchers to seek funding from medical research charities and on universities' enthusiasm for hosting charity-funded research. Many within the medical research sector are concerned that the CRSF will not reach its intended 2010–11 target of £270 million from its current £194 million total, and current evidence also suggests that some researchers are already being discouraged from applying to charities for funding.[20] We believe that further reform is needed to place charity funded research on a level playing field with research funded from other sources, and to provide long-term reassurance to charities, universities, and researchers.

3.5 We believe that the Government should conduct a comprehensive review of the level of funding needed beyond 2011 to effectively support the substantial investment made by medical research charities. In particular, funding must be set at a level which allows universities to recover full economic costs for charity-funded research at a comparable level to the costs they can recoup from research funded by Research Councils. The Government should also work with higher education institutions to ensure that universities, researchers and other funders are aware of the CRSF, and that charity research is not adversely affected.

3.6 The £135 million reduction announced in the HEFCE grant letter in December 2009, together with the £600 million cut to higher education and science funding announced in the 2009 Pre-Budget Report, is a concern to the research sector. While fuller details of these announcements are yet to emerge, it is vitally important that the CRSF is not reduced as a result. This would have an extremely detrimental effect on both universities and charities and, more importantly, on the pioneering research funded by medical research charities.

4. Estimating the Economic Impact of Research for QR Funding

4.1 The Research Excellence Framework currently under development has proposed that the impact of research be given a significant weighting of 25% in the overall assessment of research. While we fully understand and support HEFCE's view that the impact of research is important, it is clear that there are substantial difficulties in assessing and scoring this in a robust manner.

4.2 The development of medical research from basic science to clinical benefit is a process that occurs over a substantial period of time before the full effects are realised. This is estimated to take around 17 years on average, but can be as high as 25 years before healthcare benefits emerge.

4.3 Cardiovascular disease is the UK's biggest killer, with the costs of healthcare alone amounting to over £1.7 billion each year.[21] There is therefore a great need to invest in research seeking to improve cardiovascular health in the UK. The real benefit of medical research is in the impact that it has on health gains to the population. A 2008 report estimates that every £1 invested in cardiovascular medical research produces benefits that are worth 39p every year thereafter in perpetuity.[22] In other words, the cost of research is recouped through social gain within three years of making the investment, and it continues to pay such dividends every three years thereafter.

[19] Research Councils UK and Universities UK (2009) Review of the Impact of Full Economic Costing on the UK Higher Education Sector.
[20] Breast Cancer Campaign (2009) Full economic costing: the effects on charity-funded research.
[21] www.heartstats.org
[22] Health Economics Research Group, Office of Health Economics, RAND Europe (2008). Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK,

4.4 Similarly, public investment in medical research has a substantial impact in triggering future investment by industry. A 2009 report estimates that a £1 increase in extra public medical research can lead to an increase in private pharmaceutical industry research and development spending in the range of £2.20 and £5.10.[23]

4.5 Research funds can be distributed either in response to demand from the research community, so called bottom up or response-mode funding, or it can be pre-specified by the funder for specific initiatives—top down funding. Most 'breakthroughs' in medical research (eg monoclonal antibodies, stem cells, cell cycle genes) have evolved from investigator-led, curiosity-driven research (bottom up), in which the UK has played a leading role. A recent report from the House of Commons Innovation, Universities, Science and Skills Select Committee highlighted the importance of basic research in the debate on strategic science funding, citing cardiovascular research as a prime example where basic research has led to substantial translational benefits. Some of the key advances in cardiovascular medicine have resulted from a substantial amount of research carried out in non-medical departments, such as chemistry, physics and engineering.[24]

4.6 It is for these reasons that it is crucial that basic science in particular continues to be strongly funded in the UK. Whilst there are times when a top down approach can stimulate new research activity, it also runs the risk that funds can be allocated to projects (the best applications for the initiative) that would not have succeeded in open competition against other scientific proposals. Thus, funds are diverted away from high quality bottom up research towards poorer quality top down research. Therefore, it is crucially important that in any new funding arrangements there are sufficient funds for investigator-led, hypothesis driven research. Consequently, it is essential that the research budget should not be susceptible to short-term political considerations, and that Haldane principles must apply at all times. It is also important that the balance between basic and translational research must also be retained. Without basic research into mechanisms of disease, where the UK is highly competitive internationally, there will be no new findings to translate into better drugs or treatment.

Sustainability of the Research Base

5.1 A separate issue, connected to the overall sustainability of UK research, is the number of science graduates willing to consider a research-based career. The Government has identified improving the supply of scientists as a key objective within the ten-year science and innovation investment framework.[25] However, the BHF is concerned in particular about the attractiveness of cardiovascular research to academic scientists. Public funders have committed resources to research training, and there has been considerable reform of the system to make it easier to embark on such careers, but it is unclear whether these measures are sufficiently effective. Training and retaining a new generation of basic science and clinical researchers is paramount to future public health.

5.2 The BHF has recently surveyed our own researchers on the research career pathway and the environment for cardiovascular research in the UK. While the vast majority felt the UK was an excellent environment to carry out cardiovascular research, we have found that there are a number of key concerns that are felt within both basic and clinical science that are discouraging current researchers from pursuing a long-term career in academic research. Whilst these include issues relating to competitiveness of salaries and career structure, the uncertainty of future funding means that some lack the confidence and security to pursue a career in academic research.

5.3 The Government has a key role to play in helping to ensure that the UK research environment has a sustainable supply of talented, motivated scientists, to ensure that the UK continues to be a global leader in research. Consideration should therefore be given to the impact that any cuts in the research budget will have on the aim to ensure that the UK has a strong supply of scientists, engineers and technologists.

Conclusion

- The BHF makes a substantial contribution to research into cardiovascular disease across the UK. We are dependent on not only the generous donations provided by members of the public, but also on the support provided by Government to universities, and more broadly on an environment facilitative of research.
- Ensuring that sufficient, long-term support is given to universities for charity-funded research should be a priority. The Government must review and commit to charity research support funding beyond April 2011.
- Medical research provides societal and economic benefits to the UK. The full extent of healthcare benefits from basic research can take up to 25 years to be fully realised, and so caution must be applied in any move towards impact assessment through the proposed Research Excellence Framework.

[23] Office of Health Economics, Alzheimer's Research Trust (2009) Forward Together: Complementarity of public and charitable research with respect to private research spending.
[24] Innovation, Universities, Science and Skills Committee (2009) Putting Science and Engineering at the Heart of Government Policy.
[25] HM Treasury (2006) Science and innovation investment framework 2004-2014: next steps.

— Stable funding is a key incentive in ensuring basic and clinical scientists continue careers in research and help to sustain the future research base.

— If you would like further information about this response, please contact Joseph Clift, Policy Officer, at cliftj@bhf.org.uk or on 0207 554 0156. We would be pleased to discuss any of these issues further with the Committee.

Professor Peter Weissberg
Medical Director
British Heart Foundation

January 2010

Memorandum submitted by the Royal Society of Chemistry (RSC) (FC 36)

EXECUTIVE SUMMARY

UK universities are world-class in terms of science, engineering and technology (SET). Research and science education in UK HEIs make a strong, positive contribution to our economy and enrich our society.

Maintaining a strong science base and supporting innovation is essential if we are to address the challenges that face our society and achieve a balanced and sustainable economic recovery.

We should increase the level of funding for R&D to exceed those of our international competitors. Even short term cuts to funding will significantly damage our research capability, stifle innovation, reduce productivity, deter investment and reduce the economic prosperity of the UK.

SET departments in our universities should be fully funded and all funding for SET teaching, research, facilities and equipment should be ring-fenced.

The economic impact of research must be measured over decades, it must include foreign investment and the benefits of a scientifically-literate workforce, and it must look at the entire pipeline of skills, from schools to universities and industry.

1. *The process for deciding where to make cuts in SET spending*

1. The future of the UK economy lies in the growth of knowledge-based industries and the development of a highly skilled workforce because the relatively high cost of UK labour will prevent us from creating a significant number of jobs for unskilled or semi-skilled people.

2. Our ability to compete in the global knowledge economy depends upon the health of the entire skills pipeline with education in schools and universities providing a steady supply of talented, highly-skilled individuals who will become the next generation of scientists and engineers and members of a wider, scientifically literate workforce. Continuous, long term investment in SET must not only be maintained but steadily increased to meet this challenge.

3. The strength of our Higher Education (HE) sector is one of our great success stories, employing nearly 170,000 staff,[26] making the UK the most popular destination in the EU for foreign investment and students. In 2007–08, over 350,000 students from other countries chose to study at UK HEIs.[27] UK HEIs deliver excellent value for money, being both highly productive and efficient. The proportion of our national income that the state spends on our HEIs, at 0.90%, is lower than that in Germany, the United States and France, which spend 0.94%, 1.01% and 1.15% respectively.[28]

4. SET in our universities is particularly effective, with UK research ranking second only to the United States in terms of publication citations.[29] Also, it is very efficient. UK chemistry and physics departments have already made significant efficiency savings by increasing student:staff ratios and lowering departmental space per member of academic staff.[30] Further cuts in the name of efficiency would be very detrimental, compromising the quality of performance and the international standing of UK science and technology.

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[26] Higher Education Statistics Agency [HESA] [2009], Resources of Higher Education Institutions 2007–08 http://www.hesa.ac.uk/index.php?option=com_content&task=view&id=1590&Itemid=161

[27] Higher Education Statistics Agency (HESA): Students in Higher Education Institutions, table 6, 2007–08. http://www.hesa.ac.uk/index.php?option=com_content&task=view&id=1578&Itemid=161.

[28] Organisation for Economic Co-operation and Development (OECD) (2008): Education at a glance: OECD Indicators 2008, table B2.4 http://www.oecd.org/document/9/0,3343,en_2649_39263238_41266761_1_1_1_1,00.html

[29] Department for Business, Innovation and Skills: International Comparative Performance of the UK Research Base 2009 http://www.dius.gov.uk/~/media/publications/I/IntComparativePerformanceUKResearch

[30] Follow-up Study of the Finances of Chemistry and Physics Departments in the UK Universities, RSC and IOP, Manuscript in Preparation.

5. The recent International Review of Chemistry highlighted the excellent state of equipment and infrastructure within UK universities—"UK chemistry derives enormous strength from recent large investments in infrastructure, shared equipment and national user facilities"[31]—in this respect, the RSC believes the UK government should be congratulated. However, maintaining this excellence requires continuing, sustained capital investment consonant with depreciation and, if spending cuts were to be applied, here the benefits of past government investment would be rapidly destroyed.

6. Currently, many of the most significant discoveries are made by scientists with a deep, fundamental knowledge of their specialism working in multi-disciplinary teams with experts from other areas. For this to continue, we must preserve our ability to conduct ground-breaking research and development across all scientific disciplines.

7. Reducing our investment in SET would be completely counter to the national interest; this would result in fewer students being able to study the sciences, a poorly skilled workforce, less ground-breaking research in our universities, and valuable commercial investment going elsewhere. Instead, the UK government should follow the examples of the United States[31] and Germany,[32] which are both aggressively increasing their investments in SET. We should be planning for significant growth in SET in order to rebalance the economy and lay the foundations for our future prosperity.

2. *What evidence is there on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

8. As indicated below, any methodology which is used to estimate the economic impact of research must take account of timescale between discovery and commercialisation, which may take many years. Also, it must assess the economic benefit from a more productive population, with increased revenues to the individual and to the Exchequer.

9. Many of the revolutionary discoveries that have led to today's major products were made decades ago. For example, liquid crystals were originally discovered in the 19th Century. However, it was not until 1960 that their potential to provide light-weight, flat panel displays of low power consumption was appreciated, and it took another 12 years for a liquid crystal with suitable physical properties to be designed. The worldwide market for LCD TVs now generates more than £40 billion in annual revenues.[33]

10. The Human Genome Project began in 1990, and was completed in 2003 at a cost of several billion pounds.[34] As a result of this investment, massive improvements in high-throughput DNA sequencing have been achieved, driven entirely by advances in nucleic acid chemistry. It is now possible to sequence an individual genome in less than a week and for ca £30,000.[35] This is the fruit of at least 50 years of sustained investment since the ground-breaking days of Crick and Watson at the Cavendish Laboratory in Cambridge. It has huge implications for the understanding of major diseases and the developing market in "personalised genomics".

11. As these examples demonstrate, any attempt to assess the likely economic impact of research must appreciate the entire research process and the timescale from discovery to economic reward. We refer the reader to a response to a recent review which emphasises the importance of a suitable balance of funding between applied and fundamental research.[36]

12. Chemical science spin-out companies originating from university research have a strong track record in using public funds to realise commercial success. A recent RSC study showed that 55% of these companies initially relied heavily on funding from the EPSRC, but only 10% of them now rely on Research Council funding[37]—a good example of far-sighted government investment, yielding commercial fruit.

13. In addition to direct economic benefits resulting from scientific discovery, the economy will be strengthened by the scientific contribution to healthcare and medicine necessary to ensure a healthy workforce. Furthermore, education and scientific research lead to a scientifically literate workforce which is able to understand and exploit scientific knowledge. A greater proportion of science graduates pursue careers that require a graduate qualification[38] as compared with those from other subjects. Over a lifetime,

[31] Remarks by the President at the National Academy of Sciences annual meeting, National Academy of Sciences, Washington, D.C., April 2009 http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting

[32] "Science favoured by German coalition", A. Abbott, *Nature* **462**, 24, 2009.

[33] "DisplaySearch Revises Worldwide TV Forecasts", DisplaySearch 2008: http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/LCD_TV_Revenue_Expected_to_Fall_YY_for_the_1st_Time.asp

[34] Oak Ridge National Laboratory website, www.ornl.gov

[35] Single-molecule sequencing of an individual human genome. D Pushkarev, N F Neff, S R Quake. *Nature Biotechnology*. **27**, 847–850, 2009.

[36] Setting Science and Technology Funding Priorities, House of Lords Science and Technology Select Committee, RSC, 2009 http://www.parliament.uk/documents/upload/strfRoyalSocietyofChemistry.pdf

[37] Spin Out Companies from UK Chemistry Departments, RSC 2003 http://www.rsc.org/pdf/indusdiv/spinout.pdf

[38] The Chemical Skills Pipeline, RSC 2009 http://www.rsc.org/images/ChemSkillsPipeline_tcm18-159365.pdf

the economic value to the individual of completing a degree stands at ca £129,000, and for chemistry and physics graduates this rises to ca £187,000. The additional taxation revenues to the Exchequer over a working lifetime exceed £130,000.[39]

14. Many of the blockbuster medicines in the list of world top twenty best selling drugs were invented in the UK by chemists whose doctoral studies were funded by EPSRC and its precursors. A recent study estimated that at their peak, 11 of these drugs generated sales of over £15 billion, as well as obvious benefits to patient health.[40]

3. *The differential effect of cuts on demand-led and research institutions*

15. The retention of a strong UK science base relies on the maintenance of high standards in both research and education. Any reduction in funding for one activity will impair the ability of an HEI to deliver the other.

16. Recent data show that both research and teaching in physics and chemistry departments are not fully funded: in 2007–08, research activity resulted in an average deficit of 36.7% of income, while the teaching deficit was 9%. The average overall deficit for chemistry departments across the UK was 31.3%.[41]

17. As both research and teaching are loss-making, further funding cuts to either demand-led (teaching) or research-led institutions would reduce the quality of both teaching and research and compromise the standing of UK science. HEFCE has acknowledged this risk by pledging an extra £25 million in annual funding to support subjects recognised as being strategically important and vulnerable. We welcome this measure, which has reduced the average deficit for teaching to 9% of income. However, there is still enormous financial pressure on vice-chancellors who may be tempted to close SET departments (which inevitably attract higher overhead costs than Arts and Humanities faculties) in order to reduce costs.

18. In the absence of a comprehensive strategy to support a strong national science base, cutting funding may bring about the closure of SET departments on an unplanned, case-by-case basis. This will create regions in the UK with no provision for students who wish to study SET subjects. Those from less advantaged backgrounds who have to live at home for financial reasons will be unable to study these subjects, irrespective of their ability. Also, local businesses will be unable to benefit from the knowledge and expertise of universities and regional economic development will be impaired.

4. *The implications and effects of the announced STFC budget cuts*

19. The RSC recognises the need for central funding as an important element in supporting a strong science base.

20. The RSC regrets the decision by the STFC to reduce the funding for ISIS, which will result in a 50% reduction in capacity. Given the crucial importance of this facility to a wide range of cutting edge research, including improved drug delivery and the development of advanced materials for hydrogen storage, solar energy conversion and improved battery technology, the reduction in capacity greatly weakens the UK's global scientific competitiveness. The STFC should be supporting this and other such facilities and recognising the central role they have as a hub for multi-disciplinary projects that are able to push back the boundaries of knowledge, generate spin-out companies and attract international investment.

21. Funding must be provided to maintain and run these facilities. The announcement by the STFC to cut funding for studentships and fellowships by 25% compromises the ability to undertake research. By underfunding support for equipment and personnel, ground-breaking research is jeopardised and efficient use of these facilities cannot be achieved.

22. A recent review by the EPSRC in partnership with Learned Societies and other Research Councils urged that support for shared facilities should be a national priority.[42] Similar facilities in Europe are running at close to full capacity and it is interesting to note that, in contrast with domestic projects, the STFC have committed to maintain subscriptions to international projects as a top priority.[43]

5. *The scope of the STFC review announced on 16 December and currently underway*

23. Recent budget cuts by the STFC have demonstrated poor planning and a lack of foresight. The process by which the STFC reached these decisions should be reviewed.

[39] The Economic Benefits of Higher Education Qualifications, RSC and PricewaterhouseCoopers LLP, January 2005 http://www.iop.org/activity/policy/Publications/file_4149.pdf

[40] Education and Wealth, Chemistry World, Volume 6, Number 9, September 2009. http://www.rsc.org/chemistryworld/Issues/2009/September/Educationandwealth.asp

[41] Follow-up Study of the Finances of Chemistry and Physics Departments in the UK Universities, RSC and IOP, Manuscript in Preparation.

[42] Chemistry for the Next Decade and Beyond. EPSRC, IOP, RSC, BBSRC, MRC, NERC, ABPI, IChemE, Biochemical Society, 2009 http://www.epsrc.ac.uk/CMSWeb/Downloads/Other/ChemistryIR2009.pdf

[43] STFC, Science Programme Prioritisation 2010–15 http://www.scitech.ac.uk/PMC/PRel/STFC/CouncilNews161209.aspx

24. The RSC recommends that the STFC should identify facilities that are of central importance to UK science with the intention of transforming and funding them as National Shared Facilities. The announcement on 16 December has seen a dangerous shift of focus away from particle physics, astronomy and nuclear science. The RSC believes that facilities that support these areas should be fully funded where research can be shown to be internationally competitive.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

25. The improvement in the funding for SET subjects provided by HEFCE in recent years has allowed more undergraduate and postgraduate students to be educated and enhanced the quality of the education and training provided. Whilst this is welcomed, it must be remembered that the resources provided are still inadequate (see the answers to questions 3 and 8) and, given the autonomy of University vice-chancellors, the funds provided for SET can be diverted to support other activities.

26. Therefore, the RSC consider it essential for HEFCE to ring-fence the funding designated for SET teaching, research, and the associated facilities and equipment. However, the RSC urges caution in respect of ring-fencing only the HEFCE research budget since this could have unintended consequences on teaching, given the synergic interactions between these two activities.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

27. The world-leading position of UK science is quite remarkable, given the relatively low level of spending on SET. A step change in attitude towards science and education is required if this position is to be maintained and the aims of the Framework are to be fulfilled.

28. Overall spending on research and development as a percentage of GDP is a useful measure of the national commitment to science. In 2000, EU governments agreed that this figure should reach 3.0% of GDP by 2010, as part of the Lisbon Agenda. However, the more modest targets set out in the UK Science and Innovation Framework (2.5% of GDP by 2014) are yet to be realised, both in public funding and in industrial investment (which has a target percentage of 1.7% of GDP). Public expenditure on higher education as a percentage of GDP is one of the lowest in the OECD.[44] While the UK has seen a steady rise in scientific funding, particularly since the science budget was ring fenced, this commitment must continue to increase in order to bring this to levels which match those of our competitors and to attract more industrial investment in R&D.

29. The strength of UK science relies on a high number of students being taught to the highest quality to promote excellence. The RSC has raised the issue of standards in the regulation of education. A competition launched to provide direct comparison between current science examinations and equivalent exams in previous years demonstrated that contemporary exams are considerably easier than in previous decades, resulting in higher grades being achieved.[45] These concerns are being investigated by the examinations regulator Ofqual, who have agreed that there has been "a fall in the quality of science assessments".[46]

30. A major shortcoming of school science examinations is that they do not provide sufficient opportunity for more able students to demonstrate the extent of their abilities. Furthermore, a recent Government report showed that only 25% of science teachers have a specialism in chemistry,[47] and 19% have a specialism in physics. Pupils who are not challenged are not engaged, and teachers who do not have a deep knowledge of their subject will struggle to inspire their pupils. This poses a huge risk to the future of science in the UK, which relies on a supply of highly skilled scientists and a scientifically literate work force.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

31. The number of students accepting places on undergraduate chemistry courses has increased by 28% over the last six years,[48] and the recent announcement of funding for a further 10,000 students to take STEM courses has had little or no effect.

32. The RSC is concerned that there is too much focus on increasing the number of new STEM students without addressing quality or providing the required teaching support. The accompanying cut of 1.36% (HEFCE, July 24) in overall teaching funding compromises the teaching of these subjects. As a result, 33 of

[44] Education at a Glance 2008: OECD Indicators, OECD, 2008
http://www.oecd.org/document/9/0,3343,en_2649_39263238_41266761_1_1_1_1,00.html
[45] The 5-Decade Challenge, RSC, 2008
http://www.rsc.org/images/ExamReport_tcm18-139067.pdf
[46] The new GCSE science examinations. Findings from the monitoring of the new GCSE science specifications: 2007 to 2008, Ofqual
http://www.ofqual.gov.uk/files/ofqual-09-4148_GCSE_science_2007_2008_report.pdf
[47] Mathematics and Science in Secondary Schools. The Deployment of Teachers and Support Staff to Deliver the Curriculum, DEFS, 2006
http://www.tda.gov.uk/upload/resources/pdf/m/maths_science_secondaryschools.pdf
[48] UCAS data 2009.

the country's leading HEIs, in the best position to deliver top-quality STEM qualifications rejected the offer of extra places, while six opted for a lower number than allocated, pushing the extra student intake towards other institutions.[49]

33. Although the Government's offer to fund the extra 10,000 students for courses in STEM subjects appeared to be a positive development, the accompanying cut in HEFCE teaching funding suggests that this announcement was made without a clear strategic plan. Indeed, the list of subjects approved for these extra 10,000 students included non-STEM areas such as economics, business studies, management studies, finance, accounting, marketing, and human resource management.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

34. Any reduction in the unit of funding would be detrimental to the quality of education and training provided by all laboratory based subjects, including chemistry.

35. Although the "unit of funding" measures aim to increase teaching funding for more expensive subject areas, such as chemistry, the actual cost of running STEM courses with a significant practical component is higher than the 1.7 ratio that is currently used to weight funding. Some universities estimate that the real figure for chemistry is at least 2.5. A permanent solution, long advocated by the RSC, would involve removing these subjects from Price Group B and increasing their weighting to a more realistic figure.

36. Undergraduate teaching in the chemical sciences is already significantly underfunded (see section 3). Any reduction in the unit of funding will only increase this deficit and tempt vice-chancellors to make decisions which are not in the long term interest of the UK given the high economic return from investments in STEM teaching and research.

37. The RSC welcomes the opportunity to comment on the Science and Technology Committee inquiry into the impact of spending cuts on science and technology research.

38. The RSC is the UK Professional Body for chemical scientists and an international Learned Society for advancing the chemical sciences. Supported by a network of over 46,000 members worldwide and an internationally acclaimed publishing business, our activities span education and industry, training, conferences and science policy, and the promotion of the chemical sciences to the public.

39. This document represents the views of the RSC. The RSC's Royal Charter obliges it "to serve the public interest" by acting in an independent advisory capacity, and we are happy for this submission to be put into the public domain at the appropriate stage.

Memorandum submitted by Professor David Clarke (FC 37)

THE IMPACT OF WITHDRAWAL OF CAPITAL FUNDING

The University of Bristol is one of the leading research intensive universities in the United Kingdom and has a strong reputation in a variety of disciplines, particularly in Science, Technology, Engineering and Medicine, but also a range of other STEM subjects.

The University has in place a 10 year capital investment programme funded from three sources, namely University surpluses on income over expenditure, from borrowings and from capital grants. Capital grants have run at the rate of £15–18 million per annum and are a critical element of that programme. We have already, in the last 15 years or so, been able to invest significantly in Engineering, in Chemistry, in the first phase of Physics refurbishment and elsewhere. But an absolutely critical part of our programme is investment in Biological and Life Sciences which is currently housed in a late 19th C/early 20th C building which is unfit for purpose.

The credit crunch and the foreseeable consequences for income over the last 18 months has already meant that we have had to postpone indefinitely investment in a new building for our Department of Mathematics which over the last ten years has built a major international reputation. Retention of our international scholars in Mathematics is critically endangered by this inability to invest in new accommodation—they are currently situated on nine sites across the campus.

Nevertheless, we decided that the single most important critical investment for University of Bristol is £52 million for a major new building for Biological and Life Sciences. The long term process of obtaining planning permission and finalising the design details of a particularly complex building are complete and we would be hoping to clear the site shortly with a view to commencing the development later in 2010.

[49] Amendment to the funding agreements of 20 July 2009: provisional distribution of new student places for 2009–10: Annex A, HEFCE, 2009
http://www.hefce.ac.uk/pubs/circlets/2009/cl15_09/#annexes

However, the withdrawal of half our capital funding now puts this project at risk. The University has to decide between two difficult choices namely the risk of committing money and later finding there are insufficient funds for day-to-day maintenance and improvement of the estate, and the equally unpalatable risk of not proceeding and being unable to prosecute a central academic discipline in the future.

Professor David Clarke
Deputy Vice-Chancellor
University of Bristol

January 2010

Memorandum submitted by Todd Huffman (FC 38)

1. The problems of STFC are numerous. Some of these problems are impossible to avoid when severe budget cuts are imposed.

2. However, most of the difficulties STFC experiences can be either directly or indirectly traced to the manner in which the executive is chosen. The executive of STFC is hand picked by government. Consequently the role of the executive is never to "speak truth to power" but to make an attempt to impose government policy upon the research sector. Often these policies conflict with the research mission of the organization or if not in conflict, seem to have been formulated in a vacuum with no thought or advice taken on how such policies might be formulated to improve their effectiveness in these areas of research.

3. Ministers may not like to be told that their policies are inappropriate, and they may not listen anyway, but they still need to have executive members of the research councils who will tell them the truth as they see it and who will not see the civil servants in Whitehall as "bosses". This can only be achieved if the executive of the research council is clearly selected from below and further can be formally removed from below as well. An elected executive would re-instate the Holdane principle that has been essentially destroyed over the last decades . . . a principle that has resulted in the UK punching far above its weight in science and innovation.

4. STFC was initially created with insufficient funding. The exact source of this is in dispute but significant cost over-runs of the Diamond facility certainly could not have helped this situation. Had the executive of PPARC been selected from the community a much stronger voice would have been available to halt this misguided move. Even if the move was deemed "inevitable" an elected chief executive would have been able to more forcefully put the case forward to obtain sufficient funds from the treasury to start up the new council.

5. Promises of sufficient funding were broken by the government. It is likely this was even possible because it was thought there was no danger of protest or outcry when the chief executive of STFC is firmly in the grip of Ministerial masters. The effort so many are expending right now trying to recover from this initial mistake, and then almost immediately following on with even more severe cuts would be much reduced.

6. It would be a bad idea of amazing proportions to further attempt even more consolidation of STFC within some even larger research council. The first such attempt, with the creation of STFC as a larger research council containing elements that do not even have a primary research mission, has not gone well. What worked much better was a more tightly focused research council with a clearer research mission. A Fundamental Science Research Council (FSRC) ought to be created instead containing Particle Physics, Astronomy and Astrophysics, and Space Science should be created with the National labs incorporated within the "areas of excellence" Scheme that is hoovering up research money for dubious benefits.

7. A Fundamental Science Research Council (FSRC) ought to be created instead containing Particle Physics, Astronomy and Astrophysics, and Space Science should be created with the National labs incorporated within the "areas of excellence" Scheme that is hoovering up research money for dubious benefits.

8. The key is to obtain some level of clarity and consistency in the funding of research: Crisis after crisis is not helpful to research at all, let alone morale. Perhaps unknown to the people in this committee is the fact that first PPARC and now STFC have always jumped from one crisis of funding to another over the last decade. In an era which showed the greatest scientific investment in the UK for a very long time; the kind of fundamental science that actually attracts the most young people has gone from one cliff-hanger to another.

9. A research "ring fence" is therefore very welcome but the desired effect of constancy has not been apparent in PPARC and STFC—it has felt more like a series of short periods of hope dashed by new crises. Besides the ongoing problem of the cost of the international subscriptions, this boom/bust may have been partly due to the strategy followed by the leaders of PPARC who felt they needed to emphasise a catchy new project in each CSR in order to maximise the funding it received from the government. When the new project was approved it wasn't at a sufficient level, so strong cuts were required in other projects on a time scale much shorter than their natural project lifetime, while the new project needed to try to build up at an unrealistic rate. Both the "boom" and the "bust" were inefficient. (STFC has been so much worse it just doesn't bear talking about.) A ring fence of the total is therefore not sufficient—we also need an

understanding on the part of the government and its agencies that repeated short-term shifts of research priorities are unproductive. That certainly doesn't mean new priorities should never be introduced but that they need to come with an appropriately long-term vision.

Suggestions to Handle Research Budget Cuts

10. Ministers must understand that, by every independent measure thus far, UK science in Particle Physics and Astronomy is world class. There is NO FAT left in the system. We do not do any science that isn't right at the front-line of research. All cuts are going to bite into excellent programmes doing world-class research and many great ideas are already not being pursued because of the depressing climate surrounding research funding. The reduction in potential for future world-changing innovations like the world-wide-web is already a danger.

11. There is no need for ministers to consider the issue of "how to make cuts". The research community has demonstrated this year that we can rank projects on the basis of our own and external peer review and painfully remove projects of lower ranking to meet a given budget. Our goal will ever remain to keep the best research we can without destroying our infrastructure so that, if one day fundamental science is again funded, we are ready to take up the lead once again.

Declaration of Interests

12. I am an academic employed at a UK university and involved in particle physics (STFC funding).

Memorandum submitted by Professor P F Roche (FC 39)

Impact of the STFC Budget Cuts

I am writing to give my personal views on the impact of the STFC spending cuts on the astronomy programme in the UK. This is my area of research and therefore the area that I know best, but I think that the impact in other areas of STFC–supported physics will be similar.

1. The programme announced by STFC on 16 December 2009, will drastically reduce the research capabilities of the UK, withdrawing support from many productive facilities and returning the support for the UK astronomical community to levels far below those available in many other European countries. The drastic cuts in Postdoc positions and Fellowships will substantially reduce career opportunities for young researchers, and the grant funding cuts will inevitably lead to contraction of astronomy groups in Universities and very likely a freeze in the creation of tenured positions. The next few years promise to be dismal in the extreme as a direct consequence of the formation of STFC and the funding decisions that are now destroying the carefully-constructed programme developed under PPARC.

2. The "managed withdrawal" from the current UK observatories over the next one to three years will cut many projects before they are completed, in some cases wasting many years of planning and development. For example, the UK Infrared Telescope embarked on a world-leading set of infrared surveys, exploiting an innovative infrared camera that was designed and built in Edinburgh. The camera took five years to construct. On-telescope commissioning started late in 2004, followed by a seven-year programme to mid-2012 in order to deliver a comprehensive interleaved set of surveys to maximise the science return and provide a ground-breaking scientific legacy. This is now jeopardised by the planned withdrawal from UKIRT, with cessation of operations by the end of this year.

It also sends a terrible signal that world-leading UK science programmes are the most vulnerable to cuts or cancellation simply because they are within the direct control of the Research Councils. On the one hand we are told that we must have prominent UK roles in projects for them to be funded, but on the other, it is now clear that they are the first to go, often after many, many years of hard work. This is very demoralising for UK scientists and their collaborators and for the personnel at STFC who have to implement the cuts. It is no way to run a successful science programme. It is especially galling that new ideas or plans nurtured in our Universities will now have no natural home in UK facilities.

3. In ground-based optical-infrared astronomy, it is very likely that by the end of 2012, the sole facilities that the UK will have access to by right will be those operated by ESO, the European Southern Observatory. The mission of ESO, like other intergovernmental organisations, is to provide capabilities that are beyond the resources of individual member states. In the UK, the STFC programme appears likely to provide no resources for any national ground-based astronomy facilities. This is in contrast to France, Germany, Spain, Italy, Switzerland, and the Nordic countries which all operate their own observatories in Europe, Chile or the USA. It seems that the UK will once again be the poor relation in astronomy in Europe, returning to the position in the 1950s and 60s after years of world-leading research. A most unfortunate conclusion to the International Year of Astronomy.

4. Similar arguments hold for space missions. The UK is to withdraw support for satellites developed and launched at enormous cost to taxpayers. Last month, the 10th anniversary of the launch of the XMM-Newton satellite was celebrated across Europe as arguably the most successful European astronomical

satellite ever. It continues to be highly productive, and in its mature operational phase, the scientific returns benefit from a deep understanding of its performance. The STFC will celebrate this milestone by withdrawing support.

5. Last month, my colleagues and I at Oxford University interviewed almost 500 prospective physics undergraduate students as part of the university admissions process. The personal statements of the applicants emphasised three areas of physics: Quantum mechanics, Particle Physic, and Astronomy & Cosmology. The latter two of these are directly threatened by the STFC cuts. Of course, once at University, students develop interests in many other areas of physics, but these cuts seem very unlikely to enhance recruitment in SET subjects.

6. As Director of Graduate Studies for Astrophysics at Oxford, I will be meeting with our Postdoctoral students and Research Associates next week. While we do not yet know the full extent of the cuts, I will be forced to advise them that they should seek posts overseas where the prospects of a viable career are much brighter, with the hope that there can be some restoration of the UK astronomy programme in the next decade.

I regret that our worst fears of the scale of cuts and closure have been confirmed. The damage to career prospects and our international reputation will take years to repair. Unless some relief is provided, the projections are that this will get worse rather than better in the near term, jeopardising the UK's ability to fully exploit the remaining facilities that it subscribes to.

I am afraid that the widely-predicted disaster for STFC-supported physics is now upon us.

I am very grateful to you and the S&T committee for your continuing interest in the impact of pending cuts on Science.

Statement of Interests

I am a UK Delegate to the ESO Council, assessor to the ALMA Board, the Chairman of the UKIRT Board, and the grantholder for the UK Gemini Support Group.

I am a member of the Physic Department at Oxford University and Director of Graduate Studies for Oxford Astrophysics.

Memorandum submitted by South East Physics Network (SEPnet) (FC 40)

1. The South East Physics Network was set up by the Higher Education Funding Council for England in 2007 with the explicit aim of sustaining the discipline of Physics in the South East of England. For that reason we have taken the unusual step of responding to this inquiry on behalf of a group of Departments in one discipline because the most recent changes of funding of Scientific Research have the potential, indeed are likely, to undermine that endeavour.

2. The response is structured so far as is possible to correspond with the suggested format.

3. SEPnet expects that the decisions on allocations or on making cuts between the broad areas of science described by the designation of the existing research councils and academies, is something that should be informed by a broad range of scientific inputs through the Councils of each research body and government scientific advisors, and co-ordinated by the Director General, but ultimately is the decision of government and consistent with is strategic objectives. Within an existing Research Council/Academy the decisions on which areas of science or which projects should be the decisions of the scientific community guided by peer review and with regard to the overall strategic direction set by government.

4. Evidence has been collated to demonstrate that the overall economic benefit of research is positive and it has been collated by the Institute of Physics among others. The report "The Economic Benefits of Higher Education Qualifications" by Price Waterhouse Cooper for the Institute of Physics and the Royal Society of Chemistry. http://www.iop.org/activity/policy/Publications/file.pdf.

5. It is also possible to assess historically the economic benefit of individual research themes a considerable time (10–20) years after the initiation of a programme. The Research Councils annual reports contain many examples of this sort of lag in Physics and all other areas. It is much more difficult, if not impossible, to assess the likelihood of economic impact in advance of a particular study unless that study is carried out with the explicit purpose of economic benefit when it is arguably not frontier research. Such forward assessment of economic impact can therefore never be more than an amalgam of the track record of individuals/institutions and guesses about outcomes. For the purest of research the latter component is purely speculative.

6. It should be noted that the RAE or REF process run by funding councils to inform QR funding, that places emphasis on the last five or six years, is unlikely to capture the bulk of the underpinning activity that has led to such recent economic benefit.

7. If there is a shift in funding from the more blue-skies, long term research towards short term economic benefit whether by allocation or by virtue of cuts it will disproportionately affect the research led HEI's in the UK. This is because those institutions that have a larger proportion of the fundamental research that underpins a smaller amount of demand-led activity in their own institutions as well as almost all of the activity in demand-led institutions in anything but the short term.

8. We note that STFC has not suffered a budget cut compared with expectation but has had to repay a previous loan, accept a payment from the other research councils and then form an internal judgment about what can be funded on the basis of scientific peer review given other demands on its budgets. It is our view that some of this difficulty originates with the fact that STFC budget has to address many different demands not all of which are in their control. Thus, the increase in the sterling amount of payments for international facilities impacts directly on the spending that STFC can make on grant funding. The process of limited sharing of research budgets among all councils to pay for international facilities is a step to recognising this problem, but more could be done. It is not sufficient to take this from the Science Vote before it is allocated to research councils but could not some steps be taken to safeguard payments in Euros and dollars using government receipts in those currencies?

9. The cuts in STFC allocations to grants announced recently exemplify the problem set out in Section 7 in an acute way. Almost all of the grant research funded in HEI's is performed in what would be called research intensive institutions. Those institutions have established a research base encouraged by Research Councils and the RAE in the past that has concentrated in areas of high scientific endeavour at the frontiers of subjects. Within our own areas of activity in SEPnet, but more generally in Physics, this has been taken to imply work in the areas of Astrophysics, Cosmology and Particle Physics; areas of immense scientific importance and public interest. However, the economic benefits that flow from such activities in the short to medium term are the trained people and the narrower economic benefits flow more slowly from the fundamental ideas and instrumentation. Concentration in these areas associated uniquely with STFC, as well as work on Nuclear Physics, is therefore concentrated in rather few departments which therefore have a staff structure very dependent on STFC funding as the Wakeham Review of Physics noted. Some of our Physics Departments fall into this category with one having as many as 78% of its staff associated with STFC funding and three others approach 70%. The reduction of STFC grant funding for these Departments which have come to rely on it is likely to destabilise some of these Departments just at the time when, under HEFCE's guidance, we have been seeking to build both undergraduate numbers and research portfolio to better sustain Physics as a core Discipline in South East England. We are disturbed by this apparent inconsistency when both streams of funding emanate from the same Department of State. It is noteworthy that this destabilisation may well result in a reduced ability to train undergraduate numbers owing to enforced losses of staff.

Departments in demand-led institutions, although there are relatively few in Physics, will not be affected in the same way because their reliance on STFC is much smaller.

10. Because of our international subscriptions the cuts elsewhere in the system have been draconian. Even DIAMOND, which is seen as a successful project deserving of high status by STFC's science board, has a budget which is likely to slow the completion of phase three of its instrumentation installation. Across the board of Physical and Life Science's use of such facilities, the STFC's cuts will have very real negative consequences; we are already running facilities (eg ISIS) at levels well below their optimum, simply in order to save money on the electricity bill. The effect on the laser community, astrophysics and many other scientific areas is arguably worse. Generically, research is slowed down in highly competitive subjects and it takes a long time to regain a competitive position once it has been lost. As well as the effect on individual careers the ability to recruit and retain the best people is diminished. Although the scope and mode of the prioritization exercise is generally supported (since it had community involvement), there are specific areas where community advice was ignored, and there is a tangible lack of transparency about how strategic decisions have been made. The structural review of STFC is welcomed, because Lord Drayson has recognized how science spend can be unduly affected by outside factors (international subscriptions, but, just as importantly, facility costs). But the outcome of this review isn't yet known.

11. The UK education system is patently failing to deliver in Science. Of particular concern to us is its failure to deliver academics for research and teaching: SEPnet physics departments are heavily reliant on non-UK physicists, with only approximately 40% of academic staff educated entirely in the UK. The current German Excellence initiatives and France's new attempts to emulate them could easily lead to an exodus of the best continental physicists out of the UK system, leaving unfilled positions. Cuts in STFC and elsewhere will make the problem worse as they will further damage the career structure in the UK.

12. We have evidence in our institutions that the Additional Student Numbers released in July 2009 increased numbers of students in our own classes where they were allocated. We note that despite a growing demand for places in Physics in South East England as a result of our efforts at recruitment encouraged by the HEFCE places, our application for yet further student numbers was rejected.

13. The effect of any HEFCE cuts in the unit of funding for STEM subject students would be catastrophic. The unit of funding has been insufficient for a long time. It is that which has driven the closure of a significant number of departments of Physics and Chemistry in the period 1995–2005 (which correlates with a simultaneous drop in UK undergraduates in those disciplines, a situation from which we have only recently begun to recover). Whilst the vulnerable subject money has helped over the last couple of years any new cuts are likely to result in another round of closures (and from experience, an associated drop in total student numbers) which is absolutely contrary to the governments aim of providing extra support for STEM subjects.

14. We note the comments on the ring-fence applied to the Science budget within the Research Councils. It is suggested that the HEFCE QR fund and Departmental Research budgets might be ring-fenced. First, this is entirely against the very notion of QR which is to support research within an institution in the best way determined by the management of the University with its governors. If that is to be altered we shall veer towards a continental model of government involvement at a detailed level in institutions. The absence of such control is, empirically, the reason for the every success of UK HE to date. Equally importantly, it is vital to recognise that a ring-fence allows no flow in either direction of funding. Because there is strong evidence to suggest that Research, particularly in the physical sciences is in deficit in most institutions, it is currently supported by other activities so that a ring-fence would likely be detrimental to the cause.

15. We applaud the government's increased investment in Science and its bold attempts to deliver an enhanced Science base and an improved innovation platform. Some of these investments have been very successful and the creation of TSB is one such example, but the policies have not been altogether coherent. If the strategy is to get more students to study scientific subjects then there must be incentives in place for both the students and institutions to take and educate such students effectively. The only incentive that will be effective (short of dictat) is money, and there has not been adequate prioritisation of funding in the direction of what is said to be strategically important whether through education or research. Furthermore, many of the drivers in HE are towards enhanced volume as well as improved quality in pursuit of greater finance. It is likely that the country can only afford a smaller volume of high quality research, which does not argue for reduced funding but a more strategic distribution of the funds available.

Professor Sir William Wakeham FREng
Chair of SEPnet

Declarations of Interest

The submission is prepared on behalf of the Network of Six Physics Departments from:

University of Queen Mary University of London

Royal Holloway University of London

University of Kent

University of Surrey

University of Sussex

University of Southampton

Evidently the Departments all have an interest in preserving or enhancing science research funding, particularly in STFC, the unit of resource for teaching in Physics and the Number of Students studying Physics.

Professor Wakeham is also Chair of the UUK/RCUK Task Group on Full Economic Costs.

Memorandum submitted by Cluster Early-Career Scientists (FC 41)

We are all scientists in the early stages of our career, who use data from the European Space Agency's Cluster satellites. Our research is currently funded by the Science and Technology Facilities Council (STFC).

We would like to submit the attached document about the STFC prioritisation exercise for your inquiry into the impact of spending cuts on science and scientific research.

Declaration of interest: We are all supported financially by STFC, either through PhD studentships, fellowships, or as research associates employed on grants provided by STFC.

Elizabeth Davey	PhD student
Dr Robert Fear	Postdoctoral Research Associate
Dr Adrian Grocott	Postdoctoral Research Associate
Anthony Williams	PhD student

University of Leicester

Glyn Collinson	PhD student
Dr Colin Forsyth	Postdoctoral Research Associate
Roger Duthie	PhD student
Kimberley Steed	PhD student
Dr Andrew Walsh *Mullard Space Science Laboratory, University College London*	Postdoctoral Research Associate
Dr Laurence Billingham	Postdoctoral Research Associate
Christopher Chen	PhD student
Dr Jonathan Eastwood	Advanced Fellow
Edmund Henley	PhD student
Dr Robert Wicks *Imperial College London*	Postdoctoral Ressearch Associate
Dr Emma Woodfield *Lancaster University*	Postdoctoral Research Associate
Aliyuthuman Sadhique *University of Sussex*	DPhil student

SUBMISSION

1. We are scientists in the early stages of our careers at various UK universities. We are all funded by the Science and Technology Facilities Council (STFC), either by Ph.D. studentships, fellowships, or as postdoctoral research associates employed on grants provided by STFC. We use data from the European Space Agency's Cluster satellites to understand the physics of Space Weather—to learn how solar activity can cause disruption to the Earth's magnetic field harming both ground and space-based facilities for telecommunication, navigation, meteorological observations and entertainment that are vital parts of everyday life for everybody.

2. We accept the need for STFC's prioritisation programme, and therefore participated in the community consultation carried out by STFC's Near Universe Advisory Panel (NUAP).

3. The consultation resulted in a list of seven "high priority" science questions and an accompanying prioritised list of facilities required to address these questions. Three of the science questions require local measurements of particles and magnetic fields in space made by spacecraft such as Cluster.

4. We are concerned by the decision of STFC's higher committee structure to ignore the opinions of the scientific community, as expressed through the NUAP consultation. Despite the fact that three of the "high priority" questions proposed by NUAP require local space plasma observations made by spacecraft such as Cluster, and even though related facilities were rated highly, no such facilities will be supported. However, lower-priority facilities will be supported.

5. No explanation has been provided for why the community response has been ignored. We have been told that the decisions have been taken on the basis of "peer review",[50] but contrary to an open and scientific peer review process, the peer review documents, including the detailed advice and reasoning of STFC's Science Board and its advisory committee PPAN, have never been published. STFC has previously been criticised by the Select Committee for its peer review process failing to account for community consultation.[51] We believe that the current process demonstrates that STFC has made only superficial attempts to respond to this criticism.

6. The fact that these decisions have been taken without any science strategy in place at STFC is a serious cause for concern. Whilst the NUAP prioritisation was based on key scientific questions, the absence of a community-formed science strategy adopted by STFC makes STFC's choices opaque. Without such a strategy the tension between facilities and their exploitation within STFC cannot be addressed in a consistent and objective way.

7. The community consultation also recommended prioritising the exploitation of data through grants, studentships and fellowships assessed by scientific excellence rather than by the facilities used. We are therefore deeply disturbed by STFC's Science Board's recommendation to withdraw exploitation grants for projects not recommended for funding.[52] Over the last few years, STFC has funded spacecraft such as Cluster which have built up valuable data sets which will still be available for use after the end of the mission.

[50] eg http://www.ras.org.uk/images/stories/ras_pdfs/Astronomy_Forum/ASTRONOMY%20FORUM%20Jan%202010.pdf, para 14.
[51] Fourth Report of the Select Committee on Innovation, Universities, Science and Skills, "Science Budget Allocations", HC (2007–08) 215-I, pp 32–35.
[52] http://www.scitech.ac.uk/resources/pdf/SBNews161209.pdf, p 5.

To refuse to exploit these data is a huge waste of previous investment in both the hardware and the training of scientists in the field of space plasma physics. This is recognised for example by NASA, who have developed specific grant lines to exploit archived data, leading to considerable scientific progress.

8. If the stated STFC prioritisation is implemented, young scientists will leave this crucial area of research in which the UK is a world leader, or they will be forced abroad. This will significantly harm the UK's ability to sustain its expertise in space weather, and will prevent STFC from achieving the science goals identified in the consultation process. It will ultimately impact the UK's ability to play a leading role in future space research.

Memorandum submitted by Juvenile Diabetes Research Foundation (FC 42)

SUMMARY

1. Juvenile Diabetes Research Foundation (JDRF) is pleased to have this opportunity to contribute to the Science and Technology Committee inquiry into the impact of spending cuts on science and scientific research.

2. In our submission we have focused on the specific aspect of the inquiry's Terms of Reference where we have the most expertise:

— the process for deciding where to make cuts in SET spending.

CUTS TO SET SPENDING

3. JDRF exists to find the cure for type 1 diabetes and its complications and is the world's largest charitable funder of type 1 diabetes research. JDRF in the UK, affiliated to JDRF International (based in the USA), last year funded research projects in the UK with a value of £3.8 million.

3.1 As the breadth and depth of our research has grown in recent years, JDRF has developed a wide range of innovative grants and awards for researchers. The nature of its research programme actively encourages collaboration, not just between JDRF funded researchers, but also with researchers representing other conditions and medical research organisations and universities as well.

3.2 JDRF is a market leader in the funding of medical research into type 1 diabetes. We fund some of the UK's top researchers in this area and have a highly distinctive stem and progenitor cell research programme. The risk is that new treatments and research areas such as these will be badly affected by cuts to SET funding. These cuts come at a time when other countries are boosting science budgets as a means of stimulating the economy: France is investing €11 billion in higher education, Germany is spending €18 billion into promoting world-class research and in the United States, $21 billion has been allocated for federal science spending.

3.3 The proposed cuts to SET spending may well impact upon JDRF's ability to make grants to individual researchers. As a small charity, we do not have the resource to set up our own research facilities and instead fund researchers at established universities. For JDRF to continue to fund medical research, existing infrastructure needs to be in place. Any cuts to funding that jeopardise this infrastructure could also jeopardise JDRF's ability to fund at that university should the opportunity arise.

3.4 Cuts to SET spending in the area of medical research are very likely to focus on non-priority conditions that affect fewer people. JDRF would urge the Government not to forget minority conditions when deciding on future university funding budgets. Research into type 1 diabetes also has implications for other autoimmune conditions such as coeliac disease, Multiple Sclerosis and Graves disease amongst others. Niche markets such as type 1 diabetes provide real opportunity for the UK to excel as a centre of excellence.

3.5 JDRF would like to see a clear document demonstrating which areas will be subject to cuts and which will be ring-fenced.

January 2010

Memorandum submitted by UK Deans of Science (FC 43)

1. We are extremely pleased that the Science and Technology Select Committee has announced this inquiry at a time that is critical for the UK in both political and economic terms.

2. The UK Deans of Science (UKDS) has members in around 70 HE institutions that have significant science portfolios. Our primary aim is to ensure the health of the science base of the UK through the promotion and support of science and scientists and of science research and science teaching in the UK's HEIs.

3. We wish first to place on record our appreciation for the significant increases in real terms in the science budget that have occurred over the past 10 years.

4. We understand that various government and non-government groups are in the process of modelling cuts of up to 20%. Cuts at the top end of this range applied to the university STEM community would bring negative consequences that would take up to 10 years to put right. The effect of a reduction of a few percentage points would depend on the decisions as to where the cuts should fall but, in spite of the strong and negative response that would ensue from some quarters, could be dealt with in the short term. However, our greatest concerns are the message that any reduction in the science budget will give to young people considering committing their careers to science and the effect it would have on companies that rely on a strong science base in the UK to justify continuing to invest here. Even more important is the opportunity that currently exists to change the nature of the UK's economy.

5. The issue of "message" is something that cannot be dismissed lightly. The science community and the government have worked successfully in recent years to make the study of science more attractive. UK research output is world leading and the UK has increasingly become an attractive place in which to study and to do research. We need to ensure that appropriate and continuing investment takes place to ensure that we do not now give a message that science has lost its national importance. Such investment is also important to protect our reputation with international undergraduate and postgraduate students—an area of potential growth provided actions are not taken that diminish the reputation of UK higher education.

6. We realise that any argument that the science budget should be immune to the need to contribute to the reduction in the country's budget deficit may be interpreted as straightforward protectionism. This is categorically not the case. The government and almost all political parties now accept that developments in science and engineering will be the only basis through which the UK can remain economically viable and it is through investing in them that the major national and global challenges (climate change, energy and food sustainability, health and wellbeing, etc) will be solved.

7. The recent global economic crisis has led many countries to make difficult investment decisions. France is investing heavily in its universities, the American Recovery and Reinvestment Act is injecting an additional $8.9 billion in research ensuring that several large spending areas, including the National Science Foundation, are on course to double their budgets over the next 7 years, and many other countries are deliberately increasing their expenditure in research at this time. Indeed it is difficult to find any other nation that is cutting back on its investment in SET research. We simply cannot believe that in such an international environment a saving of a few hundred million pounds per annum (in the context of the UK's annual national and local government public spend of ca £1.4 trillion) is the right course of action. There is currently an almost unprecedented opportunity for a strategic rebalancing of the UK to a more sustainable, knowledge-based economy that makes full use of advances in science and technology, including the development of a more competitive workforce at all levels and especially the next generation of research leaders. We urge the Science and Technology Committee to make this point as forcibly as it can and to work with other committees in both the Houses to ensure that this message is heard, understood and acted upon. A failure to invest appropriately now will leave the UK behind as the world recovers from recession and within three years it will be too late to catch up.

The Process for Deciding Where to Make Cuts in Set Spending

8. Where cuts may fall is likely to have repercussions in the future. The cuts will have been caused by decisions of politicians, not the SET community. The science community may have many views on how and where cuts in spending might be made but we believe that decisions in this case should be made by those who have decided on any reduction in funding. They must explain their reasoning and be ready to accept responsibility for the short and long term consequences of their actions.

Estimating the Economic Impact of Research for QR Funding and Research Council Grants

9. We believe that the success of UK science as it leads the recovery from recession will be clear evidence of impact and that science research has had clear and quantifiable effects on the profitability of UK plc. Measuring impact can be more difficult, but if both the research councils and HEFCE stand by their claims that the excellence of research comes first and that impact is a secondary factor in making decisions about grants for research councils and, for the Research Excellence Framework, is a process of describing the effects of scientific work over a reasonable period, not a measure of knowledge transfer, then we believe that metrics for measurement can be defined. Areas like particle physics, where impact takes a long time, must be recognised and indeed the diversity of time scales and kinds of impact are important. Excellence in research comes first but impact is real and can be measured.

Differential Effect of Cuts on Demand-led and Research Institutions

10. We may have misunderstood this part of the Committee's inquiry but the apparent suggestion of a distinction being made between different classes of university is unclear to us. Most universities are led by demand both in teaching and research. If a differentiation is being made between a "research-only" institute and universities that always have research and teaching functions, then we again feel that this is an artificial taxonomy as the function of a research institute should include training ("teaching") as well as research.

The Implications and Effects of the Announced STFC Budget Cuts

11. There are two major concerns for our members. The first is the inability of research areas to plan programmes of research because of the instability introduced by the STFC's cuts, both on this and previous occasions. The second is the ability to pay our way in major international collaborative ventures, and the ability to maintain clear lines of sight so that UK scientists are not seen as bad or second class partners. We understand that the recent cuts are related to currency fluctuations and would suggest that ways should be found to moderate the effect of currency fluctuation. In addition the removal of the Research Councils' end of year flexibility in previous cost cutting exercises has contributed to the immediate problem and will mean that start/stop systems will be more prevalent than they need to be. Where investment in major international activity (such as ESA) is part political and part scientific, it is unfortunate if the associated costs impact on the whole of the STFC-funded research community.

The Science Budget Ring-fence

12. Members of the Committee will be well aware that it is always difficult and sometimes impossible to turn scientific research on and off as funding increases/appears or reduces/disappears. In some cutting edge, fast moving research areas a six month hiatus can make it effectively impossible to ever catch up. There is therefore a real need for the science budget to be ring-fenced and, as far as is practicable, it should not be subjected to sudden, large fluctuations. Ideally this approach should be applied to the HEFCE research budget, but we believe that this would require an instruction from government to HEFCE given its current process for allocation of such funding.

The "Science and Innovation Investment Strategy 2004–2014"

13. This ambitious document was very much welcomed by the SET community and there is evidence in many areas that the government and universities are delivering on several of its goals. We note that the Committee specifically mentions as one of the "next steps" in this document, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation. There has been a significant positive movement here through the combined efforts of university science faculties, scientific professional bodies, the science-based industries and government. However, the ambition as stated in the science and technology investment strategy included, inter alia, a "step change" in the quality of science teachers in schools, the results in science GCSEs and in the proportion of better qualified students pursuing careers in research and development. Since we are now two-thirds of the way through the period of the strategy some serious quantitative assessment of progress in this and in the percentage of GDP spent on research and development is urgently needed.

Effect of HEFCE Cuts on the Unit of Funding for STEM Students

14. We have indicated above that we believe that the route out of the current economic crisis is an investment in the world class knowledge and skills base available in the STEM community. Any reduction in support at this time will undoubtedly damage the UK's competitiveness relative to those countries who are taking a different approach to investment in science and technology. Any cut in the unit of funding for STEM students at undergraduate and postgraduate level can only give negative messages to young people about the importance of science and of a career in scientific research in the UK.

15. UKDS would be pleased to supply further comment if requested.

Submitted on behalf of the UK Deans of Science by
Prof Ian Haines, Executive Secretary

Memorandum submitted by Professor Albert Zijlstra (FC 44)

Impact and Causes of the Cuts in Funding for Research in Astronomy at UK Universities

Please find attached a submission to the inquiry on the impact of spending contacts on scientific research. The submission concerns the effect of the STFC cuts on research in astronomy at UK universities, and is based on information provided by STFC to the astronomy grant panels in January 2010. I am a member of these grant panels, and am currently Head of Science and professor of Astrophysics at Jodrell Bank, the University of Manchester.

Summary

1. The planned cuts in university grants by STFC are expected to lead to the termination of 48–50 of the 60 existing rolling grants. The rolling grants are the main source of funding for astronomy research at UK universities, and support larger projects. The scale of the cuts, and the loss of the associated fEC funding, endangers the viability of the UK physics departments. STFC suffers a conflict of interest, where it can change the balance of funding between its own tasks (subscriptions, facilities) and university funding in its

own favour. The recommendation is to put safeguards in pace to ensure that STFC does not favour itself over external stakeholders, to clarify its remit and ensure that its budget is sufficient for its remit, and to remove from its remit tasks which are not supported by its scientific goals.

Background

2. This submission to the Science and Technology Committee is in response to the call for input to an inquiry examining the impact of spending cuts on SET and scientific research. This submission is related to how STFC funds scientific research in astronomy at universities. The author is Professor of Astrophysics at the University of Manchester, and is a member of the astronomy grant panels of STFC. The author is co-investigator on two STFC grants. The host institute (Jodrell Bank Centre for Astrophysics) operates the e-Merlin national facility on behalf of STFC. This document concerns a personal submission, noting the personal interests stated above. I will discuss only the astronomy program.

3. The STFC has three distinct tasks. First, it handles international subscriptions to ESA, ESO and CERN, in order to provide access to their facilities for the university physics community. Second, it operates UK facilities, again to facilitate their scientific use, some of which is outside of its own science community. Third, it funds university research within its scientific remit in nuclear physics, particle physics and astronomy, including, but not limited to, exploitation of its facilities. STFC itself decides on the balance between funding its own facilities, funding their exploitation, and funding other research within its remit which does not make use of its facilities. It is important to note that all government funding for research within particle physics, astronomy and nuclear physics goes through STFC. This community has no access to other public UK funding streams.

4. When STFC was created, the regulatory impact assessment already noted the potential for conflict in its tasks, stating as the main risk factor: "With this approach, there is a risk that funding may be diverted away from grants to support facilities management and that Universities could also be disadvantaged in favour of Government-run facilities as a result." (http://www.berr.gov.uk/files/file36094.doc par. 25)

5. There is ample evidence that this has indeed happened. In response to STFC's financial difficulties, shortly after its formation the university grants were cut by 25% in 2007. A further 10% reduction was announced in December 2009, and in January 2010 a further 25% cut was announced to take effect after 2011. This should be compared to a 25% reduction in its facilities budget whilst the international subscriptions increased over the same time. In response to the deficit, there has been a strong shift of funding away from exploitation.

6. STFC also operates Diamond, which is used mainly by other research councils and has little overlap with STFC's scientific remit. This introduces a potentially undesirable overlap between research councils. Over the 2013–15 period, the STFC plans show a "strategic" shift of 25 million pound per year from PPAN (particle physics, astronomy, nuclear physics) to PALS (life sciences), which probably related to Diamond. It is not clear whether STFC had any choice in this matter.

University Grants

7. University research is funded though three-year grants to individual researchers (so-called standard grants), and through five-year, larger grants for teams (rolling grants). The second stream accounts for most of the research in astronomy, and the system of rolling grants is believed to be the main reason why UK astronomy is ranked second in the world. Long-term projects and strategy depend on rolling grants. The standard grants account for a small fraction of the research: at a success rate of 10% per annum, individual academics can only expect funding through this route once or twice in their academic career.

8. University grants are primarily used to fund young postdoctoral researchers (PDRAs). PDRAs typically stay in place for three years. PDRA positions provide a vital post-PhD training period. At the end of this period, the person is equipped to design and carry out independent research, and is able to lead research projects. This is the highest level of training UK universities offer. The overheads and fEC attached to these positions also provide a major source of income to physics departments.

9. In 2007, at the time of its creation, STFC funded 135 PDRA positions in astronomy per annum at universities (some technical positions are included in this number). In 2009 this was down to around 90, and as announced by Prof Mason. in January 2010, it is planned to reduce to 56-60 after 2011, for a total reduction of 55%.

Impact of STFC Cuts

10. Currently there are 60 rolling grants in astronomy in the UK. To be viable, they require a minimum of 2 funded PDRAs. The reduction in total PDRA numbers to 60 will have a very heavy impact. Modeling by Prof Cruise (chair of the Astronomy Grant Panels) shows that only 10–12 rolling grants will survive. The previous cuts have been severe, but left the rolling grant system in place, By 2013, we are fully expecting a collapse of the astronomy research at UK universities, with only a few viable groups remaining.

11. The immediate result is that the UK will obtain little return on its investment in facilities and subscriptions. A strong example is Herschel, a one-billion-euro ESA space mission with major UK involvement, which is currently the largest telescope in space. In spite of the very large investment by STFC,

there are only a few PDRAs funded to work on its exploitation. With the further reduction in PDRA numbers, there may be none in the near future. The second consequence is a reduction by half in the number of young people trained to the level of research leaders.

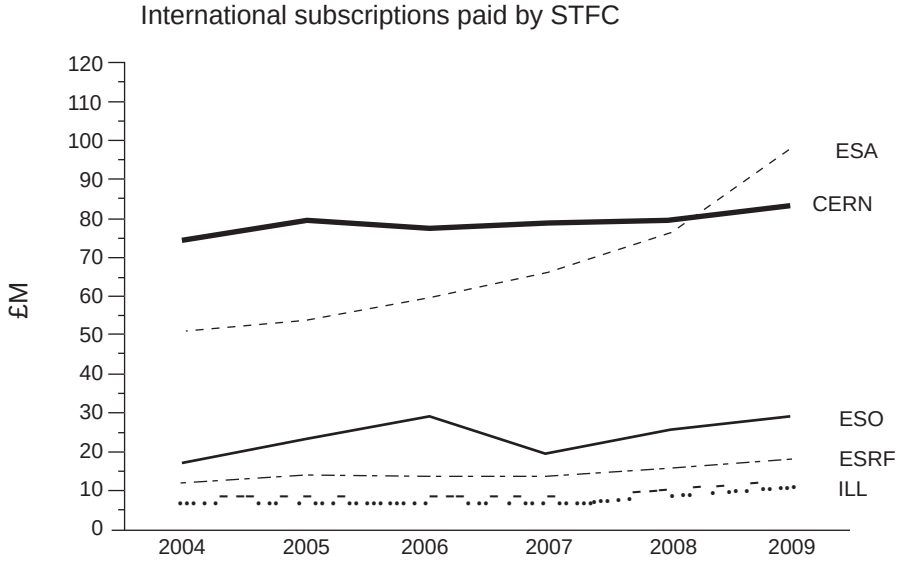
12. Physics departments in the UK depend on STFC for as much as 80% of their research income. The 2007 settlement included for all research councils an amount for fEC, aimed to make university research fully funded. For STFC, additional fEC amounts to £21.5 million for 2010–11. STFC no longer keeps this as a separate fund. Instead, the grant cuts are also applied to the fEC paid to universities. Government funds that were explicitly aimed at supporting universities, are instead used to pay for shortfalls on STFC projects, facilities and subscriptions. The reduction in university grants by STFC and consequential reduction in fEC, directly affects the financial viability of the university Physics departments.

Causes and Priorities

13. The well-published financial difficulties of STFC meant that the grants line could not remain unaffected, and a reduction was expected by the community. However, the grants line has been reduced far above expectations. This is in part due to the fact that STFC has no control over large elements of its budget. The rapid rise in the ESA subscriptions (see figure 1) especially has put severe pressure on the grants line. The grants line is the only budget element within STFC which can be rapidly adjusted. Funding streams aimed for supporting university research are therefore being used to cushion the spending on other items. This was correctly identified by the risk assessment at the time of the creation of STFC. If the ESA subscriptions would continue to increase at the current rate, funding for grants will drop to zero within five years.

Figure 1

INTERNATIONAL SUBSCRIPTIONS PAID BY STFC, SHOWING THE VERY LARGE RISE IN THE ESA SUBSCRIPTIONS
(pacrowther.staff.shef.ac.uk/subs.pdf)



14. The community consultation carried out during 2009 (the so-called NUAP and FUAP advisory panels) gave top priority to maintaining the university grants and studentships. STFC has chosen not to follow this recommendation, but as detailed above, is cutting the grants line by 35% between 2009 and 2013.

15. For the future, STFC's highest stated priority is to be involved in the e-ELT (an european 40-m telescope) and the SKA (the square kilometre array), both of which are large international projects. However, funding has to be found from within the existing budget. This foreshadows a further squeezing of the exploitation budget.

16. STFC has neither the funding nor the strategy to carry out all three aspects of its remit simultaneously. University research funding has suffered strongly, and future developments are predicted to be calamitous. The original reason to form STFC was to ensure "that the scientific and wider economic potential of UK investment in large scientific facilities is being exploited to best effect". STFC has failed on this.

A Conflict of Interest

17. To find a acceptable solution, it is important to correctly diagnose the problem. The underlying issue appears to be a conflict of interest. University researchers and STFC facilities compete for funding within the STFC. In other words, the STFC manages a competitive process for funding, where it itself is one of the participants. It is noteworthy that no problems have been reported with Diamond, which is operated by STFC but for which the exploitation grants are handed out predominantly by other research councils.

18. The solution requires a separation of responsibilities. STFC should not have the power to change the balance between facility funding and grant funding, and should not be allowed to use fEC funds for its own purposes. STFC should also not have the power to require grant applicants to make use of STFC facilities (as is currently one of the assessment criteria, set by STFC). Only under these conditions can STFC carry out its full role. If this cannot be guaranteed, STF should only fund and operate facilities, but should not have responsibility for university grant funds.

Recommendations

19. STFC needs to live within its means. It is believed that the financial difficulties date back to unrealistic funding assumptions made at or before its creation, by PPARC and by RAL, including a lack of an operation budget for Diamond.

20. There has to be sufficient funding for STFC to be able to carry out its remit. It is unacceptable that university departments are in danger of closing because STFC only has funds for its fixed subscriptions and facility operations. Maintaining viable Physics departments should be a funded, explicit task for STFC. Two dangers should be avoided: the grants line should not be locked into a funding level which endangers universities, and the rolling grant system should be maintained.

21. STFC priorities should be based on scientific criteria. It is notable that in the December 2009 prioritization, Aurora was shown to have little importance to the UK community, and Moonlite none. The UK voluntary subscription to ESA's Aurora program is in fact a main cause of the current crisis (Fig 1). There may be good reasons why the UK should be involved, such as the benefits for the UK industry. But it should not have been charged against a research budget where the researchers have little or no interest in it.

22. The conflict of interest needs to be resolved. STFC should not have the power to change the balance between facility funding, exploitation, and non-facility-related university research, to its own benefit.

Albert Zijlstra
Professor of Astrophysics
Jodrell Bank Centre for Astrophysics

Memorandum submitted by the University of Leeds (FC 45)

The funding cuts in question follow an overall dilution of QR across the sector as a result of the RAE. Whereas research-intensive universities have largely recorded increases in research expenditure over the past few years, the last three years have seen the value of Research Council new awards essentially remaining level (as evidenced by data accumulated from the Brunswick Group of Universities). Thus, the current funding cuts come on top of ongoing economies and the falling (in real terms) value of new awards, ie, they are impacting on a sector already under some stress. Science is increasingly technologically led. Thus, any "flat line" in financial terms leads to a real-terms cut in research ability. Whilst we need some sectoral re-organisation to cope with this and perhaps regional specialisation, it must be recognised that unless STEM is protected, our ability to deliver will spiral downwards.

The process for deciding where to make cuts in SET spending

1. It is not unreasonable an expectation that funders would respond to pressure on resources by becoming more selective as to the areas and individuals that they support, to maximise the benefits from what remains rather than spreading more thinly across the sector. This leads to concentration of funds in target areas and may result in perturbation of funding patterns.

2. The Royal Society of Chemistry and the Institute of Physics recently commissioned a study (Nigel Brown Associates, December 2009) of the sustainability of research in UK university chemistry and physics departments. Not surprisingly, both are in deficit. Their heavy overall dependence on public funding (85–88% in 2007–08), and the rising costs, means that universities are less likely to be able to protect these departments from the anticipated funding pressures, especially if they are to sustain high quality teaching. Thus, selectivity in research funding is likely to result in chemistry and physics departments across the sector experiencing severe financial pressure.

3. The Research Councils remind us of their long-standing intentions to direct resources towards projects which demonstrate "Impact", and an expectation of matching support from industry. The proposed assessment of Impact is an obvious, though not undisputed, feature of REF. Impact-driven research is not a new concept. The University of Leeds is an excellent example of an institution which has embraced the Impact agenda. Historically we have a culture of working at the interface between academia and society (industry, government) through multidisciplinary collaborations within the campus and externally. However, we would highlight the need to keep a balance between the funding of underpinning science (eg, through ring-fencing) to ensure that radically new ideas can be developed and that future generations of researchers can be supported and nurtured.

4. At Leeds, we have the agility to diversify our sources of research income and, indeed, approximately half of staff in STEM subjects have engaged in "applied" research over the past year. Whereas engagement with industry (either directly or through agencies such as RDAs) offers an alternative source of research income, the knowledge and understanding created by this route may be subject to restrictions on dissemination. Neither can the funding gap be easily made up through non-RC-funded routes. At Leeds we would require a tripling of our current expenditure on research from such sources to meet this gap. Clearly, this is an unrealistic expectation. Whilst European funding for research is still buoyant, the special transitional flat rate and the low overhead recoveries on some schemes are a serious disadvantage. Thus, the process for deciding on cuts in SET spending should not assume *de facto* the ability of institutions to plug the gaps in basic research from other sources.

5. There are signs that Research Councils are likely to find it easier to cut spending on the support of postgraduate research students. These students are a critical part of the research base and if the cuts fall on them, we will undermine our pipeline to new blood and create a recruitment crisis further down the time-line. In recent years the Research Councils have encouraged us to regard the training of postgraduate research students as a "people" activity to develop research careers and a broader skills base, eg, through "Robert's" funding and DTCs. We are in danger of moving backwards in this respect.

Evidence as to the feasibility or effectiveness of estimating the economic impact of research

6. The need for a measure of the economic impact of research is critical to the use of this parameter as a means of directing research funding. Currently, the metrics are being investigated for the REF through pilot projects involving evidenced case studies. Fundamental to this exercise is that claims of impact should be based on sound basic research and, in the retrospective approach, that the time to realise that impact can be significant, eg, 5–10 years. However, the approach to evaluation can only be subjective, as the economic parameters are difficult to identify and quantify retrospectively.

7. Some departments, eg, Pure Mathematics, are understandably nervous about expectations in this respect. It is important, therefore, that any approach adopted to measure impact takes on board the different expectations across the disciplines. Similarly, concern has been expressed that an economic impact-driven approach to research funding is likely to lead to incremental and un-adventurous science.

The differential effect of cuts on demand-led and research institutions

8. In the past, institutions with research and teaching activities, have been able to balance income streams to compensate for perturbations in funding patterns. The compounded effect of a cap on student numbers, cuts in core funds, and a reduced opportunity to win research funding are likely to have a serious effect on the viability of science and engineering in those institutions.

9. There is concern about the "disciplinary lottery" in the funding of scientific research through HEFCE's use of the STEM/part-STEM mechanism. That is, the same piece of science conducted in a non-STEM discipline attracts less QR resource than had it been conducted from a STEM discipline. This leads to a structural loss of ability to invest, without cross subsidy from other discipline areas, and so the true costs of conducting quality science in such an environment are not covered under a part-STEM arrangement. The proposed cuts are likely to have a disproportionate impact on such research activity.

The implications of the announced STFC budget cuts

10. Support for research in astronomy through STFC falls broadly under three headings: the near universe (including stars, star and planet formation, solar physics, planetary surfaces and meteoritics, and space plasmas), the far universe (including cosmology and galactic evolution), and astroparticles (including cosmic rays, TeV gamma-rays, gravitational waves, neutrino astronomy, and the cosmic microwave background). It is expected that a department of astronomy would engage in several of the subfields within these broad headings, if it is to provide a credible training provision at undergraduate and postgraduate level. The dismay of the astronomy community at the considerable broad cuts, and the more extreme targeted cuts in the STFC budget, is easy to appreciate. Thus, space plasmas, a subject with important impact, eg, on communications and climate, has been hit severely, as has astroparticle physics, with the expectation of the closure of world-leading research in these areas. Investment in them, and the creation of world-leading centres of research, has been the result of a rational response to increases, in recent years, in research funding. The cuts will severely damage this research base.

11. Concern amongst this community is also focused on the relationship between the 35% cut (following the 25% cut of 2008) in grants (as the flexible part of the STFC budget) and the funding by STFC of facilities. This is already causing leading UK-based astronomers and Solar System physicists to move abroad or consider leaving science altogether. The direction of research should be driven by academic excellence, rather than commitment to the funding of facilities, innovation campuses, and initiatives such as Aurora.

The scope of the STFC review

12. The long-term nature of particle physics and astronomy projects, and their reliance on large international organisations, is an argument for maintaining a separate funding body to serve this community. This view has already been expressed by the Royal Astronomical Society Forum and the Institute of Physics. Following the arguments above, it is essential that any structured Research Council should have academic excellence at its core.

The operation and definition of the science budget ring-fence

13. Clearly a ring-fence of the science budget is attractive to SET but we must take care not to undermine the funding of science which is undertaken in non-STEM disciplines (eg, Geography) which already are suffering from a lower allocation through QR. It has to be appreciated that ring-fencing does lead to some disciplines being disadvantaged, and the implications of this approach have to be considered and understood in the wider context.

Whether the Government is achieving the objectives set out in the "Science and Innovation Investment Framework 2004–2014: Next Steps"

14. The main problem with regards to the supply of graduates is that Mathematics and Physics at many schools is still not sufficiently attractive, or of sufficiently high quality, to translate into the desired growth in undergraduate courses.

Whether the extra student support, which the Government announced on 20 July 2009 delivers students in science, technology and mathematics courses

15. There are grave concerns about the viability of this scheme in view of the fact that additional support for high cost laboratory-based subjects was not included in the provision.

The effect of HEFCE cuts on the "unit of funding" for STEM students

16. It is in all our interests that the cuts in the unit of funding do not have a detrimental effect, neither on the quality of provision nor on the student experience. It is our firm belief that students in SET should receive hands-on laboratory exposure to meet the expectations of the research community and of their future employers. In response to the need for economies, colleagues have been inventive in the way they have devised methods for delivery and assessment that allow larger groups to be accommodated. We now face additional constraints for which there is no obvious way to maintain current capacity.

Declaration of Interest

The author of this response is Pro-Dean for Research in the Faculty of Mathematics and Physical Sciences, who is active in research and dependent on Research Council and other sources of Government funding. He has drawn on the views of colleagues across five faculties, many of whom serve on Research Council and funding body committees and panels.

Memorandum submitted by the STFC Science Board (FC 46)

We felt that it was important for the record to explain the thinking behind the actions that Science Board advised in light of the cuts which were necessary to balance the STFC budget.

1. The official report from the Science Board meeting can be found on the STFC web pages. Science Board was very distressed at the level of funding cut that was being called for, and it became clear early on that this would not be like previous prioritizations of the programme, but a major restructuring and re-alignment of STFC's entire remit, encompassing both facilities and fundamental science research. The level of cut needed was about 10%, but because more than half of the STFC responsibility consists of international subscriptions, this translated into a cut of approximately 25% on the domestic science programme.

2. Science Board first off recommended funding for all the international subscriptions, which provide facilities for all the grant funded science areas, and also provide most of the photons and some of the neutrons to the UK users. The extensive consultation of the community clearly identified the facilities which are made available to researchers through the International Subscriptions as being essential for keeping our scientists on the first rung on the world stage. Some of these subscriptions have gone up substantially in the last few years from a combination of increases and exchange rate effects (ESA is a case in point).

3. Science Board agreed that they had a responsibility to run STFC's own facilities at some optimal level (way below maximum exploitation) to make sense of the investment: after all, the international facilities do not get their budgets cut, but presently STFC is running their own facilities at low duty cycles. Furthermore, the idea that we should not support the new Diamond beamlines, after the government has invested £0.5 billion so that it can become an internationally competitive UK facility, would be irresponsible.

4. Any further facility development would be focused on Diamond and ISIS, but Science Board advised that investment in any other future facilities should be withdrawn because of the low likelihood of additional operating costs being made available in the future.

5. In the grant funded PPAN area Science Board could advise only for funding for the top priority projects which the communities have put forward and even these projects had their resources reduced in order to balance the budget. The outcome of this is a definite shift to "big science" projects, and more than half the projects which were being funded and will have to be terminated were smaller less high priority projects. Science Board felt that some resources must be put aside to manage this withdrawal carefully in order to give the researchers time to realign their research. However, even though some extra funds were made available by RCUK for grants this year, the cuts to the grants which are necessary in future years are substantial.

6. The dominating factors in this whole budget crunch are from the international subscriptions, an increase in the cost of research through FEC which was not fully covered by the allocation, inflation and exchange rates.

7. Throughout all its actions, Science Board took cognisance of the recommendations of its advisory panels. Each panel had its own priorities, but it is the responsibility of Science Board to weight those priorities across the entire gamut of STFC's remit. This has, not surprisingly, led to disappointment, and a feeling that the advice of the panels was ignored. Science Board would like to stress that the work undertaken by the panels, and the consultation they organised with STFC's community was a vital part of the prioritisation exercise, and Science Board is very grateful to the panels for their input to a very difficult process.

8. Science Board is satisfied that the prioritisation was a transparent and accountable exercise. Science Board also knows that the outcome is going to cause enormous problems and frustrations within the scientific community as years of scientific work are lost. Indeed, members of Science Board are experiencing those frustrations themselves, as all members of Science Board are practising scientists and are also subject to the cutbacks and restrictions imposed from the prioritisation.

9. It was not an easy exercise, and no-one is happy. It is incumbent on Science Board and the STFC Executive to ensure that STFC's community is now able to deliver a combination of top-class pure and applied research that will act as a platform for future developments and discoveries. This is essential to ensure that the UK maintains its position as one of the leading nations in scientific research and technology development.

10. Science Board is always open to ways in which it might improve its practices. It is keen to work with DBIS as it looks at the tension between grants and facilities within STFC.

11. Science Board thanks the Committee for this opportunity to clarify the process by which STFC completed its recent prioritisation exercise, and the thinking behind the (frequently unpalatable) decisions that were made.

12. We all need facilities, whether national or international, and they provide a basis for almost all of our science.

Declaration of Interests

MINOS Project Spokesperson

Member of Faculty, UCL

Chair of STFC Science Board

Professor Jenny Thomas
Chair of STFC Science Board
on behalf of STFC Science Board

Memorandum submitted by the Alzheimer's Research Trust (FC 47)

1. The Committee asked for evidence on estimating the economic impact of research. In September 2009, the Alzheimer's Research Trust and Office of Health Economics (OHE) published "Forward Together", on the complementarity of public and charitable research with respect to private spending (the report can be viewed at http://bit.ly/7tzIjl). OHE researchers examined scores of papers investigating the impact of public and charitable research spending, a debate that is particularly intense in the biomedical research sector. They found that basic research—science carried out to understand fundamental principles, such as what causes

Alzheimer's disease—appears to stimulate particularly high levels of private investment. One US study analysed in the report suggests a £1 investment in basic research leads to £8.38 of further investment over eight years. The report's lead-author, Jorge Mestre-Ferrandiz of the Office of Health Economics, said:

> "Based on the US experience, a £1 increase in UK government or charity spending on medical research could lead to an increase in private research spending from the pharmaceutical industry of between £2.20 and £5.10. These potential effects could be larger in areas, like dementia, where public and charity research efforts are focused on basic, rather than clinical research".

2. With regard to dementia research specifically, UK dementia scientists are among the world's most productive and innovative. In the US, Federal funding for dementia research is 13 times higher than UK government investment (http://www.alz.org/publicpolicyforum/08/downloads/Federal_Funding_Alz_%20Research.doc), even before accounting for President Obama's stimulus package. Despite this, British scientists are world-leaders in many areas of dementia research, including pathology, imaging and genetics (http://bit.ly/1OfyZ3). The Alzheimer's Research Trust believes it is the UK's responsibility to build on its strong science base to tackle conditions like dementia, which afflicts 35 million people worldwide.

3. The Committee sought views on "the process for deciding where to make cuts in SET spending". We are concerned that broader SET spending cuts will have a negative impact on a field that is already suffering from years of neglect. In 2007–08, less than 3% of medical research budgets (MRC and NIHR), just £32.2 million, was invested in dementia research. In 2008-09, that figure fell by 7% to £29.9 million.

4. We hope that future talent pool growth of dementia scientists will include those trained in fields like mathematics and other areas of scientific research. If funding cuts hit these fields, the Alzheimer's Research Trust would be concerned about the spill-over effects for dementia research.

5. In July 2009, over 30 leading scientists—with the backing of charities including the Alzheimer's Research Trust, Alzheimer's Society and Parkinson's Disease Society—warned of an urgent need to significantly increase dementia research funding. In an open letter, led by Professor Julie Williams, Chief Scientific Adviser to the Alzheimer's Research Trust, they said:

> "Today (21 July) the government will hold a ministerial dementia research summit at the Royal Society. After years of underfunding, it is encouraging that dementia research is receiving serious attention.
>
> "Within a generation, 1.4 million people in the UK will live with dementia, costing our economy £50 billion per year.
>
> "Yet for every pound spent on dementia care, a fraction of a penny is spent on research into defeating the condition.
>
> "Our key weakness is lack of funding, not lack of talent.
>
> "The Government must use this summit to initiate a national dementia research strategy. Most importantly, it must commit to tripling its annual support for dementia research to £96 million within five years.
>
> "If the government squanders this opportunity, we will all pay the price".
> (http://www.alzheimers-research.org.uk/news/article.php?type=News&archive=0&id=453).

6. The Alzheimer's Research Trust contributed to the Nuffield Council on Bioethics' report on dementia, published in October 2009. The Nuffield report criticised the "Cinderella status" of dementia compared with other areas of medical research and suggested that the current system of research funding allocation is flawed, stating "the major research funding bodies within the UK do not appear to have explicit policies according to which they allocate funds between different conditions, focusing rather on research excellence and the 'importance' of the topic". The Nuffield report argues that:

> "Given the social and economic impact of dementia, we believe that a more explicit approach to research priorities would be likely to lead to significant increases in research funding for dementia. If such an increase were not matched by research applications of the necessary high standard, then active steps should be taken to develop and promote research capacity in the relevant areas".

7. The Alzheimer's Research Trust is committed to increasing its funding of dementia research as much as is possible, and other third sector organisations have shown a willingness to support dementia research, however this is one area that cannot be handled by charities alone; further government support is necessary. If not via a disease-specific ringfence, then some consideration of the social and economic cost of conditions like dementia should, in our view, influence research funding decisions.

8. On 3 February 2010, the Alzheimer's Research Trust will publish Dementia 2010, a report from the Health Economics Research Centre, University of Oxford (available by contacting Andrew Scheuber ascheuber@alzheimers-research.org.uk after 3 February). The economists, led by Professor Alastair Gray, analysed the prevalence, economic cost of, and research funding for, dementia, cancer heart disease and stroke. They found that Dementia costs the UK economy £23 billion per year. That is twice the cost of cancer (£12 billion per year), three times the cost of heart disease (£8 billion per year) and four times the cost of stroke (£5 billion). Despite this, combined government and charitable investment in dementia research is 12 times lower than spending on cancer research. £590 million is spent on cancer research each year, while just £50 million is invested in dementia research. Heart disease receives £169 million per year and stroke research

£23 million. Dementia 2010 also reports that for every £1 million in care costs for the disease, £129,269 is spent on cancer research, £73,153 on heart disease research, £8,745 on stroke research and just £4,882 on dementia research. The Alzheimer's Research Trust feels this demonstrates a worrying dissonance between growing health and social care costs and commitment to developing new treatments, preventions and cures that could save billions of pounds in the long run. The Alzheimer's Research Trust believes that medical research funding bodies are not adequately considering the wider opportunity cost—the cost of not utilizing the full potential of British dementia scientists—of funding decisions.

9. In 2009, the government announced the formation of a Ministerial Advisory Group on Dementia Research, led by the Department of Health but including research funders from all sectors, including the Alzheimer's Research Trust. We strongly welcome this initiative and hope it will lead to an increase in dementia research capacity, an improvement in grant application success rates, clarify career paths for potential/aspirant dementia scientists, and sustainable growth in dementia research funding from all sectors. Given our rapidly ageing population, we must make progress soon.

Declaration of Interests

The Alzheimer's Research Trust (registered charity number 1077089) is the UK's leading dementia research charity. We are dedicated to funding scientific studies to find ways to treat, cure or prevent Alzheimer's disease, vascular dementia, Lewy Body disease and fronto-temporal dementia. We do not receive any government funding and instead rely on donations from individuals, companies and charitable trusts, money raised by individuals and gifts left in people's Wills.

Memorandum submitted by UCL (FC 49)

1. UCL is pleased to make a submission to the Committee's inquiry into funding cuts for research. We emphasise our great concern at the £915 million cuts across higher education budgets that have been announced so far. Together with those that are forecast to follow, these have serious implications for the sector and are beyond what universities can easily absorb. The cuts are particularly alarming given the international competition in research that the UK faces at a time when our competitors are investing heavily in universities and in research. We are concerned that the proposed cuts risk undermining the substantial investment in world-class research than has been made over the past decade and significantly damaging the long-term health of the UK research base—with consequent impact on our international competitiveness, economic prosperity and wellbeing. The cuts also illustrate a lack of understanding that investment in higher education and research is vital for the UK's economic recovery.

2. This submission makes comments in response to the points raised by the Committee in relation to: evaluating the impact of research; the effects of funding cuts on research-led institutions; ring-fencing research funding; and the announced STFC cuts. We finish with some general conclusions on investment in the research base.

Evaluating the Impact of Research

3. UCL strongly supports efforts to better capture the impact of UK research, which is important both to justify public investment and to enable the academic community to demonstrate the critical value of research to the UK. Examples of the different ways in which UCL's research has had major social or economic impact are given at Annex A.

Evidence for impact of research

4. Undertaking research is crucial for the continued success of the UK economy and strength of our society.[53] The benefits of university research to the UK are great, although not always easy to quantify. The available evidence tells us:

- that the UK is a world leader in research and number one in the G8 of advanced industrial nations for research publication productivity (third in the world for citation productivity);[54]
- a particularly good return given that the UK is ranked seventh in the G8 for public funding,[55] and a strong indication of the return on public investment in research;

[53] See for example: Campaign for Science and Engineering Policy Report, "Impacts of Investment in the Science and Engineering Research Base" (September 2009) and Arts and Humanities Research Council, "Leading the world: the impact of arts and humanities research" (2009).

[54] Evidence Ltd / Department for Business, Innovation and Skills. *International comparative performance of the UK research base.* September 2009.

[55] The UK spent 1.82% of GDP on R&D compared to an average of 2.24%, according to a study of 21 comparator nations (Evidence Ltd / Office of Science and Innovation. *PSA target metrics for the UK research base.* 2007).

— that there is a significant financial return on public investment in research: one report has estimated the return to be equivalent to £0.39 in perpetuity for every £1 of investment[56] and another that every £1 of pubic investment in research stimulates additional investment eight-fold over eight years;[57] and

— that UK research generates significant economic impact in terms of supporting business, attracting inward R&D investment,[58] generating new products and processes,[59] creating spin-off companies, providing skilled people, and so on.

5. There is therefore a clear rationale for continued public investment in research, which will generate a substantial financial return over the long-term and continue to deliver the new knowledge, products and services which attract investment and boost our prosperity.

6. We emphasise that the benefits of research go beyond the financial to wider, less easily measured economic benefits such as job creation, increased productivity, improved healthcare, enhanced quality of life, or increased sustainability. Publications such as the Research Councils' *Excellence with Impact*[60] and Universities UK's *Eureka UK!*[61] have described the myriad ways in which university research has had an impact on our society and boosted our prosperity. The UK is also dependent on the strength of our research base for intangible benefits, such as our quality of life and cultural wellbeing. It is imperative that we do not under-estimate the importance of those research impacts which are enormously beneficial although not readily quantifiable.

Evaluating impact

7. Evaluating the impact of research is known to be extremely difficult. Much remains unknown about the most effective and accurate methods of evaluation. As a recent report for HEFCE noted, "In some instances, the link between the original research and the demonstrable benefits are clear. But this is the exception rather than the rule. More often than not, impact is achieved through the implementation of the results of a number of research projects from a variety of HEIs over a long time frame".[62]

8. A retrospective approach is likely to be more successful in terms of identifying impact that has arisen from research (as the evidence referred to above shows), although there remain significant problems in terms of the extent to which specific impacts are directly attributable to specific research. HEFCE's approach to REF has illustrated some of the difficulties in assessing impact, not least that it will likely assess only what can readily be captured and reported (with verifiable data) rather than the full wealth of impacts arising from research in universities.

9. Although the REF approach seems reasonably sensible as a starting point for gathering of some evidence of the impact of research in UK universities, it remains a limited approach which will only partially assess the impact of research. It is also as yet untested. UCL's response to the REF consultation expressed concerns that devoting 25% of assessment of impact was too high a proportion for such an untested element. We also made clear that research impact should be considered in its entirety, including academic impact, rather than precluding academic impact when evaluating the impact of research, which imposes a false dichotomy in assessment.

10. The Research Councils' ongoing Outputs and Outcomes Collection project may in time shed further light on ways of evaluating impact retrospectively and it will be important to learn from this.

11. Recent changes introduced by the Research Councils to grant applications requiring impact summaries represent a move towards encouraging researchers to think about the potential impact of their proposed research. The Committee will be aware that this has caused perturbation in the academic community. The ways in which impact plans are used by individual Research Councils when making funding decisions remains unclear. UCL emphasises that funding decisions should continue to be made on the basis of research excellence alone, as it may not be possible to predict what the ultimate outcome or impact of

[56] Health Economics Research Group, Office of Health Economics, RAND Europe. *Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK.* London: UK Evaluation Forum; 2008. This report found that a £1.00 investment in public/charitable cardiovascular disease research produced a stream of benefits thereafter that is equivalent in value to earning £0.39 per year in perpetuity.

[57] A £1 increase in extra public medical research can lead to an increase in private R&D spending of between £2.20 and £5.10. The effect of public funding in stimulating business investment in R&D appears strongest with regard to basic research, with evidence suggesting that a £1 investment of public funds in research leads to £8.38 of further investment over eight years (Alzheimer's Research Trust / Office of Health Economics, *Forward Together: Complementarity of public and charitable research with respect to private research spending,* September 2009).

[58] See: Professor Paul Wellings. *Intellectual Property and Research Benefits.* September 2008; UKTI. UK: *Your springboard for growth* Inward Investment report 2008–09 (2009) which showed an 11% increase in investment, making the UK first in Europe, and stated that "The UK's long-established and exceptionally strong science base puts it in a unique position to attract and serve the world's investors in R&D (p 14).

[59] In 2007–08, 590 new patents were granted to UK universities and 219 spin-off companies were established; 923 spin-off companies were still active after three years (HEFCE, Higher Education-Business and Community Interaction Survey 2007–08, 2009).

[60] The Research Councils UK document *Excellence with Impact* provides a useful account of some of the economic benefits of research funded by the Research Councils: http://www.rcuk.ac.uk/news/warry.htm

[61] Universities UK. *Eureka UK: 100 discoveries and developments in UK universities that have changed the world.* 2006.

[62] RAND. Capturing Research Impacts: A review of international practice. 2009.

research will be. It is important that the Research Councils do not implement any practice which means that only those applications which are able to describe potential impact are funded, as this would lead to the stifling of the research base and a failure to fund many exciting and innovative research proposals.

12. We emphasise that whilst the impacts of research nationally can be clearly demonstrated at an aggregate level, and whilst it is possible to publish "case studies" of the impact of research, attempting systematically to evaluate the impact of research at the level of an individual project or department is problematic. UCL believes that assessing the impact of research at an institutional level would better capture the full extent of and contribution to research impact.

13. We would also distinguish between demonstrating the benefits and impacts of publicly-funded research on the one hand (which is entirely appropriate), and making funding and policy decisions based on perceptions or predictions of impact on the other. Using research impact as a driver rather than a desired outcome of policy risks undermining the strength, dynamism and diversity of our research base.

Effects of Funding Cuts on Research-led Institutions

14. The £915 million cuts (likely to be followed by further cuts in the future)[63] that have been announced to higher education budgets, including science and research, will inevitably pose great difficulties for universities. It is imperative that we recognise that our research-led universities remain one of our most valuable national assets and that we act to secure their future sustainability.

15. In particular, Government should recognise the role of research and research-intensive universities in developing solutions to global problems, through the generation of new knowledge, simulating technological innovation, and informing policy. Research-led institutions, such as UCL, which offer a high-quality research environment, concentration of talent, and a breadth of cross-disciplinary research excellence are able to play a particularly valuable role in contributing to the solution of global problems. Tackling many of the most complex social and global problems requires synthesis of knowledge from across different disciplines to provide new ways of thinking and multi-dimensioned approaches that combine different perspectives. This can only be found in those institutions which foster a breadth of research excellence. However, sustaining such excellence will be extremely tough in the face of research funding cuts.

16. We therefore argue that future research policy will need to recognise that research-intensive universities offering multidisciplinary research excellence across a breadth of expertise make a unique contribution to this agenda by enabling the tensioning of different strands of knowledge against each other, an invaluable capability to enable the advancement of knowledge and understanding and to address global challenges. In the context of the announced funding cuts and the current financial climate, it is likely to require that clear strategic decisions will need to be made on research funding policy. Research policy must maintain appropriate levels of funding for our leading research-intensive universities to enable the continued pursuit of research excellence and sustain our knowledge base—it is on the generation and wise application of knowledge that our economic prosperity and social wellbeing depends.

Ring-fencing Research Funding

Science Budget

17. UCL welcomes the increase in the Science and Research Budget over the past decade, which has more than doubled,[64] and the projected increase of 17.5% between 2007–08 and 2010–11.[65] The ring-fencing of the Science Budget within the responsible department has been a successful policy which has sent an important message both to the research community and to other government departments about the need to protect and maintain research funding. It also means, by and large, that the principle of funding for research has been immune from departmental spending pressures (although these will inevitably determine the amount of funding available for the Budget). We would strongly urge the continuation of the Science and Research Budget ring-fence in future spending reviews.

Departmental research budgets

18. Spending on R&D by government departments has decreased by 28% overall between 2000–01 and 2007–08 in real terms, and in terms of the proportion of overall R&D in the UK it comprises by 9%.[66] This is particularly concerning given recent emphasis placed on the value of public procurement of research[67] and on the importance of evidence-based policy-making, including by this Committee. Government departments should invest adequately[68] in relevant research. We believe therefore departmental research funding would benefit from a ring-fence to protect it from other funding pressures and to ensure that Government departments are investing suitably in research.

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[63] See http://www.guardian.co.uk/commentisfree/2010/jan/11/universities-face-meltdown-britain-suffer

[64] Science budget allocations have increased by 134% between 200–01 and 2009–10. David Lammy MP, response to parliamentary question; 3 Dec 2009 : Column 989W; http://www.publications.parliament.uk/pa/cm200910/cmhansrd/cm091203/text/91203w0029.htm

[65] Department for Innovation, Universities and Skills. *The Allocations of the Science Budget: 2008–09 to 2010–11,* December 2007.

[66] Department of Business, Innovation and Skills. *SET Statistics.* Table 3.2; updated November 2009; http://www.dius.gov.uk/science/science_funding/set_stats

[67] Lord Sainsbury. *The Race to the Top: A Review of Government's Science and Innovation Politics.* October 2007.

[68] This should include paying the full economic costs of research, as stated in the Research Councils UK/Universities UK report *A Review of the Impact of Full Economic on the HEI Sector* (October 2007).

HEFCE research funding

19. There has been a welcome year-on-year increase in the recurrent research funding provided through the HEFCE block grant, which has increased by over 50% in cash terms between 2000–01 and 2009–10.[69] This significant investment in QR research funding has delivered stability and has helped institutions to continue to improve their research quality and strategic management of research. The many benefits of QR funding are described in a recent HEFCE publication.[70]

20. Whilst ring-fencing HEFCE's research budget may have advantages in providing an additional safeguard for the dual support system of research funding, it may also risk serious adverse knock-on effects on other parts of the budget (for example teaching funding—sustainable teaching funding and maintaining the unit of resource is vital for institutions and we would not want to see ring-fenced research funding at its expense). It is also worth noting that the HEFCE budget, as well as supporting several different activities in universities, is already devolved and managed at arms-length from Government departments so is arguably more secure than departmental budgets.

21. That being said, we emphasise that the maintenance of QR funding is vital for the continued stability and agility of our research base, and for providing the stable, un-hypothecated funding stream that enables universities to invest sustainably and flexibly in research activities and infrastructure. QR is also vital for facilitating strategic investment, supporting emerging areas of research and curiosity-driven research, and underpinning or pump-priming other research grants, including those from business. UCL reiterates its support for QR and for the dual support system.

The Implications and Effects of the Announced STFC Budget Cuts

22. The announced STFC budget cuts are highly problematic for the research community and for universities. The impact on UCL in particular is:

— large rolling grants in Particle & Astrophysics/Space are expected to be cut by at least 15%, which is likely to mean a loss of engineering and support capability, as well as a reduction in post-doctoral opportunities and adverse impacts on smaller responsive-mode grants, especially in astronomy;

— the loss of 1-2 PhD studentships per year, which, whilst financially overall is not greatly significant, is serious for the research groups affected (equivalent to around a 15% cut);

— an expectation that fellowship success rates will reduce by a similar amount pro rata across the College—in particular the abolition of the PDRA fellowship round after proposals were submitted has significantly demoralised talented postdoctoral researchers who in many cases were submitting their first grant application; and

— ongoing doubt over the viability of specific projects (this remains despite UCL's major projects being very highly ranked and demonstrates the adverse impact of the cuts on high-quality research).

23. More generally, there is very little breadth left in the STFC programme areas which means that initiating any new project will be very difficult. UCL and other universities are also encountering increasing difficulties in securing support for talented early/mid-career staff. This is exacerbated by cuts being made to UK research funding at a time when our major competitors are investing heavily in research. The cuts risk causing serious long-term harm to the health of UK research and unquantifiable damage to retention and recruitment of both international students and researchers.

24. Aside from financial difficulties, we would also emphasise that cuts at this point in the funding cycle impact adversely on strategic planning and the balance of the STFC funding portfolio. The abandonment of long-term preparation for potential international projects to be developed in the future will have serious long-term consequences. This highlights the importance of effective forward planning, particularly in the context of tight budgets, in order to maintain the balance of the funding portfolio.

25. UCL is particularly concerned at the STFC cuts given that the difficulties at STFC have been known for two years, and that STFC has overseen a significant transfer of resource from universities to industry and the central labs. Although recently acknowledged, there appears to be a lack of political will in addressing the problems in such a way as to restore the confidence of the academic community The overall impression is of the neglect of this area of science in the UK, compounded by a lack of strategy as to how the UK invests in and exploits facilities (in the UK and internationally). Unless rapidly rectified, this will adversely affect UCL's recruitment and retention of students, postdoctoral researchers, technical staff and academics across a swathe of physical sciences.

[69] See HEFCE *Recurrent Grants* publications, 1999–2009.
[70] HEFCE. Securing world-class research in UK universities: Exploring the impact of block grant funding. November 2009.

The Financial Downturn and Investment in the Research Base

26. UCL wishes to emphasise the absolute importance of continuing to invest in the UK's research base. Our research base remains one of our most successful assets; our leading universities number some genuinely world-class institutions.

27. Research investment should be a long-term strategy which recognises the importance of safeguarding previous investment, rather than allowing our research base to be undermined and risking the loss of our leading global position, as well as necessitating costly remedial investment in the future.

28. It is also important to bear in mind the international context, both with regard to competition (our competitors are adopting strategies of targeting significant funding to develop leading research-led universities which pose constant challenges to the UK's leading position) and collaboration (addressing global problems will require increased collaboration, including to facilitate capacity-building in developing countries). The UK will need to continue to invest sustainably in research-intensive universities to remain at the forefront of research and able to set the agenda on the global research stage.

29. It should also be noted that our leading research intensive universities play a crucial role in the development and maintenance of strategic relationships between the UK and the world's emerging economies and markets such as those in China, India and the oil states. This is due in large part to those responsible for decision-making receiving their education in the west and in UK universities, often at doctoral level—so key decision-makers in key emerging economies are a product of our research base. It is also due to the relationships that exist between many individuals in the research base of emerging economies, whose expertise plays a significant role in informing policy development, and researchers in leading universities. In this sense, the UK's research base underpins not only the new knowledge and technologies on which UK exports depend, but also the human and social networks through which the UK's trading position is maintained. Any cuts in funding for the UK's research base threaten this position.

30. If public funding is reduced, it will be necessary to seek alternative sources from funding elsewhere. Whilst recognising universities' own responsibility for pursuing other funding sources, we also urge the Government to consider what incentives it can offer to business to increase investment in UK R&D (where we lag behind our competitors in any case)[71] and to boost charity research spending.

31. Finally, we wish to reiterate our severe concern at the research funding cuts and to urgently caution against any further cuts implemented as part of a short-term response to the current financial downturn, which will have grave long-term consequences and risk the health of our research base and our economy for many years to come.

January 2010

Annex A

IMPACT OF UCL RESEARCH

UCL's research grant income in the last financial year (August 2008—July 2009) totalled nearly £249 million. Public funding accounts for less than half of this (47%) with the remainder received from industry, charities and overseas—a ration of roughly 1:1 for public: private research funding.

A selection of examples describing the impact of UCL research is given below.

Informing Policy

The Commonwealth Secretariat commissioned six briefing papers on managing the health effects of climate change for the Commonwealth Health Ministers Meeting on Health & Climate Change and the World Health Assembly meeting (which sets priorities for the World Health Organization) in May 2009.

The briefings drew on the report of the UCL-Lancet Commission on Managing the Health Effects of Climate Change, which asserts that climate change is the biggest global-health threat of the 21st century. It was the work of UCL academics from many disciplines across the university—including health, anthropology, geography, engineering, economics, law and philosophy—recognising that addressing problems for global health requires expertise drawn from across range of disciplines, with new ways of integrating ideas.

Breakthrough Discovery of "Magnetricity"

Research led by the London Centre for Nanotechnology (LCN), a joint venture between UCL and Imperial College London, has discovered that a magnetic charge can behave and interact just like an electric charge in some materials.

The research proves the existence of atom-sized 'magnetic charges' that behave and interact just like more familiar electric charges, and demonstrates a perfect symmetry between electricity and magnetism—a phenomenon dubbed 'magnetricity' by the authors of the research. The discovery could lead to a reassessment of current magnetism theories, as well as profound technological advances.

[71] See Campaign for Science and Engineering Policy Report. "Impacts of Investment in the Science and Engineering Research Base" (September 2009).

Improving Health: Pioneering Sight Therapy

UCL research is developing a cell replacement therapy from human embryonic cells which could cure age-related macular degeneration, which affects around a quarter of people over the age of 60 in the UK. The goal is to replace cells essential for "seeing" lost through disease at the back of the eye. The project, led by Professor Pete Coffey, has trialled surgical procedures in a number of patients using the patients' own cells have illustrated that a cell-replacement therapy can work, demonstrating a significant improvement in sight and preventing blindness. The project aims to introduce the therapy into clinics by 2011.

Pfizer has recently made a multi-million pound award to UCL, to advance the development of the stem cell-based therapies and an international collaboration between the Medical Research Council and the Californian Institute for Regenerative Medicine (CIRM) is funding a major £2.4 million study to bring stem cell treatment for AMD to the point of clinical trial.

Evolving Our Culture

A major investigation by UCL historians, led by Professor Catherine Hall, into Britain's debt to slavery, "Legacies of British Slave Ownership", has caused two major UK businesses—Rothschild, the merchant bank, and Freshfields, the City law firm—to become the first to apologise for their historic links with slavery after the study revealed founders of banking dynasties who benefited from slavery.

The research aimed to create the first 'encyclopaedia of British slave owners', with the project building a systematic analysis of the economic, commercial, political, cultural, social and physical legacies of slave ownership. The study sought to highlight the major companies, art collections and institutions that can trace their existence back to colonial slavery in the 19th century.

Creating Wealth

UCL academics who helped to design the rules for the sale of contracts for third generation (3G) mobile phone licences, raised £22.5 billion for the UK government—equivalent to 2.5% of GDP.

Drawing on their research into game theory and the economics of competition, Professor Ken Bilmore and colleagues advised the Government on the design and implementation of the licence auction. All the companies had to bid simultaneously; as the bids increased, each company re-assessed whether they would still make a profit despite the rising costs—so the winning bids came from the best business cases.

The enormous sum raised for the Government contrasts with the sale of the 'second generation' mobile licences, which yielded payments in the region of just £40,000.

Making Our Society Safer

The Jill Dando Institute of Crime Science is pioneering "crime mapping" which considers the inherent geographically quality in crime. For a crime to occur it involves an offender and a suitable target to come together at a location. Understanding the role that this location has and the importance of other geographical factors that result in why a crime happens (eg the neighbourhood characteristics of the area from where an offender comes from) can offer vital clues that contribute to improving how we respond to crime problems and how we catch offenders. These responses could include those specific to policing and partnership approaches to crime reduction, but also to support other area based initiatives such as neighbourhood renewal.

If we can understand more about why certain places act as popular locations where offenders offend (ie crime hotspots), why certain areas breed more offenders than others, and why certain places or people are more vulnerable than others, then we can begin to more effectively get behind why crimes happen, become more intelligent in our policing, and design our operational policing, crime reduction and prevention responses to be more successful.

Memorandum submitted by Alan Wood (FC 51)

1. Science and scientific research benefits the UK economy in three key areas. Firstly scientific advances drive the economy as knowledge is transferred from the research sector to industry. Secondly the research generates a highly skilled workforce who are useful to the UK in many other sectors, for example numerous researchers who were originally trained in ionospheric physics (part of the upper atmosphere of the Earth) went on to work in medical physics whilst others went to work for QinetiQ, BAE or GCHQ. They can perform these useful roles because they acquired the appropriate skills while working in "blue-skies" research. The Royal Astronomical Society can provide full details of careers pursued by researchers trained in astronomy and solar system physics. Thirdly, the inspirational nature of certain areas of research is extremely effective at engaging and enthusing children and young people about STEM subjects. Each of these benefits (economic, skills, outreach) are vital and it would be a serious mistake to emphasise one at the expense of the others.

2. To maintain an active and vibrant research community that can deliver these benefits there is nothing more important than maintaining the grants line. This means maintaining jobs and PhD studentships at the expense of the research infrastructure. The reasoning behind this is perfectly simple. Excellent science can be conducted by good researchers on a tight budget; however excellent infrastructure cannot be exploited without world-class research teams. If world-class researchers lose their jobs in the UK our international competitors WILL employ them. As many of our international competitors offer higher salaries and greater job security it will be difficult, or impossible, to attract researchers back to the UK. This model has been successfully applied in Finland where funding for researchers is prioritised at the expense of the research infrastructure. It is vital to maintain PhD studentships as part of this programme—much of the UK research effort is undertaken by PhD students who advance their field at international level.

3. In these challenging economic conditions the UK should fully exploit its existing investments. The cost of building and deploying these instruments is large compared to the staff costs of exploiting the data.

4. Declaration of interests: I am currently a researcher in a UK Higher Education Institution.

Memorandum submitted by the Institute of Physics (IoP) (FC 52)

The Institute of Physics is a scientific charity devoted to increasing the practice, understanding and application of physics. It has a worldwide membership of over 36,000 and is a leading communicator of physics-related science to all audiences, from specialists through to government and the general public. Its publishing company, IOP Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

The Institute is pleased to submit its views to inform the House of Commons Science and Technology Committee's inquiry, 'The impact of spending cuts on science and scientific research'. The response was prepared with input from the Institute's membership. The attached annex details our response to the questions listed in the call for evidence.

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

Professor Peter Main
Director, Education and Science

The process for deciding where to make cuts in SET spending

1. There are three levels at which the decisions about where to make cuts in SET spend are made:

   — at HM Treasury level, where overall departmental budgets are set, including the total amount available for research;

   — at government departmental level, where R&D budgets and allocations of budgets to the various spending bodies (ie research councils, etc) are set; and

   — at research council and equivalent levels, where the distribution of resources to projects, facilities and grants is made.

2. On the first, it is important that a strong case is made for the Science Budget, and this would be better made if the Minister for Science and Innovation had full control over the Science Budget as a separate submission, rather than being a component of the budget of a much larger department with a wide range of responsibilities.

3. On the second, and in light of the difficulties faced by STFC during the CSR07 allocation process, the RCUK Review of UK Physics recommended that the DGSR would benefit from the advice of an independent advisory group during future CSR allocation processes to ensure there are no unintended consequences of allocations and there is accountability to the scientific community.[72] This recommendation arose as it was considered that the burden and pressure of making such difficult discussions regarding the allocations could be eased with input from the wider scientific community. In the Institute's view, this is unlikely to lead to major changes in the allocation of funds, but we support the recommendation nonetheless which has been accepted as it will help improve the transparency of the arrangements. A number of national bodies, such as the Royal Society, have been selected for this purpose. However, room should also be made available for appropriate representation from learned societies, universities and individual academics. In addition, within departmental R&D budgets, cuts will be made at department and sub-departmental levels. The Institute is of the view that each department should retain its chief scientific advisor on its board to allow greater scrutiny and coordination of these cuts.

[72] RCUK Review of UK Physics; http://www.rcuk.ac.uk/review/physics/default.htm

4. On the third, it is important that unavoidable cuts are made in line with a well-defined science strategy for each research field. There is a tendency evident in the recent STFC prioritisation exercise to look at individual projects, which can distort the overall science strategy. It is noticeable, for example, that the long-term investment in future facilities has been heavily cut, which of course preserves more current research but at the expense of future capability. In addition, it would be desirable if there was more international membership of the peer review and advisory committees.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

5. The Institute has direct evidence of the problems of attempting to quantify the economic impact of research from a historical perspective.

6. The Institute, along with EPSRC, STFC, and the Royal Astronomical Society, commissioned Oxford Economics to conduct a study to demonstrate the economic impact of physics research and to illustrate some of the wider social impacts of physics research.

7. Oxford Economics used a case study approach which selected three topics (ie LCDs, satellite navigation, and MRI scanners) on the basis that UK-based physics research was proven to be critical to the development of the technology, and which benefitted the UK economy. The study focused on demonstrating achieved gross economic benefits to the UK on the basis of empirical evidence and stakeholder consultations, without consideration to the costs of providing that benefit.

8. Some of the immediate limitations of this approach were that the study could only provide an illustration of the potential applications and benefits arising from the underlying physics research; the benefits could not be grossed-up to estimate the impact on the whole of physics research as the topics were not fully representative of the wide range of physics research; the demonstrated benefits would be purely indicative; and the strategic and policy benefits of physics research could not be quantified.

9. From the Institute's experience, estimating the historical impacts of research to the UK, using a predominantly quantitative approach, is a very difficult exercise. The time taken between the completion of research and economic impact takes many years. There are difficulties with identifying and quantifying the full-range of social and public-policy benefits from curiosity-driven research. And even if that could be done, determining the contribution of curiosity-driven physics research is challenging, not least because many new discoveries are made by multi-disciplinary teams of scientists.

10. It is also the very nature of physics research itself that makes demonstrating impact so challenging. Most economic impact assessments will focus on a particular sector of an economy (eg film, space, manufacturing, tourism and retail) that can be clearly defined or classified and then measured, either directly using official statistical sources such as the ONS, or by surveying individuals or businesses.

11. But physics is different. There is no "physics" industry, only "physics-using" industries. And even those physics-using industries may not even realise that curiosity-driven physics research underpins their business. This makes the often-used survey approach to measure economic impact difficult. For example, how many businesses selling flat-screen TVs, or logistics companies using GPS to track their fleet of lorries, would know that their business would either not exist, or would operate in a different way, without curiosity-driven physics research going back over several decades?

12. On the other hand, qualitative approaches are more straightforward, but limited, as they mainly highlight the social impacts of research. Once again, the Institute has direct experience of this. The Institute recently published a series of short case studies,[73] which showcase the vital contribution that curiosity-driven physics research has made to a number of major technological developments, which in turn have led to significant contributions to the UK's economy and/or improved the quality of life of its people.

13. In terms of the allocation of QR, the approaches that HEFCE stated in its recent REF consultation are flawed. For instance, the methods proposed for assessing impact reveal a narrower interpretation of impact to be measured than those described by RCUK, for instance. The challenges posed by time lag and attribution are severe, to the extent that effectively and fairly judging the contribution of a given unit of assessment through the methods proposed is essentially impossible. In addition, there is a danger that the REF will be judging the 'impact' of a discipline rather than the quality of the research within a discipline.

14. On the issue of time lags, research takes time to filter through but it makes no sense at all to be assessing the publications of one set of people and the research impact of another set of people who might have been in the same unit 10–15 years earlier. It would be a logistical nightmare and, what is more, the results would be meaningless as they would bear little relevance to the current situation. Furthermore, the hit and miss nature of research, which has to be seen as a global effort in this respect, will often mean that successful exploitation in the past will be no guide to the future.

15. In addition, there are problems with the HEFCE's idea of providing case studies, which represent a nave view of how research impacts on the environment, particularly research that is not immediately of direct impact to the economy. Usually, there is a body of work, which progresses by collaboration between groups

[73] IOP Case Studies; http://www.iop.org/activity/policy/Publications/Case%20Studies/page_29803.html

and the work enters the knowledge base. Of course, there are major steps forward, but for the most part, it is very difficult to point to a particular research unit that might have responsibility. This will be particularly true for major international collaborations.

16. Overall, the societal impacts of physics research are limitless, and no doubt the same applies to other STEM disciplines. But a major impact that is often overlooked is the production of highly trained workers—people that are trained though curiosity-driven research are able to provide industry the capacity to exploit and build on the results of this broad base of research. Skilled workers are essential both in the industries where this knowledge is applied, and across the UK's economy.

17. In terms of assessing the impact of research looking forward, the Institute is of the view that the current practice of requesting academics to predict the economic impact of their work also has limitations, and could be counterproductive. Serendipitous discovery via curiosity-driven research has led to many technological step-changes that have revolutionised our lives today, for example, MRI scanners, GPS technology, etc. The prediction of the best prospects for future discovery and invention is notoriously difficult, hence it is essential for the UK to support a broad research base on the basis of excellence, rather than attempting to pick winners based on economic impact prediction.

18. The Institute is of the view that the REF is entirely the wrong vehicle for assessing impact and, while the requirement of RCUK grant applicants to consider the impact of their research is fine, it should not lead to an assessment of impact. It would be better if HEFCE and RCUK worked together to assess the impact of research in a coherent manner (ie HEFCE's is about the past and evidence-based to a certain extent, while RCUK's is about the future and based on conjecture) that recognises the difficulties of what is being requested and does not place a burden on researchers to create meaningless documentation.

The differential effect of cuts on demand-led and research institutions

19. No comment.

The implications and effects of the announced STFC budget cuts

20. The latest announcement from STFC following its recent prioritisation exercise translates to a significant cut in funding, in the region of 25–50%, for all areas of STFC science. This includes internationally leading, high-profile research areas in astronomy, astroparticle physics, nuclear physics and particle physics. These cuts will clearly impact on the UK's ability to effectively carry out the best science and maximise the benefit to the country. It also has the effect of causing significant international concern on the part of our close colleagues in the US and in Europe with whom we have close collaboration on major construction projects, hurting UK credibility as a sound international partner.

21. Whilst the Institute supported STFC's efforts to undertake its prioritisation exercise in a framework designed to focus on areas of highest priority, we believe that there has not been sufficient thought given to the overall balance between important research areas and to strategically important research. This is true in all areas over which STFC has stewardship, resulting in effectively no long-term prospects for particle physics and astronomy, no long-term planning for large facilities (eg future light sources) and a planning horizon that is especially bleak for astroparticle physics and nuclear physics. We could write several paragraphs on the implications for each one of these research areas, but will focus on nuclear physics.

22. The recently published EPSRC/STFC report on nuclear physics and nuclear engineering[74] clearly stated that support for UK nuclear physics research is markedly lower than competitor countries, and that: "... further funding cuts could be terminal". STFC's prioritisation exercise has resulted in disproportionately large cuts to nuclear physics. Using STFC's own figures, there will be a reduction of £12 million in nuclear physics funding on a £30 million spend over the next five years, out of a total spend of £2.4 billion over the same period. In addition, only one out of four international nuclear physics projects which the UK is involved in (ie NuSTAR) will continue to be funded.

23. The cuts in nuclear physics amount to a 29% reduction in the current STFC nuclear physics budget. As very little of the nuclear physics budget is spent on equipment, this will lead to a corresponding reduction in the number of nuclear physicists working in UK university physics departments. STFC has justified its lack of strategic stewardship by arguing that cuts in one project will not affect other projects and that if one project survives, nuclear physics research will remain viable. This statement is simplistic and ignores the overall reduction in staffing which will reduce the UK's research in nuclear physics to a level which is insignificant in international terms and which will leave the academic community at a size which lacks critical mass and is too small to engage in significant new applied work.

24. Nuclear physics research is an important area of science, and has the potential for further development. Its contribution to the wider economy is evident in the number of trained scientists it produces. In the past five years, it has produced 109 PhD graduates. Of the 67 who have moved on to using their specific nuclear skills in industry, 24 of these have been employed directly in nuclear power companies and nine in healthcare. A further five scientists with postdoctoral academic experience were hired by the nuclear

[74] Review of nuclear physics and nuclear engineering; http://www.stfc.ac.uk/SciProg/NP/NPEngReview.aspx

industry, and one into healthcare in the same period. With the prospect of a lack of specialist skills required for new nuclear power stations, safety inspectorates and healthcare, full consideration needs to be given to the strategic importance of nuclear physics in a balanced research portfolio.

25. In addition, it should never be thought that industry will be unaffected by cuts to basic research. The benefits of publicly funded basic research to the broader economy, and specifically its central importance to industry have been well documented;[75] the benefits accrue through both the creation of a pool of knowledge, and also through the supply of people trained at the cutting edge of research to enable the national economy to absorb and develop this knowledge. Long-term basic research, such as the science funded by STFC, is an area that private enterprise cannot fund significantly, thus it is incumbent on the government to provide appropriate support. In terms of attracting and retaining R&D intensive companies, the UK must keep pace with European and global competitors and the attractiveness of the R&D "environment" is highly sensitive to damage. As such, in broad terms, within industry, the short-term impacts of STFC's cuts to basic research will be limited, though the UK's international reputation as "the place to do R&D" may well be damaged. However, in the medium- to long- term, it will be both the quality and abilities of graduates/academics and also the decline in local knowledge stock, which may have a substantial detrimental effect on the UK's ability to be a leading R&D nation.

The scope of the STFC review announced on 16 December and currently underway

26. The Institute understands that Lord Drayson's review of STFC will report by the end of February 2010 and will offer some solutions to address the financial and structural tensions that the research council is facing.

27. The Institute has submitted its response to inform the review;[76] the following are the key recommendations:

— Changes in the level of subscriptions to international facilities over which research councils have no control should not impact on the funding available for research. Changes due to exchange rate fluctuations, inflation compensation or movements in GDP or NNI should be fully compensated by central government.

— Responsibility for UK participation in international facilities should lie with the research council which makes predominant use of that facility, and where necessary the subscription should be transferred into its budget. As an illustration, STFC should retain responsibility for CERN and ESO, and EPSRC should take on responsibility for ESRF and ILL.

— Exploitation grants for astronomy, nuclear physics, and particle physics research should reside within the same research council that pays the international subscriptions for these areas, ie STFC. Moving these research areas to EPSRC, for instance, would be undesirable as they are unsuited to EPSRC's current funding mechanisms.

— A national research laboratory should be established on multiple sites to manage the national facilities which are currently within STFC's portfolio, such as the Diamond Light Source, ISIS, the Central Laser Facility and the National Centre for Electron Microscopy and Surface Analysis. These facilities are national assets available for both public and private sector users, and a clear focus is required on optimising their value to the UK.

The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

28. According to RCUK, the science budget is administered by BIS and, at the request of HM Treasury, it is ring-fenced over the period of a CSR, ie it can only be spent on designated areas of scientific R&D and cannot be spent on other areas of the department's remit.

29. However, it wasn't that long ago that the former DTI cut £68 million from the research councils' budgets due to overspend on other areas within the DTI. We are reassured that this was a one-off incident; it is important that the ring-fence is watertight as it provides continuity and confidence in science investment allowing researchers to commit to long-term projects. It is also an outward sign that science holds a central, crucial role within government.

30. A ring-fence around research council budgets is not enough, as there must also be scrutiny of what is regarded as being within this ring-fence. In recent years there have been increases in the ring-fenced science budget, but within this, there have decreases in the funding of curiosity-driven research and increases in targeted programmes/business-facing research.

[75] The Relationship between Public Funded Basic Research and Economic Performance. Report prepared by Science Policy Research Unit, University of Sussex, for HM Treasury, 1996.
[76] IOP recommendations to the review of STFC; http://www.iop.org/News/news_38827.html

31. Within department R&D funding the case is less clear cut, although in a situation that is remarkably similar to the DTI raid mentioned previously, one of the departmental R&D budgets that is currently ring-fenced, ie DH, was recently subject to a £60 million raid.[77] In many government departments, the demands on departmental R&D will necessarily be driven by both short- and long-term government policy, and a ring-fence may not be suitable to keep pace with this. However, it is clear that there needs to be more transparency and scrutiny of R&D spending within both civil departments and MOD. Over the past five years there have been significant cuts in these R&D budgets, cuts which, as they often take place at sub-departmental level, can happen "under the radar". A nominal ring-fencing of departmental R&D may be beneficial in aiding scrutiny of these funding decisions.

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

32. The government has been taking the issue of the supply of STEM graduates seriously, and the Institute has responded to a number of (former DIUS) consultations that have explored issues including future demand, and the use of incentives to universities or employers to encourage more young people to study STEM.[78] In addition, as set out in the next steps document, the number of students studying A-level physics, chemistry and mathematics have increased, although the numbers for physics are still too low. However, we are pleased that DCSF is funding the Institute's *Stimulating Physics Network project,*[79] *which aims to improve the uptake of A-level physics.*

33. However, this effort is being countered by the side-effects of the government's widening participation policy, particularly the 50% target for participation in higher education. Within the last decade, there has been a major expansion of university places; very few of these have been in the STEM area. Physics numbers, for example, have stayed flat over this period, while subjects such as drama and media studies have soared. It is hard to understand a higher education market that is driven solely by the choices of students who have little or no information about career prospects and employers' needs. Therefore, if this market is to be viable, there is an urgent need for the provision of independent, comprehensive information to young people and their families regarding the range of options available to STEM graduates, the quality of such career options, the demand for such graduates by employers and the potential financial rewards.

34. Alternatively, some adjustment of the market, to recognise that some subjects are more important than others, might be appropriate.

35. One of the largest barriers for students wanting to pursue STEM subjects remains the shortage of well-qualified teachers, particularly in physics, where we estimate a net loss of around 250 teachers per year from an already depleted workforce. Targets for recruitment across all sciences are now being met, in line with the next steps document, but the numbers in physics are still too small.

36. The DfES/DCSF/TDA has set up a number of schemes to increase the number of physics specialist teachers. Although some of these do involve attracting physics graduates from other professions, the two principal ones involve providing either a knowledge booster course preceding the PGCE training, the *Physics Enhancement Programme*,[80] or retraining existing biology teachers to teach physics, the *Science Additional Specialism Programme*.[81] The Institute is heavily involved in both these programmes. Such initiatives appear to be the only plausible route to remedying the shortage of physics teachers.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses

37. As far as the Institute is aware, very few physics departments took up the offer, partly because the additional places were not fully funded.

The effect of HEFCE cuts on the "unit of funding" for STEM students

38. It is too early to say what impacts the cuts in HEFCE's budget for 2010–11 will have, but suffice to say that any impact on the unit of resource for teaching will be a concern, especially if HEFCE decides to cut the additional funding for very high-cost subjects of strategic national importance, such as physics.

[77] http://www.telegraph.co.uk/health/healthnews/6647757/Cancer-and-dementia-research-funding-could-be-spent-on-free-social-care-says-Andy-Burnham.html
[78] IOP response to Analysis on Demand for STEM Skills: http://www.iop.org/activity/policy/Consultations/Higher_Education/file_31256.pdf
[79] Stimulating Physics Network; http://www.stimulatingphysics.org/overview.htm
[80] Physics Enhancement Project; http://www.iop.org/activity/education/Teaching_Resources/Teaching%20Advanced%20Physics/page_6013.html
[81] Science Additional Specialism Programme; http://www.iop.org/activity/education/Teacher_Support/sasp/page_33328.html

39. Any cuts to this now recurrent targeted allocation (ie £25 million from 2009–10 following an initial allocation of £75 million from 2007–08 over three years), which compensates for the shortfall in the unit of resource that we identified at around 20% in a detailed financial study,[82] could affect the viability of physics departments (with the potential threat of closure for the smaller ones), many of which, for the first time in over a decade, are breaking even.

Memorandum submitted by the Magnetosphere, Ionosphere and Solar-Terrestrial (MIST) Council on behalf of the MIST science community (FC 53)

On behalf of the Magnetosphere, Ionosphere and Solar-Terrestrial (MIST) council we would like to submit the accompanying memorandum as evidence to the Committee's inquiry into the impact of spending cuts on science and scientific research.

MIST is an informal community of UK-based scientists with interests in physical processes within the Sun-Earth system and other planets. This includes studies of the mesosphere, ionosphere, thermosphere and magnetosphere of Earth and of other planets and the solar wind. The role of MIST is to help promote these interests to the public, wider scientific community and other stakeholders as well as provide a platform for scientists to present their work to the rest of the UK community. MIST is currently represented by a council formed of five elected members.

Although part of the MIST science area has been transferred to NERC following the Wakeham review of physics, the Science and technology Facilities Council (STFC) retained space-based observations of the solar-terrestrial system and solar system space plasma physics. The recent prioritisation has done significant and lasting damage to this important area of science with little regard to the community input. STFC's lack of strategic thinking (they still have no council-wide strategy) is disproportionally harming areas of internationally excellent science. It is far from clear to many in the MIST community that STFC in its current form is a fit custodian of British Science.

Dr Andrew J. Kavanagh
Member of MIST council

MIST council:
Prof Mike Hapgood (chair)
Dr Colin Forsythe
Dr Gabby Provan
Dr Andrew Kavanagh
Prof Betty Lanchester

Executive Summary

1. MIST council would like to address two issues named in the inquiry: the implications and effects of the announced STFC budget cuts and the scope of the STFC review announced on 16 December and currently underway. The budget announcement by STFC in December has its roots in the settlement received by STFC in the 2007 comprehensive spending review (CSR07). Initial cuts imposed by STFC to the grants line and facility operations were insufficient to plug the financial hole. Relief provided by DIUS/BIS prevented the situation from becoming worse by covering the cost of fluctuating exchange rates and providing a loan to help with cash flow but did not address the initial shortfall. The recent budget announcement from STFC is based on an assumption of future flat cash settlements given the current economic outlook.

2. The MIST community appreciates the financial constraints on STFC that have driven this approach, but is deeply concerned about the strategic consequences of these effective cuts for UK research. Implications arise across the whole remit of STFC science funding (astronomy, space, particle and nuclear physics) but MIST has a responsibility to the space-based solar-terrestrial physics and space-plasma physics communities who have been hit hard by the recent cuts. In particular we have grave concerns over the process by which STFC prioritised its science, the lack of strategic planning and implications for future science development. Significant damage to national capability is likely with the UK reduced in stature and its ability to deliver world-class science.

Further Reduction in the Grants Line—Job Losses

3. In 2008 and 2009 STFC imposed a 25% cut on the grants line; the announcement on 16 December 2009 revealed a further 10% cut. This has meant a significant loss of job opportunities for the present generation of UK young scientists and will reduce the number of young people developing advanced skills. The short duration of UK PhD training, compared to most of our economic competitors, means that early research

[82] Study of the finances of physics departments in English universities; http://www.iop.org/activity/policy/Publications/file_21216.pdf.

jobs play a vital role in bringing our young scientists to world-class levels of skills: the UK three-year PhD + four year post-doctoral position provides the same experience as a seven year PhD elsewhere. The severity of the cuts cannot be underestimated.

4. At a recent Astronomy Forum[83] meeting the chair of STFC's Astronomy Grants Panel (AGP) informed[84] the assembled scientists that although in the past rounds they had supported ~90 positions, this year only 75 posts would be available (this is estimated from funding 12 standard and 14 rolling grants). However this number is likely to reduce to 56 posts in the future. The damage caused by such a reduction was highlighted by the AGP chair. This of course has implications for the review announced by Lord Drayson—any move to protect the grants at this new level will be safeguarding a sub-par level of investment. These figures represent purely the impact to astronomy and space (including solar and space plasma physics) and it is likely that similar scenarios exist within particle and nuclear physics.

5. The reduction in funding for university groups will impact heavily on future capabilities. It must be noted that many of the world-class instruments that the UK has produced were developed by university groups supported through the grants lines. Reducing that support will reduce the UK's ability to plan for the future of UK science within the STFC remit. Research is essential in maintaining UK skills and capabilities in specialist areas such as STP (and nuclear physics for example). The presence of active researchers in teaching is important for maintaining and advancing the level of technical content in teaching; it is an important path for innovation. Thus it is essential to support the research within universities as it is a critical part of the skills base; it supplies both people and ideas and drives quality. The programme from STFC appears to consider research as irrelevant to the wider development of the UK skills base and it seems to bear little resemblance to the community input.

Process of Prioritisation

6. Following the previous inquiry into budget allocations, and the subsequent Wakeham review of physics, STFC set up advisory panels to bolster communication with the community. At the same time aspects of MIST science that impacted upon the Earth's environment (and which were ground-based, such as EISCAT) transferred to NERC;[85] STFC retained space based aspects and fundamental space plasma physics (eg Cassini and Cluster). MIST science within STFC fell under the auspice of the Near Universe Advisory Panel (NUAP); following extensive, but hurried, community consultation NUAP (and the other committees) developed a series of fundamental questions forming the basis of a science strategy.[86] NUAP did an excellent job within a constrained timeframe and selected seven highest priority questions with associated instrument/facility rankings required to address them. They also, along with every other panel, asserted that protecting the grants and fellowships was of utmost importance (these, of course, translate into jobs for young scientists who are the backbone of a continuing science programme).

7. The announcement on 16 December 2009 revealed clear conflicts between the prioritisation and the NUAP strategy.[87] Of interest to the MIST community were: the cut to the grants and fellowships (highest priority from NUAP); managed withdrawal from several in-situ space plasma missions (Cluster, Cassini and Venus Express) even though they were identified as high priority for answering three of the 7 strategic questions; in contrast, STFC elected to fund the Aurora program, despite this being ranked as lower-middle priority on a single key question.

8. It appears that although the advisory panels were requested to provide a strategic input to PPAN, PPAN's remits was simply to tension all facilities against each other with no strategic consideration. The exact process will not be known until PPAN release their report following their meeting (this week). MIST contends that a list of facility priorities does not constitute a coherent science strategy. This conflict of approaches must be addressed before further damage is done to the STFC science areas. STFC must use the work of the advisory panels to develop a coherent science strategy which can then inform any future reviews to avoid doing further damage.

9. This issue has been raised at the Astronomy Forum where the chair and CEO of STFC met with senior members of the astronomy community. The chair of NUAP also wrote to the chair of STFC council to highlight the discrepancies and received a response that did little to address the issue.[88] The reason for lack of strategy above the advisory panels is not clear, yet given the impacts on certain areas of science one could be forgiven for thinking it was the intent of STFC to close certain areas of science. If STFC wishes to close down areas of research and of UK leadership, it should be explicit about that a strategic level—and be clear about its wider implications for the UK in terms of impact on the supply of people with advanced skills. Such decisions should not be left to a facility prioritisation exercise.

10. A second weakness of the facility-ranking approach is one that MIST has highlighted in the past; without due consideration for strategy it is the smaller communities that tend to bear the brunt of negative funding decisions. It now becomes clear that past representations were not special pleading. Although the cuts to astronomy and particle physics are severe, nuclear physics has been significantly affected. Many of

[83] http://www.ras.org.uk/images/stories/ras_pdfs/Astronomy_Forum/ASTRONOMY%20FORUM%20Jan%202010.pdf
[84] http://pacrowther.staff.shef.ac.uk/Cruise-15Jan10.pdf
[85] http://www.nerc.ac.uk/press/releases/2009/30-solar.asp
[86] http://www.scitech.ac.uk/resources/pdf/MergedNUAPDraftStrat161109.pdf
[87] http://pacrowther.staff.shef.ac.uk/NUAP15Jan10.pdf
[88] see http://www.mist.ac.uk for email and response at http://www.mist.ac.uk/STFC_response.pdf

the issues raised by that community jibe with similar issues that were aired when STFC decided to cut all funding for ground-based STP instruments (and associated research). The prioritisation represents a failure of process, inclined against smaller communities who may well generate important skills critical for a high-technology society.

Withdrawal from ESA Mission Extensions

11. The current prioritisation calls for major cuts in existing science programmes including "managed withdrawal" from five space science missions in which the UK has key leadership roles (Cassini, Cluster, SOHO, Venus Express and XMM). STFC has also announced that it will cease to fund research based on data from these "lower priority" missions,[89] all of which have publicly accessible archives that will support much new world-class science over the next five years. Each of these missions has recently (October 2009) received an extension from ESA, for which the UK presumably voted; thus the withdrawal sends a message to our colleagues in ESA that the UK is far from a reliable partner further damaging our international reputation. The prioritisation represents a massive hit on the UK science community's ability to operate space missions; a poor initiation for the formation of the new space agency.

Loss of In-situ Space Plasma Missions

12. A specific concern of the MIST community is that the programme of managed withdrawals falls heavily on the study of solar system plasmas—in particular, cutting all missions that makes in-situ plasma measurements (an area of UK international leadership).[90] In-situ study of space plasma forms a significant element of the ESA science programme and forms a part of the payloads of Rosetta and Bepi-Colombo. Similar measurements are planned on several of the ESA Cosmic Vision candidates. Of the four space missions with current UK involvement in the in-situ measurements only Rosetta was funded, and that is about to enter a four year hibernation prior to reaching its target. Thus the decision to withdraw support is undermining an internationally recognised area of UK leadership (see MIST—Appendix1) and influence at a time when future missions will depend on our expertise (and the UK can reap the benefits).

13. The proposed cuts will create a funding gap during which relevant UK capabilities will wither. Technical competence will be lost and the international recognition of our community is endangered as the UK attempts to take lead roles in future initiatives. Of direct economic impact, the UK ability to monitor and, more importantly, characterise space weather hazards (see MIST—Appendix2) will be restricted, just at a time when there is a growing European interest and US programme in this area. It is puzzling that at a time when economic impact is recognised as important STFC not only actively encourage ground-based STP (an area of excellent science as well as potential impact) to move to another research council, it seeks to retain the space based component and then cuts significant parts of it.

The Review of STFC Structural Issues

14. Lord Drasyon's announcement of a review of STFC's structure was welcome indicating recognition that there were flaws within STFC. It is not within the power of Lord Drayson to affect changes to the recent STFC prioritisation without breaching the Haldane principle and so he is right to concentrate on ensuring that future damage to research is minimized. In terms of restructuring STFC and in seeking solutions to the damage to research it is worth quoting from the regulatory Impact Assessment on the creation of a STFC.[91]

15. "there is a risk that funding may be diverted away from grants to support facilities management and that Universities could also be disadvantaged in favour of Government-run facilities as a result. This approach could also lead to the risk of a potential conflict of interest in grant giving for example in the future management of large facilities which are currently operated or managed by CCLRC on behalf of the UK".—paragraph 25.

16. Sadly paragraph 28 is also relevant indicating that we got the worst of both worlds:

17. "To continue with the current arrangements would run the risk that the UK does not fully exploit its investment in large scientific facilities as currently decisions on investment are taken by several different Research Councils without an overall priority-setting process in place".

18. Whatever the review concludes it is far from clear that retaining the current STFC management that has exacerbated the problems should be part of the solution. In the consultation before STFC was formed:[92]

19. ". . . NERC expressed concern that the analysis in favour of Large Facilities Council lacked sufficient supporting evidence. It also considered that a Council whose mission is driven by supporting facilities rather than having a clear scientific mission may find it difficult to maintain a strong relationship between facilities and users".

[89] http://www.scitech.ac.uk/pmc/prel/stfc/CouncilNews161209.aspx
[90] http://pacrowther.staff.shef.ac.uk/Schwartz-15Jan10.pdf
[91] http://www.berr.gov.uk/files/file36094.doc
[92] http://www.dius.gov.uk7/media/publications/F/file34028

Declaration of Interests

Dr Kavanagh is supported on a STFC research grant and uses Cluster data

Dr Provan is supported on a STFC research grant utilising Cassini data

D Forsythe is supported on a STFC research grant utilising Cluster data

Prof Lanchester performs space plasma research using in situ data for modelling and theory

Prof Hapgood works with Cluster and is employed by STFC

Memorandum submitted by the Society for the Study of Artificial Intelligence and Simulation of Behaviour (FC 54)

Nature of this Submission

(i) This submission is by the executive Committee of *The Society for the Study of Artificial Intelligence and Simulation of Behaviour* (SSAISB or AISB), which is the main academic society in the UK for the discipline of Artificial Intelligence (http://www.aisb.org.uk).

(ii) Founded in 1964, the society has an international membership drawn from both academia and industry, and from a wide range of disciplines, such as Philosophy and Psychology, as well as Computing. It is a member of the *European Coordinating Committee for Artificial Intelligence* (ECCAI) (http://www.eccai.org).

(iii) We make references in various places to the HEFCE proposal / consultation document concerning the proposed new *Research Excellence Framework* (REF) at http://www.hefce.ac.uk/pubs/hefce/2009/09_38/09_38.pdf.

(iv) Comments on this submission should go to the main author and society chair, Professor John Barnden.

Executive Summary

1. Some impact measurement may be reasonable in the REF, but it should not insist on academic departments themselves converting their own research results into impact.

2. Two different things should be distinguished and (possibly) assessed:

ability to produce impactful research; and

ability to convert research results (one's own or of others) into impact.

3. Our points on this matter are based not just on what appears to us logical, but also on (a) the pragmatics of assessment, and, most importantly, (b) properly serving the governmental policy aims that impact assessment is intended to serve in the first place.

4. There is a grave need for the HEFCE proposal to be augmented with safeguards concerning conflicts of interest of research "users" such as companies who are involved in impact assessment and who could benefit from particular assessments of impact.

Detailed Comments

5. In the following we put aside grave concerns we have about an excessive amount of weight being given to whether an academic department has already demonstrated the economic/social impact of (some of) its research. By inevitably making departments concentrate on research whose impact can be securely demonstrated in a 10–15 year period, this could constrain research in such a way as to militate in the long term against the very sort of impact that the public would understandably like to see from academia.

6. However, in the rest of this document we assume that impact assessment is in some way to be included in the REF (Research Excellence Framework).

7. We applaud the careful thought that has gone into several aspects of the proposed REF scheme, and especially the avoidance of an expectation that every researcher should be engaged in impact generation.

8. However, the currently proposed scheme is in parts inadequate, confused or counterproductive, for the following reasons.

Confusion of two aspects of impact

9. Paragraph 68 of the HEFCE proposal is exactly wrong in the view encapsulated in the following segment:

> We do not envisage that a unit [eg academic department] could claim credit for impact which was based on research undertaken in the unit but which was exploited or applied through the efforts of others, without a demonstrable contribution by the unit to that exploitation.

This mixes up two things: having the research excellence to be able to generate ideas that turn out to have important and solid impact; and having the ability to convert research ideas (whether one's own or other people's) into impact. It seems to us entirely unjustifiable that the originators of an idea with major impact should fail to get credit just because they have not themselves done the exploitation. This is especially important point in view of contributions academics in the Computer Science area make to open-source software. More generally, the route to market often passes through a chain of academic and industrial researchers.

10. But conversely, we feel that conversion even of others' ideas into impact is worthwhile and should be credited.

11. Thus, the current scheme is doubly unfair and illogical. We strongly urge adoption of a scheme that separately measures both impactfulness— the extent to which a department or other unit's research has led to impact (however, whenever, wherever and by whomever achieved)—and the extent to which the unit is engaged in conversion into impact (wherever the ideas came from and however old they are).

12. This separation would have several pragmatic benefits for the REF assessment process, apart from being fairer and more logical. It would help to some extent with the time-lag problem of deciding how far back the exploited research ideas can go, as this issue would only be relevant to assessing impactfulness (it simply does not matter in the case of conversion how old the ideas are). It would help by encouraging separate sets of rules, criteria and indicators for impactfulness and conversion, rather than mixing them up together.

13. Also, the current mixing-up of the two aspects is potentially dangerous to the very policy that impact assessment is meant to serve. Chasing conversion to impact could inhibit the production of the very sorts of ideas that could have long-lasting, sustainable, revolutionary, . . . impact. Equally, requiring conversion to be based on a unit's own ideas could inhibit the very sort of conversion activity the government would like to encourage.

Who is responsible for conversion?

14. We also wish to draw attention to two matters of general policy where we feel that most discussion about impact, knowledge transfer etc. is naïve, misguided and misdirected.

15. First, whether an attempt at impact succeeds is often dependent on matters beyond the control of researchers or even whole universities, making it invidious to compare different attempts without taking all relevant external factors into account, such as the politics of the day, the general economic climate, volatile technological fashions, etc.

16. Secondly, the impact assessment scheme in the HEFCE proposal falls into the trap that many have fallen into in the past of imagining that it is primarily the responsibility of universities to do conversion into impact. Conversion is at most a responsibility shared with industry and government, and indeed is arguably more the responsibility of the latter two organs.

17. Rather, it is impactfulness, as opposed to conversion, that universities might be expected to provide.

User involvement in impact assessment

18. We are worried by the statement in para 96(c) of the HEFCE proposal that it is mainly user members of panels who would assess impact submissions. Users should certainly be strongly involved, but academics need also to be strongly involved, to ensure that the claimed impact is genuinely founded in research ideas rather than only having a superficial connection to a body of research. It is very easy for someone who is not an academic expert in the discipline to have a wrong idea of the nature or significance of ideas within the discipline. The HEFEC proposal is naïve as to the wisdom and vision of "users".

19. We are also concerned about how problems of users' conflicts of interest will be adequately dealt with, given that users will be allied with particular sectors of the economy, etc. and with particular companies, etc. The REF scheme's careful attention to such ethics-related matters as the panel nomination process and to equality and diversity issues in returned-staff selection needs to be matched by proper safeguards concerning user conflicts of interest when assessing particular departments, projects, etc.

Breadth of impactfulness

20. Paragraph 72 of the Hefce REF proposal says:

> The expert panels will assess the evidence against two criteria for impact:
>
> — their reach (how widely the impacts have been felt); and
>
> — how significant or transformative the impacts have been.
>
> They will also consider how far a submitted unit has successfully achieved impact across the full range of activities and contexts appropriate to its field of activity; it should not be possible to achieve the highest score by concentrating narrowly on only a part of the territory that the unit might have been expected to cover. Through the pilot exercise we will refine these criteria.

We believe that this is wrongheaded in penalizing departments that exert impact only in a "[narrow] part of the territory that the unit might have been expected to cover". The unit could well be able to be much more effective this way than attempting breadth. Surely what is important that the university system as a whole (and not even a particular whole university, let alone a single department) cover the breadth of possible impact, rather than that each department do so. The provision in the paragraph could actually be detrimental to the success of government policy in deriving impact form the university system.

Impact weighting and its uniformity

21. Paragraph 84 fo the HEFCE proposal is wrongheaded in imposing (great) uniformity of weighting of research outputs, impact and environment across different academic areas. The importance of impact (especially) could be radically different across different areas. Decisions on the issue should not be based just on simplicity of assessment.

22. Also, we question why a university's decision to place a department in one area for REF purposes versus another on the basis of weighting differences should be pejoratively labelled as "tactical". If the research in question can validly be assessed in two different areas, then it can validly be subject to different provisions for those areas. Why should the choice not be viewed as universities acting in a responsible, strategic way?

23. As regards the actual weightings proposed, 60% for the actual research outputs seems low for a Research Excellence Framework. We would suggest 70% for research outputs. The remainder should be divided in a discipline-sensitive way between impactfulness, conversion to impact, and research environment, with 10% each as a guide.

Significance component of research-output assessment

24. A further problem in the currently proposed scheme is that the "significance" component in research-output assessment allows for economic/social/. . . impact as well as academic impact/significance. This seems entirely illogical now that there is a separate impact arm of assessment. The impact part of a submission to REF could refer to relevant research outputs. Removing economic/social/. . . impact from research-output significance would also have the pragmatic benefit of easing the task of academics in assessing outputs and would reduce or eliminate the possible need for complex provisions for "users" to be involved in research-output assessment as opposed to impact assessment.

January 2010

Memorandum submitted by BCS Academy of Computing (FC 55)

1. The BCS Academy of Computing is a body in formation, comprising a partnership between the British Computer Society (BCS), the Council of Professors and Heads of Computing in the UK (CPHC), and the UK Computing Research Committee (UKCRC). The Academy will operate as a Learned Society for Computing at all levels within the UK, focusing on Computing Education and Research, and the use and application of Computing Education and Research within UK industry and society. As part of the remit of the Academy, a representative role for the discipline in relation to major public bodies and funding agencies is envisaged, and it is in fulfilment of this role that this response has been produced. Although the Academy is not yet fully operational, a launch event being planned for Easter 2010, it was felt that this inquiry was of such importance that it warranted an Academy response.

Declaration of Interests

2. As identified above, this response represents the interests of those engaged in Computing Education and Research, and in the use and application of Computing Education and Research in UK industry and society.

3. The rest of this document provides specific responses on the majority of the issues raised in the Science & Technology Committee Press Notice ?11 (09-10) dated 13 January 2010.

"The process for deciding where to make cuts in SET spending"

4. We take the view that it would be inappropriate to make any comments on the process, since any level of cuts will damage the sector. In our view, the existing level of funding for Computing is inadequate, having suffered a HEFCE band-cut some years ago, which took funding below the existing cost level for students on Computing courses. A similar cut is currently being proposed by the SFC in Scotland. It also seems inappropriate to cut funding for courses for which extra funds have been applied in the last 6 years in an attempt to increase student numbers, even in a time of economic stringency. If the UK is to compete in the global marketplace for advanced IT products and systems, digital media production and content generation, and next generation technologies, as well as in scientific and computing research, analysis by the Sector Skills Council, e-skills UK and CPHC shows that there is already a shortfall of high-quality graduates with high-level skills. Cutting the unit of resource will diminish the quality of resources and staffing in UK Universities,

with commensurate effects on the quality of research, teaching, and the capabilities of our graduates. This will significantly damage our international reputation, which will inevitably affect our ability to attract high quality students, including those from overseas who provide significant third stream funding for Universities already. In terms of the future wealth creation capability of the UK IT industry, and the international capability and reputation of UK computing research and higher education, maintaining or, if possible, increasing the unit of resource for key subject areas such as Computing should be the goal.

"The differential effect of cuts on demand-led and research institutions"

5. There can be no argument that reductions in funding will impact on the levels of research being undertaken at all types of institution, since cuts will result in reductions in staffing levels and therefore a greater percentage of the remaining staff time being taken up with the core business of teaching. Since the various time allocation surveys carried out at UK Universities over the last decade have all clearly demonstrated that UK research is already significantly funded by the unfunded use of academic staff personal time, this is clearly a finite resource and not one which is readily available to mitigate staff reductions. One clear outcome from the RAE last year was the recognition that world-class research was taking place across the sector in all types of institutions, post-92 as well as pre-92, and in so-called demand-led as well as research-intensive. The RAE results from HEFCE showed that the top 22 research-intensive institutions, which receive approximately 80% of research funding from EPSRC, account for approximately 53% of 4* (outstanding world class) research outputs. The remaining 47% of 4* outputs were produced by the other HEIs, but with only 20% of the overall research funding. These figures suggest it is necessary to take a very careful look at ROI when deciding what model to use when considering the best use of public funds. An immediate outcome of the RAE results was a redistribution of QR funding, which has already resulted in some staff reductions in research-intensive institutions, with a commensurate reduction in research capability. Further funding reductions, especially in the unit of resource, will result in even heavier pressures on staff in all institutions, but may have a disproportionate effect on staff in demand-led institutions, which already have high SSRs, in reducing time and capability within those institutions to continue to produce high quality world leading research outputs. Therefore, it would seem likely that cuts in funding, particularly in unit of resource funding, will not only affect research in all types of institution detrimentally, but are also likely to have a disproportionate effect on the world class quality of UK scientific and computing research. If the outcome of such cuts was to focus research funding onto a smaller number of research-intensive institutions, as would seem likely given the arguments presented, then that would be in direct opposition to UK Government and EU Commission policies for the development of a globally competitive knowledge economy, which requires far higher levels of technical qualification within the workforce. In order to meet the need for many more highly technically qualified personnel, exposure to cutting-edge high quality research, as part of the study programme, has to be available at the majority rather than the minority of HE institutions.

"The implications and effects of the announced STFC budget cuts"

6. Almost all of the major science projects, and the large equipment tools and systems provided and maintained by STFC, have a significant computing element. Whilst this is often seen as support rather than research, in fact a great deal of applied computing research emerges from these "Big Science" projects. However, there are very few direct computing research projects funded by STFC, and therefore, while we would argue for the maintenance of as many projects and as much facility as possible within the STFC budget, we recognise that this is an area of major expenditure which will be subject to significant reduction. Another danger that we perceive in this situation is in UK scientific research reputation and international collaboration. STFC is responsible for the payment of fees, and maintenance of a collaborative presence, at all the major international scientific research facilities worldwide. Budget cuts that reduced this facility would have an immediate impact on the ability of UK researchers to engage in international research networks and utilise international scientific tools, such as the large hadron collider at CERN, and as such our reputation and presence in world scientific and computing research could be seriously impaired. We would therefore argue that the STFC budget cuts, and the current review, should take great care to mitigate any impact on UK membership of the international scientific and computing research community.

"The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets"

7. Computing has not been supported through the STEM initiatives, and does not currently feature in considerations of budget ring-fencing. We would argue strongly that such ring-fencing is necessary, and should be imposed at all levels that are feasible to achieve, and it should be focused on those subject areas that are identified as supporting wealth creation, global competitiveness and international reputation for the UK economy over the next decade, and those areas that are identified as of strategic importance in national planning. We would also argue very strongly that Computing in general, and computing research in particular, is a key subject that should be ring-fenced in any such exercise. Whilst we have seen a greater than 50% decline in undergraduate student numbers in Computing courses over the last decade, we have also seen a significant increase in the percentage of overseas students taking postgraduate taught and research courses in the UK, and they now represent more than 50% of that student population. The implication of this is that

we have been training our own international competition, and unless we continue to invest in and develop our own capability in computing research, and indeed in teaching, then we will be overtaken by a number of developing economies that have invested heavily in obtaining overseas technical qualifications for their own nationals. In terms of the operation of a ring-fence on research budgets, this should be reasonably easy to achieve by applying existing research funding accounting models to QR funding, and thereby seeking returns identifying the application of that funding in strategic subject areas. At a departmental level this may be difficult to monitor effectively, but organisations such as the BCS Academy will be in a position to monitor and provide feedback, separate from HE institutions, to prevent significant abuses.

"Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation"

8. With regard to the question of impact of Government strategy on STEM graduate numbers, our view is that the impact of this strategy over the last 6 years has been to see a small increase in student recruitment numbers on undergraduate courses in Science, Engineering and Mathematics, but since Computing has not been included in any real sense in the STEM initiative, the impact of the strategy on Computing has been negative. During the last six years there has been a significant decline in the number of students applying for and studying Computing, and we take the view that some of this reduction is attributable to the impact of the STEM initiative encouraging students to take Science, Engineering and Mathematics courses. Good support for this argument can be found in the overall decline in students studying Science and Mathematics at A level during this period, which means that the additional STEM support was based on supported courses fishing in a smaller pond of potential students, in competition with unsupported Computing courses. We have made strong representations to Government to argue that Computing should be included in the STEM subjects and able to attract the funding support and national advertising that results from such inclusion, but to-date such support has not been forthcoming, and as a result Computing finds itself in a continued decline.

"Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses"

9. With regard to the additional student numbers funded for STEM subjects in 2009, to date there is limited evidence to suggest that this has had any significant impact on Computing although there is anecdotal evidence of an increase in numbers across the UK. We do, however, have to recognise that this takes place in an environment of credit crunch where a larger than expected number of students have applied to University, with fewer taking gap years or moving direct into paid employment. One clear anomaly of the approach taken is that any institution signing up for ASNs in STEM subjects could strategically move existing student numbers into other subject areas, thereby ensuring that these ASNs were met by STEM students without any significant increase in the actual number of students in STEM subjects. However, the significant issue for Computing is the need to see a continued level of growth in supported student numbers at both undergraduate and postgraduate level over the next five years to, at least, address the decline that we have seen over the last eight years. Without this, the existing identified shortfalls in graduate numbers to support the UK IT industry and the UK knowledge economy will continue to grow, and our global competitiveness and market lead will disappear. ASNs are needed to achieve this, but they need to be carefully targeted, and supported by active recruitment, funding and incentives to encourage students to take Computing courses.

"The effect of HEFCE cuts on the "unit of funding" for STEM students"

10. As indicated earlier, we would view this as an inappropriate and damaging decision for the future competitiveness of both the UK knowledge economy, and UK scientific research. Although Computing has not been treated as a STEM subject over the last six years, in terms of funding initiatives and national incentive schemes and publicity, we have no confidence that this will continue to be the case when the unit of funding is being reduced. Computing has already suffered a band reduction from HEFCE, with the same approach currently being considered by SFC, and the outcome of that reduction in funding has been to reduce resources for students, in terms of state-of-the-art software, hardware, research exposure and staffing. Whilst the costs of home and office computing equipment have reduced significantly in recent years, this does not mean that all computing costs are now at a similar level. The costs for dedicated bespoke hardware and specialist software to support scientific and computing research, micro and nano technology development, digital media production and content development, and next generation technologies, are still expensive. However, students taking technical qualifications in Computing require exposure to these tools and technologies, and cutting-edge research outputs, to develop the skills and knowledge necessary to be able to work effectively in the UK IT industry or in computing research. To be clear, we do not support an argument that funding cuts should be spread equably between subject areas in UK HE Institutions. If the UK Government is not in a position to fund all UK students at current levels, then we would argue that funding should be maintained and, if possible, improved, for those subjects that are identified as contributing directly to UK wealth creation and global competitiveness, and other priority areas identified in national strategy. Whilst UK HE institutions will seek efficiency savings and alternative funding streams,

as they have for the past decade and longer, there is considerable danger in assuming they will be able to mitigate any cuts in national funding. If the UK Government is prepared to give up our current global reputation and competitive position in the IT industry, digital media, next generation technologies, and scientific and computing research, then simply making cuts across the board will achieve this. Non-equable support, in the form of ring-fencing, differential levels of funding, incentive schemes, or other innovative funding schemes, are required to maintain and improve our global reputation and competitiveness.

Memorandum submitted by Oxford University (FC 56)

1. The technological basis of modern economies demands a technically literate population and a research base capable of sustaining innovation. University research and education is a key element of the innovation infrastructure capable of engendering economic growth. The underpinning element is a critical mass of world-class researchers and students that generates new ideas, refines them, and develops them into new paradigms, systems, processes and concepts. Universities therefore play a critical role in supplying the education, training and new knowledge which undergirds and enables social, cultural and economic development that can meet the needs of a modern society. The costs of maintaining world-class education and research are not small but are an investment in the future. In relative terms this investment is not large when compared with other countries or with other expenditure.

Process of Making Cuts

2. A functioning SET base requires stability and critical mass. If this is not present, then it is both unlikely that the ideas that prove to be transformational will be generated, and unlikely that they will be recognised and exploited. The foundation for scientific research must be sufficiently well-resourced to be dynamic, flexible, and collaborative and some significant proportion of the effort must be disinterested.

3. The process of evaluating priorities is therefore vital. It is crucial to defend Science Engineering and Technology, and the argument must be about the other things we wish to live without. However, it is important to recognise that not everything can be afforded, and so the process for deciding on the allocation of scarce resources within SET must be firmly based in sustaining the quality of the science. It may be necessary to recognise the need to re-organise programmes, but it is essential that the Research Councils have the time and space to undertake the decision making process in a measured and consultative way, led by the science, and in full cognisance of the risks. We consider that it is likely to be most effective to invest properly in a small range of activities across a broad range of SET.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from an historical perspective (for QR funding) and looking to the future (for Research Council Grants)

4. QR is essential to research-intensive universities. It provides the platform from which risky, adventurous curiosity-driven innovation can be undertaken and assessed before competitive project bids are made to Research Councils, industry and commerce and charitable research sponsors. We note that QR is already itself awarded in a competitive way at institutional level.

5. QR enables new avenues of enquiry to be explored to assess the potential fruitfulness of pursuing the research through a developed submission for funding. Research Councils provide one, albeit important, component of a research funding portfolio, and allocate resources largely away from non-STEM subjects. Therefore QR not only provides an essential platform upon which excellent research can be built and a wide knowledge base sustained across a broad range of disciplines and inter-disciplines, but also it enables UK government funding to effectively leverage support for particular projects from many other sources. Without this core funding, such an approach would not be possible.

6. At Oxford, QR funding leverages very significant funding from other sources. The Research Councils also have a part to play in working with sponsors to provide the best value for funding research, and improving the economic and social benefits which result. This must entail a strategy on the part of research councils that is responsive to the current economic climate. This point is raised in the discussion on STFC below but it can be applied more generally.

7. In the biomedicine area, this is important in the context of a major transfer of funding by the non-government sponsor of research (the Wellcome Trust) away from response-mode grants to a much smaller number of career awards, thereby exacerbating the current lack of discretionary spending at MRC. We would encourage the MRC to reduce still further their level of commitment to intramural research, in favour of external, response-mode grant funding.

Effects of the STFC budget cuts

8. The process by which the impact of cuts to STFC funding was decided exacerbated the effect on the science. Decisions on cuts appeared to lack sufficient balance between political and scientific priorities, and the result may destabilise important areas of research in the UK. The country risks losing leading scientists, post-doctoral Research Assistants and technical staff, as they lose access to facilities and the ability to partner with the best scientists and facilities.

9. Oxford planning has focused on the very top priorities that STFC has always had: in astrophysics E-ELT, SKA and in particle physics LHC related science. Even these very high priority activities are cut by 10–30% which is most circumstances would be regarded as a severe cut.

10. Beyond 2012 STFC's planning leaves the UK with no access to optical/infrared telescopes in the northern hemisphere. The extensive closure of facilities gives us much less opportunity to pursue our research aspirations through future grant applications.

11. In addition there are extensive cuts in the funding for studentships (to be cut by 15%) and fellowships (to be cut by >25%), together with a cut in the funds available for grants by a further 25% on top of the 25% cut of 2007–8. From 2011–12 the number of PDRAs that can be supported by STFC grants will be half what it was in 2005.

General remarks about STFC's operation and implementation of the cuts

12. There are very substantial differences between the advice from consultation and the actions taken. The advisory committees put studentships/fellowships in the highest priority category because of the importance of sustaining the knowledge base, but these have been cut. They also supported continuing access to northern hemisphere telescopes above the AURORA Mars exploration programme but STFC funded the latter and the telescopes are to be closed. There are other examples.

13. STFC was created with insufficient funds to deliver on its existing programme and commitments. The onset of the financial crisis, with the associated reduction in the international value of sterling compared to the currencies in which international subscriptions are paid, has squeezed the budget even harder. The result is that the UK astronomy programme, without doubt the strongest in the world after the USA (based on citation evidence), has in two years been severely damaged. The bounty of careful investment and planning over three decades has been lost in a few months. The cuts announced in December will turn damage into devastation.

Scope of the STFC Review

14. We welcome the review in both intent and scope. We strongly endorse the continued existence of a number of autonomous research councils with identifiably different areas of research interest, and managed with a comprehensive and cohesive scientific agenda, by persons with expertise appropriate to the area. We believe this provides a diverse and competitive funding landscape that fosters excellence. Continued scientific scrutiny is appropriate to ensure that the UK remains at the forefront of both disciplinary and interdisciplinary research. We do not believe that a monolithic agency, led by a managerial agenda, will sustain the flexibility and creativity required for the UK to continue to be internationally competitive across a broad range of science and technology research.

15. An important lesson may be drawn from the current STFC dilemma, many of which are associated with inadequate support for its mission, and some of which relate to how the Council has managed this severe constraint.

16. There are three contributory factors that have generated STFCs financial problems:

(a) it was established with an inadequate budget;

(b) it is responsible for international subscriptions, the sterling value of which is not in STFC's control:

(i) There are two parts to this problem: exchange rates, which have moved against sterling, and growth in net national income, NNI, on which international subscriptions are based. When the UK economy does well and grows faster than those of other partners in say CERN or ESA, our NNI rises and our subscriptions increase. As the international subscriptions are paid from STFC, when the economy does well, there is less money remaining in STFC for domestic PP and space science.

(ii) STFC inherited facilities, and a large staff, that provide access and services for a research community largely funded by other research councils. If a new international facility is proposed that outperforms one they currently run, should they invest in the new venture or shore up their own facility to avoid running it down?

17. STFC has an inherent lack of flexibility because the resources which are required to run the facilities cannot be adjusted on the same timescale as the cuts are required. The grants become the only adjustable component of their programme, and projects are being run down. They are squeezed by both their international subscriptions and the cost of domestic facilities.

18. There are proposals that.

(a) the exchange rate/NNI risk should be transferred to higher in the system (Treasury,/BIS/RCUK). This makes good sense because at a higher level there are factors that move in both directions as things change eg. as NNI rises VAT receipts, income tax and co-operation tax receipts also rise; and

(b) the research councils that fund the exploitation of facilities (eg.MRC, BBSRC, and EPSCR for Diamond) should be asked to sign up to a 3 + 3 year rolling subscription in line with the (C)SR where they are committed for three years and provide an indicative budget for the following three. This would give STFC a fixed income pot against which to charge the facilities.

19. One suggestion is that project and exploitation grants for PP& A should move to EPSRC. This is not at all desirable:

(a) responsive mode success is much lower in EPSRC (< 10%) cf. STFC (15%);

(b) the timescales involved in big science are very much longer than for EPSRC business. Space missions and accelerators take over a decade to bring to fruition, telescopes about the same; and

(c) it would not make sense to leave the PPA facilities in STFC and remove the grants, they just work too closely together. The PPA community develops and builds its own facilities, it does not simply use tools provided by others.

20. What is the best option for the UK? Probably to fund facilities from user RCs, fix the exchange rate/ NNI problem, and leave the PPA facilities and grants in STFC.

21. What are the risks?

(a) Government accounting rules mean that STFC still has to manage the depreciation of all the facilities through its non-cash allocation. These costs would have to be charged to the user RCs as well.

(b) The new Space Agency might take a large chunk of funding from STFC leaving it again with an inadequate budget. When the Agency is established it should not further damage the Astronomy & Space Science programme in STFC.

Demand-led and Research Institutions

22. Basic science and economic impact are not and should not be mutually exclusive. There are "no such things as applied sciences, only the applications of science".[93] But this is predicated on a research base of sufficient capacity both to generate and to recognise important new ideas.

23. The high investment research industries work close to market and are therefore narrowly focussed, while the Universities complement and extend scientific exploration. They also undertake disinterested research. Both sectors undertake research with economic impact but typically the time lines, the purposes, and the motivation may differ. Losing the ability to support and disseminate basic and disinterested research for short-term expedience would have long term economic impact, and this is what Universities do well. University research also expands knowledge transfer and exchange not only through the economic impact of their research projects but also from the supply of University graduates to all areas of the economy.

24. Bertrand Russell argued "Even the pursuit of knowledge, if it is utilitarian, is not self-sustaining. Utilitarian knowledge needs to be fructified by disinterested investigation, which has no motive beyond the desire to understand the world better. All of the great advances are at first purely theoretical, and are only afterwards found to be capable of practical applications. And even if some splendid theory never has any practical use, it remains of value on its own account: for the understanding of the world is one of the ultimate goods".[94]

25. The transition from fundamental research to economic impact is ably demonstrated by the invention of the laser (the 50th Anniversary of which occurs in 2010) or by the invention of the World Wide Web or the Magnetic Resonance Imager. All of these were first pursued as basic science, with no view to application, and all of which took many years to find their full potential. Now it is hard to understand how one could do without them. Disinterested research therefore holds the key to significant long-term impact. For example, the pharmaceutical companies work on the A and B HIV-1 clades because they are found in the developed world where countries have the funds to buy the drugs, and the companies can recoup the heavy investment quickly. Universities work on the C clade found in Africa, and other genetic variants and this work is funded by the charities. If no-one worked on the C clade then the potential for economic devastation would not be limited to Africa.

26. In the biomedicine area, we note the context of a major transfer of funding by the non-government sponsor of research (The Wellcome Trust) away from response-mode grants to a much smaller number of career awards, thereby exacerbating the current lack of discretionary spending at MRC. There is clearly a tension between intramural and demand-led research funding in such situations that may destabilize the ability to deliver world-class research.

27. Universities provide technologically literate graduates and future research scientists, many of whom will work in commercial and industrial enterprises and some of whom will sustain the research and education in the Higher Education system.

28. For example, this University helps to meet the national need for STEM graduates, 4.9% of the UK's undergraduate places in Physics are provided by University of Oxford, and 3.8% of the places in Chemistry.

[93] Louis Pasteur.
[94] Bertrand Russell, *On Education*, Allen and Unwin, 1926; Routledge, 2010.

29. At graduate level, we have 3,951 postgraduate research students. We make a sizeable contribution in Clinical Medicine (431 students; 6.4% of the UK total); modern languages (14.9% of the UK total); and in STEM subjects we provide 7.4% of the UK's Chemistry research students, 8.8% of Physics research students and 8.8% of Mathematics students. Research and development is at the heart of the knowledge economy, and Oxford's provision of postgraduate research opportunities plays an important role in training future generations of researchers.

Operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for HEFCE research budget and departmental research budgets.

30. BIS ring-fenced the following funding to RCUK for the duration of the current spending round: £2.9 billion 2008–09; £3.0 billion 2009–10; £3.2 billion 2010–11. We welcomed the fact that these funds were guaranteed for sciences, and could not be used by BIS for other purposes, since it offered stability for the Research Councils, notwithstanding the STFC situation. There is as yet no such guarantee for the period beyond 2011, unless we assume the commitments in the 2004–14 framework still hold.

31. There is currently no ring fence for science within HEFCE's QR allocation; we prefer the flexibility this provides. There is a need to recognise the value of research across all subjects, not just those that have impacts which are easy to quantify.

Whether the Government is achieving the objectives it set out in the Science and Innovation Investment Framework 2004–14: next steps

32. The increased funding for research in the past decade has indeed placed the UK in the forefront of international activity in many STEM areas. Because of this, the UK is a place that is attractive to researchers and students from all over the world. It is difficult to assess the direct impact that such attraction has, but it is likely, over the long haul to be very large.

33. Nationally, however, the ambitions to improve STEM skills will only work if there are teachers educated to degree level working in schools.

34. There are dangers in too much concentration of funding in STEM areas. The Arts, Humanities and Social Sciences must not be ignored. Technology may provide new ways to do things but other disciplines provide the social and cultural contexts. For example the BBC iplayer is a highly innovative technology that has had a global impact for the UK. It is, however, useless without high quality content. There is synergy between STEM and non-STEM, many of which provide excellent grounding in logic and analysis, policy and economic development, environmental, industrial and commercial management and innovation, as well as supplying language skills, and the foundation of the media and leisure Industries. Further, increasingly the major challenges for society will have multi-component solutions. Energy security and sustainability, for example, will require research that not only encompasses science and technology, but also policy, economics, and cultural changes. Similar arguments could be made for health care and climate.

Whether the extra student support which the Government announced on 20 July 2009 for 10,000 higher education places delivered students in STEM

35. We have no comment on this point.

The effect of HEFCE cuts on the unit of funding for STEM students

36. The additional funding for High Cost and Vulnerable Subjects has been helpful in supporting students in these subjects. The University has maintained undergraduate numbers in the STEM subjects, and has increased postgraduate numbers. The costs of teaching and laboratory facilities, including equipment are high.

37. It is difficult to comment on the effect of the additional student numbers without knowing whether a shortage of STEM graduates arises from an inadequate supply of university places, an inadequate supply of qualified applicants, or a mismatch of course provision to demand and qualifications of applicants. We note that Government has encouraged STEM graduates into teaching and hope that this has resulted in improved access to university STEM courses.

Memorandum submitted by Cancer Research UK (FC 57)

SUMMARY

A world class science base in the UK is vital to maintaining and enhancing the health and wealth of the nation now and in the future. We want the UK Governments to commit to providing stable and long-term funding for biomedical research. Whilst we recognise cuts may be necessary, there are some areas that must be protected.

The UK is in a unique position in relation to cancer research funding with Government and charities acting as equal partners, each providing roughly 50% of total funding. In the current economic climate we are particularly concerned that the long-term sustainability of cancer research in higher education institutions is protected through the continued provision of Government funding to support charity research. This is important to provide benefits to patients.

Medical research should have an impact—ultimately in terms of benefit to patients and the public. However, we remain cautious about our current ability to assess impact effectively and consistently. Consequently, we would recommend against using a measure of "impact" to help decide where funding cuts should be made.

Cancer Research UK is entirely funded by the public and in 2008/09 we spent £355 million on research, supporting the work of more than 4,500 scientists, doctors and nurses. We are the world's leading charity dedicated to cancer research and the largest independent funder of cancer research in Europe. We fund research into all aspects of cancer from exploratory biology to clinical trials of novel and existing drugs as well as population-based studies and prevention research.

Cancer Research UK welcomes the opportunity to respond to this inquiry.

1. *The process for deciding where to make cuts in SET spending*

In recent years, the UK has benefited from an increase in Government investment in biomedical research though the National Institute for Health Research (NIHR), the Medical Research Council (MRC) and through supportive funding for charity-funded research. In addition to Government funding, private investment and a huge increase in charity funding via Cancer Research UK, the Wellcome Trust and others, has led to more money for research. This has reinvigorated the research effort, made the UK a world leader in research, and led to benefits for the UK including the return of researchers from overseas.

Biomedical research projects generally take in the region of three to seven years to produce a result. The recent cycle of huge spending increases followed by cuts is in danger of destabilising the research effort. We recognise that in the current financial climate cuts may be necessary, but we believe great care must be taken to target cuts so as not to completely unravel progress made in recent years.

It will be vital to protect areas where cuts would be most damaging. This is particularly true for funding provided through government/charity partnerships, where the charity sector is highly unlikely to be able to make up any short fall due to government cuts.

Protecting the unique relationship between government and charity funding for research

The UK is unique in that charity funded research is a major contributor to the strength and impact of the UK science base, especially in medical sectors. Members of the Association of Medical Research Charities provided funding of £935 million for research in 2008–09 alone. This equates to a third of all publicly funded research in the UK. In cancer research, charities contribute as least as much as government to the direct costs of doing research. It is important that there is sufficient support for scientific research funded by charities and conducted in universities. The results of the Research Assessment Exercise announced in December 2009 demonstrated the contribution that charities were making to the quality of research conducted in UK universities. Cancer studies received the top rating for all the scientific and medical-related subjects, with around 80% of the studies being funded by charities, the majority from Cancer Research UK. Medical research charities have been able to fully integrate their work with universities, and the collaborative environment that this has created has realised significant benefits for science in the UK.

Cancer Research UK alone funded £165 million of research in UK universities in 2008–09. Cancer Research UK awards grants to support the direct costs of research in UK universities. These direct costs make up a proportion of the full Economic Costs (fEC) of research. These fEC must also take account of the universities' infrastructure costs, which are funded by the Government. We believe it is the responsibility of Government to cover the infrastructure costs of research in universities so that more of the money generously donated to us by the public can be spent directly on researching cures for cancer. We estimate that a Cancer Research UK award would provide on average 50% of the fEC. By contrast, Research Council grants typically provide 80% of the fEC, with the expectation that this will rise to 100% in future years. As a result, the financial burden to universities of taking on charity awards is greater, and consequently we believe universities are starting to encourage their researchers to apply to other funders.

The Science and Innovation Framework in 2004 included commitments that Government would provide an additional element of QR funding to support charity research in universities in England, known as the Charity Research Support Fund (CRSF). The CRSF is allocated by the Higher Education Funding Council for England (HEFCE) based on research activity in universities.

It was originally indicated that the CRSF in England would reach £270 million by 2010–11, however given the current economic climate it is unlikely that this amount will be reached. In December 2009 the Secretary of State for Business, Innovation and Skills circulated the grant announcement letter to HEFCE for the academic year 2010–11. Among £180 million of efficiency savings, there was a commitment to protect

research funding, which we hope equates to a maintained level of CRSF in line with that of 2009–10. However, we are awaiting a final announcement from HEFCE, due in March 2010. There is no formal commitment to the CRSF beyond 2010–11.

The continued existence of the CRSF and equivalents affects the entire medical research landscape in the UK. Universities and charities alike need to be able to plan their future funding with the secure knowledge that the CRSF and equivalents will continue. A "stop start" approach to CRSF funding would damage to the research base, and could disproportionally affect progress in cancer research. We believe that the Government has a responsibility to maintain university infrastructure, to enable innovative charity research to be funded on a competitive standing. This is essential to the stability of the unique research landscape in the UK.

Continued support for jointly funded institutes

Cancer Research UK is partnering with the Medical Research Council, the Wellcome Trust and University College London to build the UKCMRI. The vision for the UKCMRI is to create a world class research centre that will tackle some of the biggest medical challenges we face. This will be the largest biomedical research centre in Europe. The project aims to find new ways to treat diseases such as cancer, and will bring together the best scientists, doctors and researchers. Bringing together the leading research organisations will allow scientists to collaborate widely as well as share cutting-edge resources and knowledge. Continuing to support the creation of this ground-breaking Institute will be a clear demonstration of the Government's commitment to investment in science—and we were pleased to note the current Government's commitment of £300 million restated by the Chancellor in his pre-budget report. Any reduction in this support could delay or even derail this exciting project. This would seriously limit the scope of our national ambition in biomedical research for decades.

Cancer Research UK and the MRC jointly fund the Gray Institute for Radiation, Oncology and Biology in Oxford (GI-ROB). GI-ROB is leading the way in re-establishing the UK as a world leader in radiotherapy and radiobiology research. It has only recently reached full operating capacity. Any reduction of funding could seriously destabilise this institute.

How cuts might be made

(a) Concentration of funding in fewer institutions

Cancer Research UK has recently opted to concentrate its research funding in up to 17 Cancer Research UK Centres, located throughout the UK. Only locations judged to have a critical mass of cancer research after a lengthy assessment were eligible to apply to become Centres. We view a concentration of funding in particular locations as a reasonable strategy to be explored when considering how to minimise the overall impact of budget cuts. However, there would need to be a robust procedure in place to decide which locations should be targeted for different disciplines within research.

(b) Cutting funding in areas viewed as having lower strategic importance

In 2008 Cancer Research UK published its five year Research Strategy. As part of this we undertook a review of our research portfolio to decide what areas of research were most important to us achieving our goals. As a result of this exercise certain areas of research were viewed as a lower priority for the Charity and a decision was taken to no longer fund in these areas.

This decision was based on a clearly articulated set of goals. By knowing exactly what we wanted our research portfolio to deliver, we could assess what research would be most important in helping us achieve these goals. We also recognised that the areas of research excluded from our portfolio remained vitally important in the fight against cancer. We continue to work to ensure that these areas of research receive support from other funding agencies, and will work in partnership with other funders to sustain this research.

Cutting funding for areas of less strategic importance depends on having clearly articulated goals and a comprehensive strategy. As strategy and priorities can change over time, care must also be taken not to irreparably damage any area of one research.

(c) Cutting funding in areas viewed as having less impact

Cancer Research UK is committed to ensuring that the research we fund ultimately has an impact on the health and well-being of patients and the public. As yet there is no robust way of measuring the potential impact of research. As such Cancer Research UK would not recommend that an assessment of potential future impact is taken into consideration when deciding which areas of research to cut.

(d) Cutting funding across the board

Cancer Research UK believes that this option is the least favourable, and that all other options should be explored before implementing an across the board cut in funding.

2. *Evidence on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

Cancer Research UK is committed to ensuring that the research we fund ultimately has an impact on patients and the public. We are now starting to develop methods to assess the impact of the research we have funded on health.

However the science of impact assessment of research is in its infancy and it will be some time before we will be confident in our methodology. Demonstrating the economic benefits of research is an even tougher endeavour. Whilst it might be said with relative confidence that biomedical research generates economic returns it is not possible to discern the relative economic impact that different types of research might have. This is particularly complex when comparing basic versus applied research.

Whilst progress has been made on assessing the economic impact of completed research, in our experience, accurately assessing the potential impact of research yet to be completed may be an unattainable goal. Impact is not something that can be easily predicted. Trying to articulate potential impact of a research project at the time of grant application will likely therefore be an exercise in guess work. This is further complicated if the course of a research project changes over time in response to results being generated. We would urge caution in the use of impact measures and their influence on decisions about what research does or does not get funded.

Impact assessment and the Research Excellence Framework

Whilst we strongly support the need for a greater understanding of the impact that research can have on the health and wealth of the nation, we believe there are a number of unanswered questions about how the Research Excellence Framework (REF) will attempt to include an assessment of impact. We are concerned about the lack of clarity on the methodology that will be used to assess the differential impact of different types of research (eg basic versus applied). We believe developing this methodology will be a challenging task and will take some time.

We are concerned about the lack of clarity surrounding how impact will be credited. To illustrate this challenge we ask what credit Watson, Crick and Franklin would have been afforded for the invention of DNA fingerprinting made decades after their discovery of the DNA code.

There is a real risk that this development will have unintended and unwelcome consequences. We are concerned that the inclusion of impact could artificially skew the composition of university departments as they recruit researchers from fields viewed to be of higher impact.

Given the huge difficulties in accurately assessing impact, and as this methodology has not been previously tested, we believe that the proposal that a quarter of the weight of the REF assessment be based on impact is too high and should be reviewed.

3. *The differential effect of cuts on demand-led and research institutions*

By their nature research institutes require stable and predictable funding. In a financial squeeze, there is only so much that can be cut from institute core budgets before the institute becomes unviable. Funding for research infrastructure is also a long-term commitment that cannot easily be cut without compromising large numbers of research projects. In a time of budget cuts it is almost inevitable that response mode funding streams experience the greatest pressure in funding. Should investigators find it too difficult to win response mode awards, they may consider moving to other countries with more readily available funding.

We anticipate that any cut in available government funds for research will result in a rise in applications to Cancer Research UK. Whilst we have been able to maintain our research spend through the current economic crisis, we would not be able to meet this increase in demand and the success rates for our applications would fall. We are also concerned that response-mode funding for new awards will suffer disproportionately as funding is tied up in existing long-term commitments.

4. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

We believe that it is crucial that the Higher Education Funding Council for England research budget is protected and remains a strong Government commitment. In particular we want a commitment to the Charity Research Support Fund which is a component of the QR research budget that HEFCE allocates.

We hope you find our comments useful. We would be happy to provide any further information or a representative to give oral evidence as required.

January 2010

Memorandum submitted by the Academy of Medical Sciences (FC 58)

Overview

1. Spending cuts to the science base put our economic recovery at risk by undermining the pipeline to, and workforce of, our research intensive industries. In responding to this consultation from the House of Commons Science and Technology Committee we have drawn on our recent publication: *Reaping the rewards: a vision for UK medical science*, which sets out our priorities for the next Government (please find enclosed).[95] The Academy of Medical Sciences is the independent body in the UK representing the whole spectrum of medical science. Our mission is to ensure better healthcare through the rapid application of research to the practice of medicine. Our response focuses primarily on the medical and biomedical sciences, but many of the points that we make have relevance across other research disciplines.

Protecting the Science Base

2. Cuts to science base funding must be avoided. Our recent report: *Reaping the rewards: a vision for UK medical science* outlines how medical research will create new jobs, catalyse sustained economic growth and help to restore public finances by improving health and making the NHS and public services more cost-effective and productive. Our position is supported by the recent economic analysis of the Life Science Sector, which highlights the value and future potential of this sector and the comparative advantage afforded by the UK's research base.[96]

3. This is not the time to undermine the research base that underpins the economically valuable Life Sciences sector, particularly when analysis commissioned by DIUS in 2009 highlights the challenge that the UK faces in maintaining its international lead in certain fields without the additional investment that meets the growing competition from the technologically specialist research countries such as China, South Korea and Singapore.[97]

4. Medical science is a long-term endeavour. Major reductions in funding will cause significant harm. Areas of research that are cancelled before they can deliver represent wasted investment. Moreover, subsequent loss of staff and expertise mean that projects and research areas cannot easily be resumed if funding subsequently becomes available.

5. Public investment in medical research must be sustained if it is to continue to leverage many times its value in funding from industry and charities. For example, a recent report commissioned by the Alzheimer's Research Trust found that every £1 of public or philanthropic spending on basic research can lead to an increase of £8 in private investment over the following eight years.[98] The same report found that every £1 increase in public spending on medical research stimulates investment of £2 to £5 in research by the pharmaceutical industry.

Valuing the Ring Fence

6. The science budget ring fence is vital for maintaining confidence in the UK's commitment to research both within and outside the UK.

7. We note the Committee's interest in whether a ring fence should be established for departmental R&D budgets. The ring fence around the health research budget has been very successful. Previously, research within the NHS suffered through the diversion of money intended for research and infrastructure support into direct patient care. NHS managers are subject to intense pressures to deliver immediate healthcare targets, and therefore afford a low priority to research. As a result, the NHS has often been perceived by the academic and commercial community to be a challenging and inconsistent research partner.

8. Over the last four years, a number of initiatives have sought to increase the standing of the NHS as a partner in health research. The most significant improvements have resulted from the establishment of the NHS National Institute for Health Research (NIHR) with its ring fenced budget and the associated formation of the Office for the Strategic Coordination of Health Research (OSCHR), which has promoted coordination of the strategies of the MRC and NIHR and driven greater coherence across the spectrum of UK health research.

9. Ring fencing the R&D budgets in other government departments will allow a long term strategy to be developed for the use of this budget to underpin evidence-based policy making. As in all areas of research, in spending departmental R&D budgets, peer review should be used to assess the quality of proposals and evaluate final reports.

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[95] Academy of Medical Sciences (2010). *Reaping the rewards: a vision for UK medical science* http://www.acmedsci.ac.uk/index.php?pid=99&puid=172

[96] BIS (2010). *Life Sciences in the UK—economic analysis and evidence for "Life Sciences 2010: Delivering the Blueprint"*. BIS Economics Paper no.2URN 09/1072 http://www.berr.gov.uk/files/file54303.pdf

[97] DIUS (2009). *International comparative performance of the UK research base*. Report by Evidence for DIUS. http://www.dius.gov.uk/science/science_funding/science_budget//media/publications/I/ICPRUK09v1_4

[98] Alzheimer's Research Trust (2009). *Forward together. Complementarity of public and charitable research with respect to private spending*. http://www.alzheimers-research.org.uk/assets/docs/20090917162138ForwardTogetherSep2009.pdf

Maintaining a Balanced Research Base in the Face of Spending Cuts

10. In medical research it is more helpful to consider an iterative cycle of ideas that should exist between the laboratory, clinical and population sciences, rather than the rather simplistic dichotomy between "basic" and "applied" research. All parts of the cycle need to be properly funded.

11. We are aware of discussions around possible responses to budget cuts which include reducing funding to all areas of research and institutions ("sharing the pain"), or focusing limited funding on research areas judged to be of highest priority or institutions regarded as the most productive. Strategies that follow either course must address the associated risks. Spreading cuts equally risks suboptimal funding in all areas of research, while focusing cuts on a small number of areas or institutions risks undermining the pinnacles of excellence that exist outside the favoured institutions or research fields.

12. The UK needs to maintain a balance between responsive mode and priorities-led research. Society-at-large expresses its priorities though support for the medical charities, which then take the lead in pursuing those research goals. However, important areas of clinical need (eg mental health, respiratory medicine, diseases of the digestive system, urinary incontinence) receive very little charity money. Such areas must be considered carefully by government funding agencies.

13. Too much emphasis on priorities-led research brings the danger of sequestering money away from more readily soluble research problems. For example a pressing medical need may not be soluble at a given time with the given state of knowledge and technology. Top-down identification of priorities must be informed by knowledge of scientific tractability, and accompanied by solicitation of innovative and challenging ideas from the scientists and dialogue with the wider stakeholder community. The UK's history of supporting responsive mode research over the long-term has generated considerable, though often unanticipated, health and economic rewards.

Safeguarding the Next Generation

14. We are concerned by the recent announcement of the £398 million cut to the budget of the Higher Education Funding Council for England (HEFCE) that will impact on the funding of teaching in English universities.[99] There is a virtuous circle between teaching and research that generates new knowledge and brings health and economic benefits. Not only is the quality of tomorrow's research dependent on the quality of today's teaching but today's researchers benefit from the insights that come from teaching students—particularly about new or unfamiliar areas. Cuts to teaching therefore threaten current and future generations of researchers.

15. The UK's reputation for research-led teaching attracts students from across the globe. However, even before the recent HEFCE cuts, the Academy had become concerned that this reputation is being eroded. The report of the Academy's working group on the role of teaching in academic careers will be published in the Spring and will make recommendations to redress the balance between teaching and research.[100]

16. We are particularly concerned that reducing the number of PhD students may be seen as an "easy option" in response to expected cuts in Research Council budgets. This risks producing a gap in trained researchers who will be available in the future when funding is increased. The UK's international share of PhD students in the natural sciences is falling (although those in the medical sciences have increased slightly) and the ratio of UK researchers to total population has declined while that of our competitors has risen.[101, 102]

Measuring Impact

17. Medical research produces a wide range of socio-economic benefits, but systematic evaluation of research outcomes is difficult and both national and international research funders continue to grapple with the methodological and organisational challenges involved. Such evaluation must take account of: the international nature of the research enterprise; the value of negative research findings; non-incremental developments in knowledge; the importance of blue-skies research; and the long interval between scientific advance and tangible clinical and/or commercial benefit.

18. A 2008 report commissioned by the Academy of Medical Sciences, Wellcome Trust and MRC demonstrated some of the ways in which impact can be quantified.[103] It showed for example that every £1.00 invested in public or charitable research into cardiovascular diseases in the UK between 1975 and 1992 produced a stream of health and economic benefits equivalent to earning £0.39 per year in perpetuity.

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[99] Mandelson P (2009) *Higher education funding 2010–11*. http://www.hefce.ac.uk/news/hefce/2009/grant1011/letter.htm

[100] For further details about this study please see: http://www.acmedsci.ac.uk/p47prid59.html

[101] DIUS (2009). *International comparative performance of the UK research base*. Report by Evidence for DIUS. http://www.dius.gov.uk/science/science_funding/science_budget//media/publications/I/ICPRUK09v1_4

[102] BIS (2010). *Life Sciences in the UK—economic analysis and evidence for "Life Sciences 2010: Delivering the Blueprint"*. BIS Economics Paper no 2 URN 09/1072 http://www.berr.gov.uk/files/file54303.pdf

[103] Health Economics Research Group, Office of Health Economics, RAND Europe (2008). *Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK*. London: UK Evaluation Forum. http://www.acmedsci.ac.uk/p99puid137.html

19. In terms of evaluating the impact of past research we have expressed some reservations about the proposals by HEFCE to include a measure of impact in its new Research Excellence Framework (REF).[104]

20. Time lags: measuring impacts over 10–15 years may not be long enough. For example it can take up to 17 years to see the impacts of cardiovascular disease research.[105]

21. Attribution: impacts usually emerge from several pieces of work, so cannot easily be attributed to only one or two departments, particularly for in the case of researchers that were involved in the earliest stages of research.

22. Weighting of Impact: as this is a new, as yet untested area, it may be prudent to attribute a lower weighting to impact in REF.

23. We support efforts to encourage researchers to think about the potential impact of their research when developing their grant proposals, both to maximise the value of this public investment and because such consideration can lead them to consider different approaches and possible collaborations. Much biomedical research involves the use of animal or human subjects and is already subject to an additional level of review that assesses whether the expected impact of the work justifies the use of animal or human subjects. Consideration of direct or indirect economic impact must not prevent excellent, speculative research proposals being supported in response mode funding. Some targeted funded programmes will have a specific impact in mind. In these cases it is important that peer reviewers and peer review panels are competent to assess them.

The Academy of Medical Sciences

The Academy of Medical Sciences promotes advances in medical science and campaigns to ensure these are converted into healthcare benefits for society. Our Fellows are the UK's leading medical scientists from hospitals and general practice, academia, industry and the public service.

The Academy seeks to play a pivotal role in determining the future of medical science in the UK, and the benefits that society will enjoy in years to come. We champion the UK's strengths in medical science, promote careers and capacity building, encourage the implementation of new ideas and solutions—often through novel partnerships—and help to remove barriers to progress.

January 2010

Memorandum submitted by the Motor Neurone Disease Association (FC 59)

1. Introduction

1.1 Few conditions are as devastating as Motor Neurone Disease (MND). In the majority of cases it is rapidly progressive, always fatal and kills five people every day in the UK. It leaves people locked into a failing body, unable to move, speak or eat normally. The intellect and senses usually remain unaffected. There are around 5,000 people living with MND in the UK. Half of people with the disease die within 14 months of diagnosis. There is no effective treatment, and there is no cure.

1.2 The MND Association (registered charity number 294354) is the only national organisation supporting people affected by MND in England, Wales and Northern Ireland, with approximately 90 volunteer-led branches and 3,000 volunteers. The MND Association's vision is of a World Free of MND. Until that time we will do everything we can to enable everyone with MND to receive the best care, achieve the highest quality of life possible and to die with dignity.

1.3 One mission of the MND Association is to promote research into the causes of MND and effective treatments for the disease. The Association spends a higher proportion of its research funding budget on MND than any other organisation in the United Kingdom. Research funded by the MND Association is classified as follows:

- to identify the causes of MND;
- to create and validate new disease models;
- to identify disease markers (bio-markers);
- to develop and expert workforce;
- to improve clinical research and care management;
- to facilitate information flow with leading research centres around the world; and
- to strengthen our partnership and influencing activities.

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[104] Academy of Medical Sciences (2009). Response to the Higher Education Funding Council for England's consultation: the Research Excellence Framework http://www.acmedsci.ac.uk/p100puid170.html

[105] Health Economics Research Group, Office of Health Economics, RAND Europe (2008). *Medical Research: What's it worth? Estimating the economic benefits from medical research in the UK*. London: UK Evaluation Forum. http://www.acmedsci.ac.uk/p99puid137.html

1.4 The MND Association encourages a multidisciplinary approach to research to:

— stimulate innovation;

— attract and support promising young scientists;

— draw in established researchers working in related fields; and

— assist researchers in accessing large-scale sources of funding.

2. Declaration of Interests

2.1 The MND Association currently funds four research awards (three clinical fellowships and one joint project grant) in partnership with the Medical Research Council. These awards support clinicians wishing to pursue scientific research and aim to strengthen the links between laboratory and clinic.

3. The Impact of Set Spending Cuts on MND

3.1 The MND Association does not feel it is in a position to respond to all issues outlined in the call for evidence. This response will focus on the implications and effects of SET spending cuts on people living with MND.

3.2 The continued funding of innovative, world-class research is imperative in the fight against MND.

3.3 It is estimated that the maximum direct costs to the health and social services for a person with MND is approximately £200,000 annually, and represents a maximum cost to health and social services in UK of £373 million a year in addition to indirect costs to the economy of approximately £1.1 billion.

3.4 The UK is currently at the forefront of clinical research into MND, providing clear benefits for patients, however this position is generally perceived to be under threat as funding resources decrease and other diseases, such as cancer, are prioritised over rarer conditions like MND.

3.5 Basic scientific research, which may be incorrectly regarded as lacking a value-for-money element, is key to ensuring continued advances into MND research. The MND Association is seeking to develop a translation research pipeline to transfer emerging knowledge from the lab to the clinic. A translational pipeline cannot be established without the continued emergence of new knowledge and ideas. There is currently insufficient funding to pursue translational opportunities that arise from basic research. Any further cuts on SET spending will result in additional missed opportunities and could hamper future breakthroughs in identifying the cause and possible treatments for MND.

3.6 Continued funding cuts could result in researchers leaving the United Kingdom to pursue their research in other territories where SET funding is less restricted. Likewise, it may be increasingly difficult for research centres in the United Kingdom to recruit talented researchers. This situation would result in the eroding of the United Kingdom's position at the forefront of scientific and clinical research.

3.7 The MND Association is currently funds more MND research projects than any other organisation in the United Kingdom. As a charity, the MND Association is unable to meet the funding needs for MND research using its own resources. This will be especially true if the Association is required to meet funding shortfalls caused by a decrease in SET spending. Continued and sustainable government funding is imperative to find the cause and a cure for MND.

4. Recommendations

4.1 The MND Association urges the Select Committee to consider the detrimental impact of SET spending cuts on MND research. The field of MND research is moving at a faster pace than ever before. However, there is currently insufficient funding to ensure continuing and sustainable world-class research into the cause, cure and clinical treatments for MND. Further cuts in SET spending would hamper future research breakthroughs for this devastating disease at a time when more advances than ever are being made.

4.2 Any proposed changes to SET research funding must balance perceived cost-effectiveness with real-terms value to the United Kingdom's economy. This should include consideration of the significant social and economic costs to the National Health Service and other statutory services incurred on behalf of people living with MND, as well as the economic benefit from the United Kingdom remaining an international centre of excellence in MND research.

January 2010

Memorandum submitted by William Gelletly (FC 60)

Declaration of Interest

I am an emeritus professor of Physics at the University of Surrey. My main research interests are in Nuclear and Atomic physics. I am a member of the Board of the Health Protection Agency and also have a strong interest in Health matters, particularly the effects of radiation, chemicals and environmental change. I was a member of the Physics unit of assessment panel at the last RAE.

The process for deciding where to make cuts in SET spending

It is hard to comment on how high level decisions are made since the discussions and process at BIS and Treasury levels are opaque.

At operational level the normal process of peer review by independent reviewers and experts is acceptable although not perfect. The recent process carried out by STFC is completely unacceptable. Here they pretended to have peer review but the reality is that the members of PPAN and the Science Board were all compromised because they had a vested interest in the outcome. Their personal areas of research interest were all under threat. Not surprisingly the outcome was that the cuts were inversely proportional to the number of committee members working in each general area. Unless peer review is carried out by independent experts it cannot lead to sound judgements. This particular process was completely flawed. It was also a process that took no account of national needs or priorities.

STFC's problems stem from its failure to persuade Government of the importance of its portfolio in the 2007 CSR. The idea of an independent advisory group helping the DGSR in future reviews to minimise unexpected consequences seems a sound and sensible one. The members should not just be drawn from the *Great and the Good* but should include people who are known for their independence of view.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective and looking to the future

We are perhaps not best placed to answer this question. However one of us is a member of IOP's Science Board and we are well aware of the Institute's attempts, with others, to try to quantify the economic impact of a number of science discoveries/developments made in the UK. It turns out to be very difficult to do this in any sensible way.

We accept that the taxpayers who fund public research in the UK. should be informed of the outcome not just in terms of the contribution to our understanding of the natural world but also how it improves the economic health and well-being of the country. HEFCE proposes to make Impact a major component of the next RAE exercise with a weighting of 25%. It seems to us that this will do all of us a disservice. Because of the long time delays before the real IMPACT of any piece of research can be observed and assessed the fact that those who did the research may be long gone at the time of assessment then the exercise will be both very uncertain and difficult. The assessment will have little or nothing to do with the research quality of the current department concerned. If HEFCE intends to embark on this route then they should scale back on the weighting to 10–15% until they can establish a methodology which will be trusted by both funders and academics. The present proposals to demand case studies as evidence of Impact will also lead to an entire "creative" industry in Universities for presenting these case studies and absorb a great deal of effort and resource. In its presently proposed form it is unlikely to contribute to determining the current research quality of any department.

The differential effect of cuts on demand led and research institutions

No comment.

The implications and effects of the announced STFC budget cuts

The final effects of the STFC budget cuts are hard to foresee but they are extremely unlikely to be beneficial. However one can say immediately that they have already greatly damaged the reputation of UK science in terms of the reliability of UK research groups and individuals as collaborators. Since particle physics, astronomy and nuclear physics all have long timescales and it takes large collaborations to build facilities and detectors the continuing crisis in STFC funding is very damaging. Equally harmful are the cuts in studentships and fellowships. Here the lifeblood of the subject is not cut off completely but is throttled. A whole cohort of bright and eager young people will be cut off in one fell swoop. Some will be cut off from funding, others will emigrate to more enlightened and welcoming climes. This is true in all of STFC client areas but it is acutely so in nuclear physics. The subject has been neglected and chronically underfunded in the U.K. compared with our competitors in Germany, France, Italy, Japan and the U.S.A for a long time. The cut of roughly 40% since 2006–07 has exacerbated the difference.

None of this would matter if nuclear physics was not an important area of science with numerous applications in areas such as energy, healthcare, national security and defence. In the cuts made by STFC there seems to have been little or no consideration of the balance between important research and equally important considerations related to the training of skilled manpower and strategically important research. In particular in the case of nuclear physics it was noted in the recent EPSRC/STFC report on nuclear physics and engineering that support for nuclear physics research is markedly lower than in competitor countries, and that "—further funding cuts could be terminal". It is perhaps never wise to take the most gloomy view of any situation but certainly STFC's recent exercise means that they intend to spend only £12 million pounds out of £2,400 million on nuclear physics over the next five years. This will hardly provide an incentive to Vice-Chancellors to hire nuclear physicists or attract young people to the subject. The result will be a considerable erosion in our ability to help train the skilled people needed at M.Sc. and Ph.D. level that the UK needs. STFC appears to think that as long as there are some physicists of any kind such teaching will not suffer. However there is ample evidence that having non-specialists teach subjects in school leads to a

decline in the popularity of the subject and the quality of the teaching. If we intend to build new nuclear power stations and be intelligent customers for the foreign suppliers this seems a very short-sighted decision. STFC may well say that energy lies in the EPSRC domain. This is a prime example of passing the buck. If STFC wish to show that the research is relevant they should be working hard to help EPSRC sponsor the training and applications of nuclear physics. As outsiders we feel often that protecting their baronies is more important than collaboration for the benefit of UK plc. RCUK should be looking hard at how to make all such boundaries transparent and invisible to researchers.

Although nuclear physics has had a very small footprint in the UK in recent times it has certainly been highly regarded in all recent reviews of UK physics. It will be hard to sustain that excellence. It is always easy to destroy a community and hard to restore it to health. STFC stewardship does not seem to stretch to such considerations.

The scope of the STFC review announced on 16 December and currently underway

Yet again vital decisions are to be made without any of us really knowing anything other than is in the press announcements that he wishes to do something about the negative effects of tensioning between facilities and research grants.

International subscriptions should be fully compensated by the Treasury. It is a nonsense to have fluctuations in exchange rate, which are completely out of the control of RCUK, to fall on the research councils.

Research grants to exploit facilities should lie with the council that pays the subscriptions. Thus particle physics grants should lie within whatever is left of STFC after Lord Drayson's exercise and ISIS should lie within EPSRC. For nuclear physics the priority would be to join FAIR, which will be a Mecca for nuclear physicist over the next 20–25 years.

The operation and definition of the science budget ring fence, and consideration of whether there should be a similar ring fence for the HEFCE research budget and departmental research budgets

It has been stated that there is a ring fence around the science budget within BIS but it has already been breached when in the former DTI. The science community will have little confidence in such statements unless they are somehow given greater emphasis. This is again vitally important for subjects with long timescales which need commitment and continuity over long timescales. If the government is serious about science being important for our future economic health then a similar ring fence should certainly apply within HEFCE. Without such a strategic decision the great efforts to stop the decline in student numbers in physical sciences will have been wasted. Vice-Chancellors are in general hard-nosed about their finances. If the money lies in sports science or some other area and not in physics or engineering then they will promote the former and not worry about the decline in the latter unless they are getting a strong steer that these subjects are important and a strong steer means resource and a commitment over the long term.

Whether the extra student support delivered students in STEM courses

Very few universities took it up because it was only partly funded.

The effect of HEFCE cuts on the unit of funding for STEM students

It is too early to say but the finances of physics departments are fragile so any cut in the unit of funding is likely to induce universities to cut staff in STEM areas, especially when STFC makes large cuts in research funding as well. This may lead to closure of some small departments and shrinkage of others with the result that they will be less efficient. Since teaching must be carried out by a reduced number of people it is likely to lead to a loss of overall research potential in critical subjects and may also affect the quality of the teaching.

Memorandum submitted by the University of Leicester (FC 61)

Submitted by Professors K C Lee (PVC Research and Enterprise) and M A Barstow (PVC, Head of the College of Science and Engineering) on behalf of the University of Leicester

The process for deciding where to make cuts in SET spending

At the moment it is not clear that there is any process. While the cuts to HEFCE budgets have been announced in the secretary of state's letter to HEFCE, how these will translate into reductions in grants to University remain unclear. Furthermore, the level of "protection" that might be afforded to SET subjects is unknown.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

In general, there is a long time separation, often decades, between the original scientific research and eventual exploitation and economic impact. Often particular economic benefits may result from a combination of discoveries that could not be forseen at the outset of the research. Therefore, it is hard to make a strong connection between specific expenditure on research and benefit to the economy. Individual case studies are useful for illustrating how exploitation can be pursued effectively. However several attempts to assess the overall impact of research (or individual disciplines) never seem to provide useful answers for relating total research spend and its distribution across subjects to economic impact.

The differential effect of cuts on demand-led and research institutions

Although potential cuts have been signalled where these are likely to fall is not yet known, with the exception of STFC (discussed below). Therefore, it is not possible to comment in detail on this question. However, there are a number of warning signals in terms of the balance between funding of "blue skies" research and research where the potential economic impact may be more evident. There is a danger that funding for the former will diminish. It could be argued that, in the current financial climate, a short term reduction in "blue skies" would not be damaging, but this is not true. Current research capabilities have been established over decades, with strong stimulus during the past 10–12 years. Proposed funding cuts will lead to rapid loss of expertise and capability, through redundancies and closure of facilities. It is clear from the experience of the 1980s and early 1990s that recovery from such a policy takes a long time. In particular, the fact that some countries are putting more money into science as a fiscal stimulus will lead to a drain of talent from the UK.

The implications and effects of the announced STFC budget cuts

The STFC budget cuts are the most immediate example of the risks outlined above. The STFC was created without sufficient funds to cover the programme it inherited and the situation has been made worse by a difficult CSR outcome for the Council and the financial pressures of the economic downturn (mainly the exchange rate effects on the large subscriptions, but also the inability to provide extra funds to solve the problems). The recent programmatic review, while not perfect, was carried out in a more consultative and effective way than previous attempts to balance the budget. Nevertheless, it was carried out without a clear, published science strategy and the effect is a transfer of funds from the particle physics, astronomy, space and nuclear physics areas into the support for facilities such as Diamond and ISIS. While the rationale, to fully exploit these large national facilities is a valid one, it does mean, conversely that the UK is not reaping the full reward from its international investments as it withdraws from telescopes, space projects and particle/nuclear physics experiments.

One of the most damaging effects of the STFC cuts will be in the severe reduction of the science exploitation grants to Universities. How the cuts will be distributed will be a result of peer review of individual programmes, to be announced later. However, it is clear that smaller research groups may fall below the critical mass needed to function. STFC supports around half of the research carried out in UK physics departments. Therefore, it is inevitable that overall physics departmental finances will be damaged by the cuts and some may no longer be viable. The reduction in exploitation funding will lead to those areas of science within STFC's portfolio where we are competitive with the USA or ranked second, losing that competitiveness and position, thereby downgrading the international profile of the UK. This will exacerbate our ability to compete with our European partners in ESA.

This also puts at risk the government's goals for increasing student numbers in physics and STEM subjects in general. There is already anecdotal evidence that A level students are starting to avoid disciplines which are related to STFC. This will have consequences for these areas of science in the short, medium and long term, if something is not done to change the view.

The scope of the STFC review announced on 16 December and currently underway

It is hard to find exactly what the terms of reference of the review are. However, there are clearly some areas that need to be considered in any review process:

> The impact of currency fluctuations on subscriptions (ESA, ESO, CERN etc): The science budget would be better protected if these were dealt with, as in other countries, outside the science budget as part of high level international commitments. However, it should be noted that any change now would "freeze" into the STFC budget the current lower level of cash available for grants. Any change should take into account what has happened to exchange rates since the financial crisis began and build in some budgetary compensation for this.
>
> The balance between facilities operation and exploitation grants: At the moment the facilities operation costs are dealt with by STFC on behalf of all the research councils. Like the subscriptions, these costs are not entirely within the control of STFC and as they increase the apply pressure to the only remaining flexibility; the science grants. Any new structure needs to prevent the continual reduction in the science grants line, which has a damaging effect on Universities and the supply of young scientists into the economy.

The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

All areas of research will be undermined by the proposed cuts to HEFCE. Many subjects outside STEM are economically and culturally important, so it is very difficult to argue for protection of STEM subjects within the HEFCE budget at the expense of these. Nevertheless, if STEM provision is not protected in some way, this will add to the difficulties of STEM departments as income from the research councils seems bound to fall. Ideally, the government should reconsider its rationale for targeting higher education for cuts while protecting schools. The production of graduates is a strong driver of the economy, so if the HE system is undermined there will be significant economic damage.

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004-2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

Until spring 2009, considerable progress had been made towards meeting the objectives of the 2004–14 framework. However, the imposition of the cap on all student places also limited the number of STEM students that could be accommodated without incurring fines. Therefore, in individual subjects the intake of home/EU STEM students either remained static or declined. Therefore, no further progress towards government objectives was achieved. Furthermore, this effective limit on the number of STEM places risks discouraging students from pursuing STEM subjects at A-level and could undermine the genuine progress that has been made in increasing A-level numbers in the physical sciences.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses

No! STEM subjects are expensive to teach and all these places were unfunded. Therefore, this University did not have the capacity to accept any of these additional places.

The effect of HEFCE cuts on the "unit of funding" for STEM students

Had we accepted any of the additional student numbers, this would have been a de facto acceptance of a lower unit of resource. However, it could be argued that the STEM unit of resource is already too low. Even under recent funding levels it has been difficult to invest appropriately in important facilities and support that underpin teaching programmes. Therefore, any proposed cut to the unit of resources would make this situation worse and might prevent delivery of all or parts of some science programmes. Some of the consequences may be:

> Larger class sizes as a result of a poorer staff/student ratio will make certain types of lab work which requires intensive supervision or specialist small lab facilities near impossible or at least very costly to teach. This may lead to an unintended effect on the STEM curricula.
>
> In field based disciplines such as Geology and Geography, a poorer staff/student ratio and a loss of resource may impact on the number and quality of field courses that are currently on offer, due to shortages in staff who could supervise the students abroad, leading to a narrower learning experience.

M A Barstow

January 2010

Memorandum submitted by Loughborough University (FC 63)

1. *The process for deciding where to make cuts in SET spending*

Making cuts in Science, Engineering and Technology (SET) spending when we are in a competitive global market hopefully out of recession is probably not a good policy. The case for the return on investment in SET can be made to demonstrate it as a mechanism for aiding economic recovery. If cuts have to be made then the obvious answer is that it has to be done strategically with a particular view to the scientific base we will need in the longer term. An urgent discussion of strategy is therefore required.

2. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

We should not underestimate the economic contribution, and the impact the UK has, in training the next generation of researchers world wide. Research in SET is an integral part of economic development where new initiatives and a knowledge economy are essential for success. There is much evidence through case studies that SET research has had direct economic and other impact. The EPSRC and others have provided examples of this. As well as the inherent contribution as described, evidence from case studies can provide

an estimate of economic impact. This is a complex question however. For a more profound understanding the issue would have to be investigated in more detail. The current pilot study of impact assessment being conducted by HEFCE will probably demonstrate that.

3. *The differential effect of cuts on demand-led and research institutions*

Those institutions without a critical mass of research will find it difficult to sustain that research. Research led institutions will need to maintain their critical mass and invest in the future to maintain world leading facilities and activity. We should not forget the damage done to subjects such as chemistry by earlier cuts.

4. *The implications and effects of the announced STFC budget cuts*

Probably a knock on effect to greater demand from the research councils which are already under pressure. We must be cafeful how we manage cuts where they affect our intrnational partners. Much damage could be done if we are not involved in world leading initiatives involving collaboration. We must appreciate the cosequences of a loss in reputation. The balance to cuts in larger facility use of course is the possibility of more responsive mode research and this has a significant role to play. It is therefore a question of value for money which the subject experts are best placed to judge.

5. *The scope of the STFC review announced on 16 December and currently underway*

No immediate response to this. It is a question of strategy. It is important to recognise that uncertainty has a detrimental affect and it is important to sort out what we are going to do as soon as possible.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

The point about cuts is made above. If cuts have to occur it is related to strategy. Ring fencing research at the expense of teaching may be useful in the short term but without the qualified students in the longer term then a required research base may not be possible to achieve.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

Much progress has been made on this and STEM subjects are receiving significant university applications from school leavers. It would be counter productive to reduce much needed students in this area when we have spent so much effort in ensuring these important subjects are being taken up.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

This is presumably a matter of record.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

STEM should be protected. Cuts in the unit of funding provide great damage and can lead to a reduction in quality in some institutions that cannot afford to maintain standards. It is a question of balance however and the contribution of the arts, humanities and social sciences to UK PLC should not be underestimated. The value of cross disciplinary research for example is widely recognised.

Declaration of Interests

Loughborough University has interest as a UK university that carries out significant research and teaching in STEM and other subjects.

Memorandum submitted by the Open University (FC 64)

1. *The process for deciding where to make cuts in SET spending*

At present there does not appear to be a "process" that the community can engage with in a meaningful and constructive way. There is a view that policy is being made 'on the hoof' and a structured debate is perhaps unlikely given that we are in an election cycle. Thus irretrievable decisions should not be made prior to the election, for example announced decommittment from international projects. This is not to suggest that some of these decisions would be changed but rather that a more coherent debate is likely after the political and thence funding landscape is known.

There needs to be further consultation on those areas of research that transcend one research council as these are the most vulnerable to "cuts by default". There does not appear to be a RCUK programme at present rather RC by RC announcements.

The lack of a coherent strategy and "blue skies v applied" research also requires further community discussion and engagement with commercial partners in light of recession budgets in the commercial sector. Further incentives for SMEs to conduct research are needed at a time when their budgets and ability to borrow remain constrained.

At HEFCE level the failure to support an increased number of STEM UGs at a time of recession seems contrary to other countries and the ELQ decision for STEM seems increasingly counter intuitive with the need to retrain and reskill people in the STEM sector for the advanced, high tech needs.

2. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

Quantitative evidence of "impact" would be a good measure if it were independently available but it is not—it's has the same difficulties as "quality—we know it when we see it but there is no simple measure. There is little evidence that there are any robust markers that the community would have faith in at present. This is not only true in UK but similar conclusions have been drawn in major competitors (USA Germany and Japan). Therefore the decision to lower the role of Impact in REF is to be supported.

3. *The differential effect of cuts on demand-led and research institutions*

The OU overall is certainly demand led in recruiting students and while a cap on numbers may not be the immediate issue, the effect of ELQ is. Certainly the potential loss of funds from RCUK and in particular STFC will have severe implications for the OU's Science Faculty, where the STFC portfolio is approx 40% of its income.

4. *The implications and effects of the announced STFC budget cuts*

These are similar to those across the Sector. Whilst he OU itself is quite well aligned with the new STFC priorities the overall loss of funding to be expected by lower returns on rolling grants highlights the potential for crisis outlined in the Wakeham report for those Departments whose research is based on STFC "big science".

The loss of studentships and fellowships has serious implications for a whole generation of younger career staff and we face a 'lost generation' in these fields as current young staff move abroad or leave the field. The ramifications of UK as being viewed as a strong player in the field and "reliable" partner in long term projects due to short term cuts should not be neglected. The UK is almost certain to no longer be the world's number two publishing power (after US) is astronomy and related areas in the future.

5. *The scope of the STFC review announced on 16 December and currently underway*

See comments above. Since this is the second "crisis" effecting STFC since its formation the rationale for STFC is to be questioned particularly in the operation of facilities. The cancellation of the New Light Source project will in effect remove the UK from a whole series of research fields in physical and chemical sciences. However a return to the "ticket system" costing facilities in grants is also not a solution having been tried and failed. In part due to lack of coherence in the different RCs to budget these costs. A major review of STFC remit and operation of central facilities is needed but must be given time and this time gain confidence of the whole community. A second/third rapid overhaul by what are seen to be closed committees is to no ones benefit.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

The OU does not consider that a ring fence around the Higher Education Funding Council for England research budget and departmental research budgets would be appropriate and that this may overly concentrate research funding into a small number of very large University departments.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–14: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

We feel that there is a clear disconnect between the "posturing" and the facts—for the current post doc generation, who might form the next cohort of academics, there is little appeal for a career in university science. The tone as well as the reality of budget cuts, loss of staff etc will not persuade students to pursue STEM. Given the path being taken by RCs (particularly STFC) with regards to PDRAs and reduction in University places there is little hope of maintaining the supply of well trained graduates, this is a major issue for UK PLC and contrary to other countries including China, India and Brazil, In addition, the pressure

on costs will impact on practical science in Universities which, combined with reduce research income, which in many UK universities help subsidize teaching (contrary to OU), may be expected to lead to further closures of STEM departments risking more regions of "STEM deserts" for UGs at a time where more home based students are likely.

An increase in part-time education and life-long learning should be part of the strategy for increasing STM provision (which is good for OU) but there is little evidence to show that it is (indeed ELQ has been brought in the most damaging way imaginable) if people were being subsidised for taking a second sojourn in HE then they should have been charged directly with scholarships for (re)training in specific fields.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

There is little evidence to suggest that this is the case. Whilst STEM numbers have increased slightly over last decade these were not in proportion to the numbers seeking HE. The problems of STEM recruitment are not to be fixed by a short term one off announcements. They are often driven by poor STEM teaching at school level (particularly in state sector) and the poor image of STEM in careers both for financial reward and the "cultural image" of STEM. These problems have not fundamentally changed over last two decades.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

STEM training is inherently more expensive than most other areas. Any alteration in a negative way from current figures is likely to engender a crisis in STEM Departments making many unsustainable leading to closure. The OU certainly could not sustain its current Science programme if there were major changes in its unit of funding since further staff cuts would be needed.

Professor Nigel J Mason, OBE
Physics and Astronomy
Faculty of Science.
The Open University
On behalf of the Open University

January 2010

Memorandum submitted by ADS (FC 65)

1. Introduction

(i) ADS is the trade body advancing UK AeroSpace, Defence and Security industries with Farnborough International Limited as a wholly owned subsidiary. A|D|S brings together the combined strengths of the long-standing Association of Police and Public Security Suppliers (APPSS), the Defence Manufacturers Association (DMA) and the Society of British Aerospace Companies (SBAC).

(ii) Aerospace, Defence, Security and Space industries are major UK business sectors based on high-value engineering. With a turnover of £20 billion a year, UK aerospace companies continue to invest c. £1.8 billion in research and development and sustain 223,000 UK jobs. Aerospace turnover was evenly divided between civil and defence sales in 2008 with exports making up a considerable share of income, accounting for 69% of UK aerospace sales.

(iii) The UK has a 17% global share of the civil aerospace market, 10% of the defence market and is well placed to provide the equipment and necessary expertise to take the lead in the increasingly significant security and space sectors. UK companies also have a significant share of the global aftermarket (service) sector, including maintenance, repair and overhaul of both fixed-wing and rotary-wing aircraft providing significant components of the UK industry.

(iv) As well as being substantial generators of activity in their own right, the four sectors also stimulate GDP and employment in other parts of the economy. For example, the Space sector whilst supporting 70,000 jobs, also generates an additional £1.6 billion a year through R&D spill-over effects.

(v) There are many cross cutting Government strategies that have an impact on the UK aerospace industry including the Advanced Manufacturing Strategy, Low-Carbon industrial strategy, High-level Skills Strategy & Leitch review, the Defence Industrial Strategy and the developing Space Innovation and Growth team process.

(vi) Industry and Government developed a joint strategy for the sector which was published in 2004 as the Aerospace Innovation and Growth Team report (AeIGT). This publication identifies the key strengths of the UK industry and identified what was needed to ensure the UK maintained and grew its global position. Both technology and skills investment were identified as being of paramount importance. These conclusions have been reviewed and underpinned by the development of a National Aerospace Technology Strategy report and the development of a set of Technology Roadmaps, which link collaborative research programmes to business opportunities worth $3.15 trillion.

(vii) The overall trend is for strong order growth over the next 20 years, Airbus forecast that 25,000 new passenger and freighter aircraft valued at US $3.1 trillion will be delivered between 2009 and 2028. Getting the right levels of investment in UK research programmes is fundamental to UK based companies winning work on future programmes and securing high-skilled manufacturing jobs.

(viii) UK aerospace companies are world leaders in the rotorcraft (helicopter) market which is forecast to be worth £30 billion, up to 2027. Whilst the Defence Industrial Strategy does include rotorcraft and identifies the need to retain skills onshore to provide through life support for the Armed Forces, there is no specific rotorcraft strategy designed to support the development of the UK civil market.

(ix) Unmanned Aerial Systems is another key market for the aerospace sector estimated to be worth $20 billion up to 2020, due to emerging developments in security and surveillance. A key element to UK companies winning work in this market in addition to sustaining the right investment into technology development programmes is ensuring a supportive Air Traffic Management framework which permits both flight and testing of unmanned systems.

2. *The process for deciding where to make cuts in SET spending*

(i) We would strongly recommend that the process addresses a number of key issues.

(ii) No cuts made where current spending is fully recognized as supporting nationally-agreed strategies, already underwritten by government, industry & academia.

(iii) If there are cuts, these should be outside recognised institutes of excellence (ie We should protect the "best" since this is more likely where the innovation will come from).

(iv) Reduction in duplication across academia in both education and research. There is scope to make cuts without affecting UK research capability—for example, research could be tested to verify its applicability to nationally-agreed strategies.

(v) Increase proportion of funding opportunities where academia only get the money if they really team with industry.

3. *UK Aeronautics Research Institute proposal*

(i) The Aerospace and Defence KTN are brigading government, industry and academia to develop a proposal for a UK Aeronautics Research Institute. This will deliver leadership in aeronautics research excellence and address fragmentation that exists in the UK today.

(ii) Aeronautics expertise is currently scattered across a large number of university departments. This dilution of academic excellence threatens to degrade UK capability and disable strategic inward investment from industry. In a number of cases, technology "push" from publicly funded research is currently disconnected from applications.

(iii) The absence of such a body means there is no national organisation mechanism to undertake a programme of underpinning research of national strategic importance which can safeguard strategically important facilities and sustain and grow National capabilities in composites, flight physics, electronics and many other areas.

(iv) Other nations such as France and Germany have maintained large, powerful, publicly funded research institutes in the Aerospace sector (eg DLR and ONERA), which has given them greater influence on the European stage, eg in shaping the Framework Programme.

(v) The proposals are still being developed but the objective is that an institute would reduce complexity and encourage greater industry and university collaboration. The ease of working through a central point of contact in comparison to separate negotiations with multiple universities is attractive to industry and academia. In addition, the institute would provide a stronger link between academic research and the market-driven National Aerospace Technology Strategy. The NATS roadmaps span more than a decade but research grants usually last a few years. The institute would provide continuity to research programmes and a stronger link between academic research and commercial applications.

(vi) Currently, the UK is strategically disadvantaged with respect to influencing EU Aeronautic Strategy for two reasons.

(vii) The UK is not represented on influencing bodies such as the Association of European Research Establishments (EREA).

(viii) We are unable to attract anything more than 50% EU funding in the absence of a Public Research Institute.

(ix) There is a real opportunity to address these gaps and deliver greater linkages between academia and industry and to increase the ability of the UK to achieve greater EU support for research funding. The objective is not to duplicate or competitively undermine the excellence already established within Industry, Academia and RTOs, but to create coherency between these individual entities, thus ensuring UK Aeronautics remains globally competitive and sustainable. Initial proposals will be finalised in February 2010.

4. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

(i) In the development of defence equipment and technology the Government through the MoD has a direct influence on aerospace through both procurement and research investment. There has been much public discussion about the need for a Strategic Defence Review and A|D|S supports this process. Since our armed forces cannot do their job without defence equipment provided by industry it is essential that a renewed and refreshed Defence Industrial Strategy is an integral part of the SDR process.

(ii) Defence equipment like health and IT procurement programmes is a direct means by which Government investment has the ability to channel investment into skilled jobs, technology and innovation, whilst at the same time delivering world-class equipment to our Armed Forces.

(iii) A recent report by Oxford Economics produced an analysis of how a range of sectors contribute to the national economy. The report concluded that relative to other parts of the economy, the defence industry generates significant benefits consistently across a range of comparators. These include: returns to the Exchequer, impact on GDP, number of jobs, skill development, research and development investment and export potential. Across all these criteria, defence is judged the third most attractive sector out of 27 included in the study.

(iv) Defence equipment also provides export opportunities as equipment that is tried and tested in the UK is more likely to attract export customers. Defence exports in the UK account for 55,000 jobs and additionally encourage innovation and contribute returns to the Exchequer.

5. *The differential effect of cuts on demand-led and research institutions*

6. *The implications and effects of the announced STFC budget cuts*

(i) The UK has an excellent academic base, however international competition is intensifying. Full economic costing is making the UK a more expensive place to do academic research, and protracted negotiations with some Universities over intellectual property rights are hampering the pace at which new programmes can be launched.

(ii) Research Councils are increasingly receptive to the needs of industry, and initiatives such as EPSRC Strategic Partnerships are welcomed and should be encouraged.

(iii) The benefits of a strong Aerospace industry have been recognised by other nations. The global nature of the industry enables companies to make choices as to where they invest, including in innovation. The UK must remain vigilant and agile to respond to the increasing threat of very attractive propositions being tabled overseas. It is inevitable that manufacturing will follow where innovation takes place.

(iv) The technology and innovation created by aerospace research often transfers between civil to defence applications and vice versa. For example composite materials developed in civil aerospace are used in defence applications, defence technology has a role in security applications. The same is true of skills and process improvements. There is an opportunity to achieve more efficient investment in government supported research through bringing together joint defence and civil programmes. The Technology Strategy Board which has a coordinating role in investment is the natural body to bring these different objectives together. Advancing this goal does require the full engagement of academia also.

(v) The network of Advanced Manufacturing Research Centres have an important role to play in creating new designs, products, processes and skilled employees for both aerospace and wider applications, as many technologies from the sector spill over into other sectors.

(vi) The proposed Manufacturing Technology Centre (MTC) in the Midlands, along with the Advanced Manufacturing Research Centre (AMRC) in Sheffield and the Advanced Forming Research Centre (AFRC) near Glasgow, will provide a powerful network linking companies, industrial sectors and universities and spanning a range of high integrity, high productivity process technologies. At several levels, the network will provide an infrastructure capable of supporting future public and privately supported manufacturing technology research.

(vii) Industry experience with the Advanced Manufacturing Research Centre (AMRC) an initiative led by Sheffield University and Yorkshire Forward has been very positive. The centre which opened in 2004 operates as a department of the University around a partnership of some 40 industrial companies. The focus is on machining processes, composites and automated assembly.

(viii) The programme has already been expanded with a £10 million additional investment earlier this year, by Yorkshire Forward with support from Rolls-Royce. The Rolls-Royce Factory of the Future, has delivered a four-fold expansion of the AMRC on the same Sheffield site. Further plans are also being formulated to further expand facilities with two further buildings providing a 40% increase in floor space.

(ix) The compelling characteristics of the model are pace and scale underpinned by industrial leadership and a very non-traditional and results-led approach from the University.

(x) This successful model has been built upon and scaled up to bring a broader range of technologies whilst preserving the benefits of specialisation within each Centre. In 2007, industry achieved agreement with Scottish Enterprise and Strathclyde University to launch the AFRC—a Centre that will focus on advanced forging and forming processes with an initial capital input from Scottish Enterprise of £17 million. Land preparation is now complete, construction has started and the Centre will open during 2010.

(xi) The Manufacturing Technology Centre (MTC) represents an ambitious step towards completing the first stage of a UK network. The proposal is to bring together three Universities—Nottingham, Birmingham and Loughborough along with The Welding Institute and a more broadly based, cross sector industrial partnership. The scale of the Centre reflects the very rapid growth seen in Sheffield and an intention to straddle a broader range of process technologies including high integrity joining, net shape fabrication and automation.

(xii) The programme is now at an advanced stage with the East Midlands Development Agency and Advantage West Midlands. A final formal decision on funding is expected during Q3 2009 with MTC research projects being launched during the second half of 2009 and the facility to be opened early 2011. The MTC was "announced" as part of the Government's manufacturing strategy in September 2008.

(xiii) A|D|S expects that industrial support for the manufacturing research network will be strong and international. As with the AMRC in Sheffield, we believe that industrial membership of the new Centres will grow rapidly once the facilities are open.

(xiv) A number of leading industrial companies are already committed to centres within the emerging network (including Rolls-Royce, Airbus, Boeing and BAE Systems) with significant interest from a wider group of cross sector industrial partners.

(xv) At an industrial level A|D|S believes that there are strong overlapping interests in high integrity, high productivity manufacturing technologies that will continue to attract a range of industrial sectors—including automotive, heavy vehicles, nuclear, oil and gas and aerospace.

(xvi) In summary the benefit of these centres to industry include.

(xvii) Access to world-class research facilities and academic staff supporting fundamental and applied research in manufacturing technology.

(xviii) Strong market pull and industrial leadership from partners, especially the larger Original Equipment Manufacturers.

(xix) Leverage knowledge from cross-sectoral collaborative partnerships between leading academic institutions and major industrial companies.

(xx) Rapid "technology pipeline" from concept—demonstration—exploitation, bridging the gap between University research (MCRL 1-3) & industrial application (MCRL 7-9).

(xxi) We cannot allow any spending cuts to impact on the above activities, as this will further disadvantage the UK.

7. *The scope of the STFC review announced on 16 December and currently underway*

8. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

(i) We recognise the need to review all governmental spending in the current economic climate. However, we must also recognize the need for the UK to be ready and able to support and maximize its potential when the upturn comes.

(ii) We would strongly advocate that the scope of the review addresses an improved use of available funding, rather than carte-blanche cuts. An independent review of the benefits accrued, and the direct linkages to nationally-approved strategies would be preferable criteria for the review.

(iii) Ring-fencing budgets would be acceptable, if determined against the above criteria.

9. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–14: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

10. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

(i) We fully support all initiatives that will encourage increased uptake of STEM subjects throughout education. It is too early to determine whether these initiatives have been successful, although the initial results look promising. However, we would also caution that the ongoing proclivity to continually launch new initiatives is not helpful. We would strongly recommend that we use this opportunity to fully assess the full spectrum of initiatives, and rationalize them to ensure a more comprehensive possibility of success.

(ii) We are in grave danger of confusing the landscape—let's simplify, get better value-for-money, and be successful—the success should be measured on output, not input.

January 2010

Memorandum submitted by Syngenta (FC 71)

1. *The process for deciding where to make cuts in SET spending*

The future of the UK economy lies in the growth of knowledge-based industries and the development of a highly skilled workforce. As a consequence, investment in research and development (R&D) and innovation is essential to drive the UK's economic recovery. It will underpin future growth in productivity and competitiveness—in particular for high value-added export industries and in the wider knowledge economy. It will also provide the basis for tackling major global challenges such as climate change, food security, international security, threats to health, and growing constraints on supplies of natural resources. The UK must maintain its standing as a world leader in scientific research and strengthen its position as a place for businesses to locate and expand all their R&D and innovation-related activities.

Our ability to compete in the global knowledge economy depends upon the health of the entire skills pipeline—education in schools and universities providing a steady supply of talented, highly-skilled individuals who will become the next generation of scientists and engineers and members of a wider, scientifically literate workforce. Continuous, long term investment in Science, Engineering, Technology and Maths (STEM) must not only be maintained but steadily increased to meet this challenge.

The strength of our Higher Education (HE) sector is one of our great success stories and yet the proportion of our national income that the state spends on our HEIs, at 0.90%, is lower than that in Germany, the United States and France, which spend 0.94%, 1.01% and 1.15% respectively.[106]

Many of the most important and financially valuable discoveries are being made by scientists with deep, fundamental knowledge of their specialism working in multi-disciplinary teams with experts from other areas. For this to continue, we must preserve our ability to conduct ground-breaking research and development across all scientific disciplines. Indeed, as an example, cut backs on agricultural R&D in the 80's and 90's really did reduce our ability to react to the world food crisis and we are concerned that the BBSRC institutes are currently facing up to a further round of reduction, consolidation and restructuring, just at the time when finally the importance of Ag R&D has been recognised. This is marked contrast to other countries, notably China, France, and the USA which have announced further investment in Science and Technology, including in plant biotechnology and agriculture.

2. *What evidence is there on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

Any methodology which is used to estimate the economic impact of research must take account of timescale between discovery and commercialization, which may take many years—in our industry it is in the range of five to –10 years for a new crop variety and 15–20 years for a new crop protection chemical. It must also assess the economic benefit from a more productive population, with increased revenues to the individual and to the Exchequer. The short term benefit from investment in research in Universities is quite clear to us and that is well trained and effective scientists and engineers who can be recruited by industry.

There is work published that estimates the value to a student in terms of lifetime earnings of various subject choices—see the links below that clearly show the value added through higher education.

http://usgovinfo.about.com/library/weekly/aa072602a.htm

http://www.guardian.co.uk/education/2007/oct/03/schools.uk1

http://www.prospectsnet.com/cms/ShowPage/Home_page/Main_Menu___News_and_information/Graduate_Market_Trends_2007/Financial_benefits_of_a_degree_and_the_impact_of_variable_fees__Spring_07_/p!eLaggjj

The government could make more use of that in prioritising reductions in some humanities and modern course choices (eg Media Studies) since if S&T is to be a national priority as needed, then disproportionate cuts will be needed elsewhere. The importance of professional qualifications is also clear. Raising the image of STEM related professions may also add value and prestige and make them more attractive career choices.

3. *The differential effect of cuts on demand-led and research institutions*

While research and teaching are often considered separately, it is important to realise that a strong UK science base relies on high standards in both. At the moment, because of underfunding and cross-subsidization any change in funding for one activity is likely to heavily affect the ability of an HEI to deliver the other.

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[106] Organisation for Economic Co-operation and Development (OECD) (2008): Education at a glance: OECD Indicators 2008, table B2.4.

It is often noted that as both research and teaching are loss-making, further funding cuts to either would only serve to make a bad situation worse. This would threaten the quality of both teaching and research, and compromise the standing of UK science. We believe that it is important to continue investing in STEM at University (and school) level to secure the UK's science base and that that research and teaching in STEM should be fully funded. Education in STEM subjects is an investment in the future for individuals and for the country as a whole. Individual institutions should be challenged to think creatively about finding additional revenue streams—eg by making better all year round use of their facilities, as well as being more ruthless on non-productive costs. Most campuses clearly haven't been designed with operational or energy efficiency in mind!

In the absence of a comprehensive strategy to support a strong national science base, cuts to funding may bring about the closure of SET departments on an unplanned, case-by-case basis. This could create whole regions with no provision for students who wish to study SET subjects. Those from less advantaged backgrounds who have to live at home will be unable to study these subjects, irrespective of their ability. There will also be fewer opportunities for local businesses to benefit from the knowledge and expertise of local universities, less innovation and less wealth creation. Therefore, if it becomes necessary to reduce further the number of departments teaching and researching specific STEM subject areas in order to take advantage of economies of scale, then it is important to focus, not only on excellence in the subject, but also on ensuring that there is a regional component to the strategy.

4. *The implications and effects of the announced STFC budget cuts*

Syngenta recognises the need for central funding as an important element in supporting a strong science base.

Given the capital investment which has already been made, it is important that funding be provided to maintain and run these central facilities at close to maximum capacity to make best use of this investment.

5. *The scope of the STFC review announced on 16 December and currently underway*

Syngenta recommends that the STFC should identify facilities of central importance to UK science with the intention of transforming and funding them as National Shared Facilities.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

The government should decide its priorities for investment in subjects which benefit UK plc This should lead to the training of graduates in the subjects required by the nation to enhance its future prosperity. The Government should then fully fund the places required. Given a difficult economic climate, the allocation of subject places should be UK plc demand led and not student demand led.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation*

The world-leading position of UK science, engineering and technology is clearly recognized by global companies such as Syngenta and as such, as a place in which to invest in R&D and manufacturing, However, the UK must not be complacent: given the global competition for our investment, the Government needs to ensure that it makes the necessary investment in science and education to maintain this position.

The Government also needs to encourage broader and deeper links between universities and businesses and provide greater encouragement for businesses to invest in R&D in order to raise the overall spending on research and development as a percentage of GDP.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

We welcomed the increased investment focus on STEM subjects. The flow of new students depends very much on inspiring students before they make critical subject choices, and this is still an area for concern.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

Any reduction in the unit of funding would be detrimental to expensive, but valuable laboratory based subjects, such as chemistry. We are already concerned at the limited practical experience gained by students both at school and on many undergraduate courses. Undergraduate and post graduate teaching in the sciences should be fully funded and seen as an investment in the future prosperity of UK plc.

Can better use of university facilities be made in offering vacation courses and summer schools? For some courses these could be a cost effective alternative to a four year course with a foundation year as well as providing opportunities to inspire students through hands on science and also teachers through professional development training.

Memorandum submitted by the Society of Biology (HC 72)

THE IMPACT OF SPENDING CUTS ON SCIENCE AND SCIENTIFIC RESEARCH

1. We welcome the Committee's urgent attention to this issue but note that it is difficult to present real data to evidence a reply at this early stage of the planned retrenchment.

2. Accurate case-by-case estimates of the economic return on specific research funding are unlikely unless they are of near-market activities. However, we strongly assert that the welcome improvement in funding of the general research and HE environment over the past decade was a critical investment that has already contributed to real economic growth.

3. However, additional returns on that investment have yet to be realised and we are concerned that the talent and environment on which their full development depends should be protected. We believe that ongoing investment in science skills and their use can continue to attract inward investment, support export markets and, very importantly, continue the tradition of the UK's contribution to global prosperity and well-being. This is highly valued by the public and internationally respected.

4. The threatened STFC budget cuts have caused alarm in the HE and research sector which of itself can be damaging. Already there are threats to the integrity of research programmes with researchers considering moves to other institutions, including institutions abroad. This will be an evolutionary process and the stresses applied may well produce quite a different landscape across some disciplines. We sincerely hope that this can be managed adaptively to help protect important areas and vulnerable subjects.

5. We are in communication with our members on these matters and will continue to be so. We hope to be able to provide sound information to inform judgments on policy implementation as it emerges. We urge the Committee to maintain its oversight of this issue.

THE SOCIETY OF BIOLOGY

The Society of Biology is a single unified voice for biology: advising Government and public bodies and influencing policy; advancing education and professional development; supporting biologists, and engaging and encouraging public interest in the life sciences. The Society of Biology is a charity, created by the unification of the Biosciences Federation and the Institute of Biology, and is building on the heritage and reputation of these two organisations to champion the study and development of biology, and provide expert guidance and opinion. The Society represents a diverse membership of over 80,000—including students, practising scientists and interested non-professionals—as individuals, or through the learned societies and other organisations listed below.

The Society of Biology is pleased for this response to be publicly available and will post a copy at www.societyofbiology.org when the Committee allows.

MEMBER ORGANISATIONS REPRESENTED BY THE SOCIETY OF BIOLOGY

Anatomical Society of Great Britain & Ireland
Association for Radiation Research
Association for the Study of Animal Behaviour
Association of Applied Biologists
Association of Clinical Microbiologists
AstraZeneca
Biochemical Society
Breakspear Hospital
British Andrology Society
British Association for Lung Research
British Association for Psychopharmacology
British Bariatric Medical Society
British Biophysical Society
British Crop Production Council
British Ecological Society
British Lichen Society
British Microcirculation Society
British Mycological Society
British Neuroscience Association
British Pharmacological Society
British Phycological Society
British Society for Ecological Medicine
British Society for Immunology
Heads of University Biological Sciences
Heads of University Centres of Biomedical Science
Institute of Animal Technology
International Biometric Society
Laboratory Animal Science Association
Linnean Society
Marine Biological Association of UK
Nutrition Society
Physiological Society
RNID
Royal Entomological Society
Royal Microscopical Society
Royal Society of Chemistry
Science and Plants in Schools
Scottish Association for Marine Science
Society for Applied Microbiology
Society for Endocrinology
Society for Experimental Biology
Society for General Microbiology
Society for Reproduction and Fertility
Society for the Study of Human Biology
Society of Pharmaceutical Medicine
Syngenta

British Society for Matrix Biology
British Society for Medical Mycology
British Society for Neuroendocrinology
British Society for Plant Pathology
British Society for Proteome Research
British Society for Research on Ageing
British Society for Soil Science
British Society of Animal Science
British Toxicology Society
Experimental Psychology Society
Fisheries Society of the British Isles
Freshwater Biological Association
Genetics Society
UK Environmental Mutagen Society
University Bioscience Managers' Association
Zoological Society of London

Supporting Member Organisations
Association of Medical Research Charities
BBSRC
GlaxoSmithKline
Medical Research Council
Pfizer UK
Wellcome Trust

Memorandum submitted by Jonathan Haskel (FC 73)

How much does publicly funded research contribute to UK economic growth?[107]

Universities undertake two major tasks: teaching and research (the third being the administration required to manage these processes). There are then at least two possible mechanisms whereby these tasks affect economic growth:

(a) Teaching. More skilled students raises the human capital of the workforce and so growth.

(b) Research. New knowledge spills over to other sectors, raises their knowledge capital and so leads to new products, services, methods of production etc.

This note attempts to quantify the second of these effects and thus the impact of a cut in public support for research. The first effect is quantified in Haskel (2010).

The impact of publicly funded university research on the economy

How much does the knowledge from university research spill over and so affect growth in the private sector? The problem with estimating this is that the private sector is itself generating knowledge via its own investment in R&D, software and other knowledge spending, so one has to separate out the role of this and that of universities, plus other effects such as knowledge from abroad etc.

First some facts. UK companies spend around £12 billion per year on R&D. The UK government spends around £10 billion on R&D. Such public spending Britain ranks 9th in public support for higher education, in the form of grants to universities and research councils for research, among OECD countries, relative to 16th in 1996.

That reported public spend on R&D consist of about 33% spend on research councils, 33% on defence R&D, 20% on civil R&D (ie in non-defence Government departments) and the rest being the general support to university research (funding distributed according to RAE performance). The research council money is then obtained by universities in turn by competitive allocation. It is spent on funding the discovery of new knowledge paying for researcher time and equipment. Such new knowledge must be made publically available. Of that research council money, over 90% goes on engineering, natural sciences and medicine. Funding for social sciences and the arts is about 6% of the total.

In Haskel and Wallis (2009) we have attempted to measure the extent to which such public support raises private sector growth. Again, this is not the only metric; medical support for example might raise life lengths or happiness, but this is the metric we choose. We do so because it is argued, by those who wish more taxpayer support to be forthcoming, that the ideas created by publically funded research are freely available and so can be commercialised by the private sector. If this is so, then the private sector should not mind funding such knowledge. If on the other hand, the private sector is asked to fund knowledge that provides them no advantage, then taxpayers have reason to be unhappy.

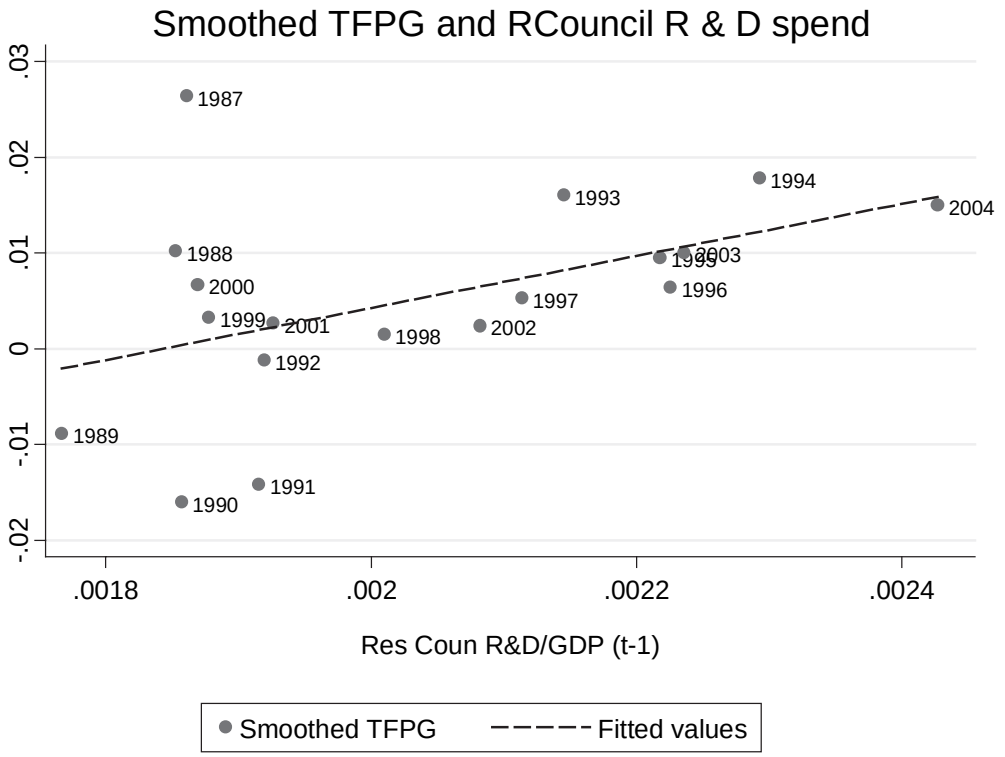
Measuring the effect then of public sector knowledge on private sector growth is a tricky undertaking, for one has to control for all the other factors that might affect private sector growth. The most obvious ones are the accumulation by the private sector itself of its own knowledge, via investment in R&D, software etc. plus the accumulation of other inputs, such as hiring more labour and employing more machines. Thus the starting point is to try to measure that part of growth not accounted for by own investment in knowledge, capital and labour; this is called total factor productivity growth (single factor productivity is output per unit of labour input, total factor productivity is output per unit of labour, capital and own-knowledge input). Total factor productivity growth is then that part of private sector growth determined by factors not directly funded for by the private sector. So it could be determined by publically funded knowledge from UK universities that is free to everyone. Or it could be determined by knowledge freely available from

[107] The views set out in this note are solely those of the author.

anywhere in the world, be it publically funded by other countries or privately funded, but leaking out of the private sector in those countries. The medium of such knowledge spillovers could be the internet, or foreign trade or foreign direct investment. Attempting to parse out these possible effects is what our study tries to do.

The main finding is set out in Figure 1.

Figure 1

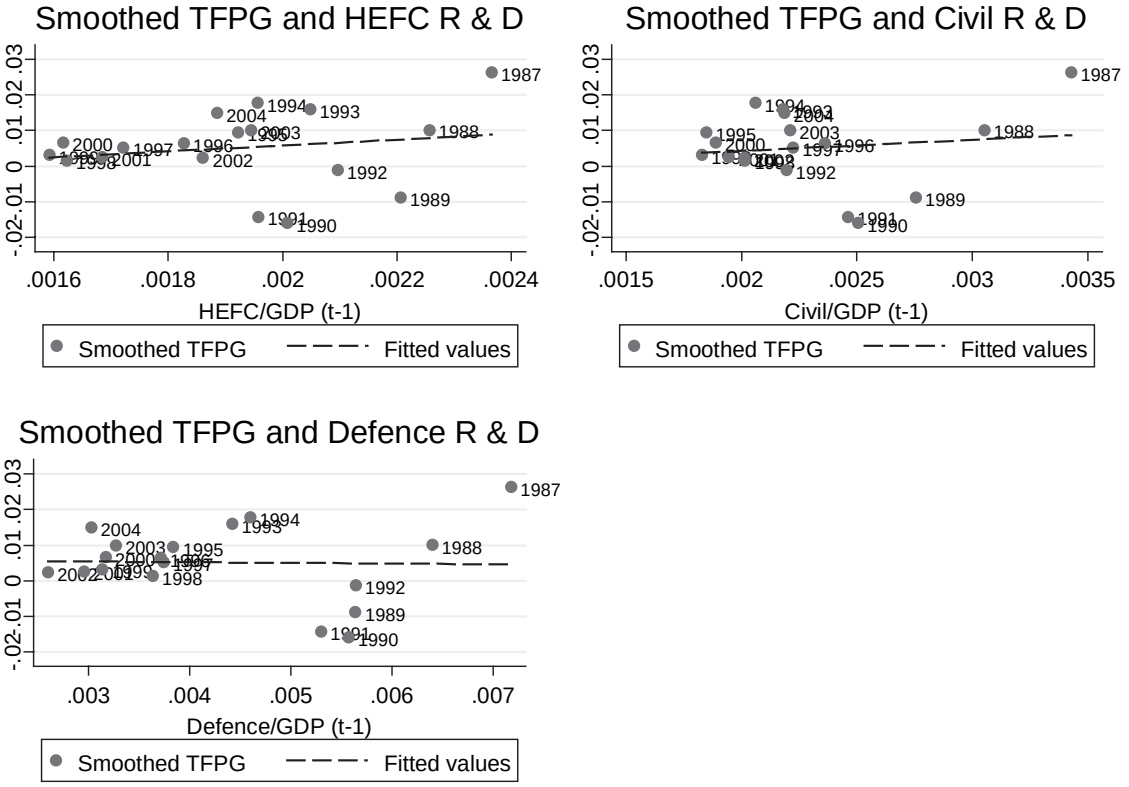


Note: Research council spending is as a proportion of GDP, lagged one year.

The vertical axis shows total factor productivity growth (TFPG). In 1987 for example, the upper left point, this was 2.5% (each point is a year). The horizontal axis is spending on research councils in the previous year (as a proportion of GDP). The scatter shows the line of best fit and is upward-sloping. That says, in words, that increases in public support for R&D via research councils is associated with increases in private sector TFPG a year later (a very similar picture holds for lags of two and three years). Of course the relation is noisy and other factors are likely occurring, but the points turn out to lie sufficiently close to the line to give a statistically significant relation.

The point can be further illustrated below. These show cross plots with the other spending categories, civil and defence R&D. There is not as strong a relation; in fact, the relation is statistically insignificant.

Figure 6



We can further use the slope of the line to determine the contribution of research council spend to GDP. Current spend is around £3.5 billion. The slope of the line suggest this gives around £60bn additional market sector output. If, to be conservative, one halves this, one gets a contribution of publically funded research to GDP of £30 billion, which is about 2% of GDP. Put another way, if support for research councils was cut by, say £1 billion from its current £3 billion, GDP would fall by around £10 billion.

References

Jonathan Haskel, (2010), "How much do UK Universities contribute to UK Economic Growth?", draft paper, available on request from c.edlin@ic.ac.uk

Jonathan Haskel and Gavin Wallis, (2009), "Public Support for Innovation, Intangible Investment and Productivity Growth in the UK Market Sector", draft paper: http://www.ceriba.org.uk/bin/view/CERIBA/PublicSupportCeriba

Jonathan Haskel
Imperial College Business School

January 2010

Memorandum submitted by Professor Joao Magueijo (FC 74)

I would like to ask how it can ever be ensured that cuts driven by politically defined criteria (such as "social impact" or other concepts being considered) will not be corruptly implemented, leading to a meltdown of science and academia.

1. Specifically I note that over the past 10 years we have witnessed a proliferation of levels of management and administration, at University and at government level. More than ever these have severed contact between those doing front-line work (here defined as teaching and research) and those making the political decisions:

> [For example at Imperial College the number of levels of administration has more than doubled in the past 10 years.]

2. I also note that the day is yet to come when decision making bureaucrats will consider the possibility that they are the main burden to the system and that they should fire themselves as a first measure in cost saving. Therefore every time cuts are proposed with qualifiers such as "the front-line is ring-fenced", or "high social impact activities will be protected", we see academic administrators and science politicians redefining "front-line" or "social impact" so as to include themselves and their pet initiatives. Something as vague as "social impact" is particularly vulnerable to this:

> [One example, taken from many, is the government driven training schemes, such as CASLAT at Imperial College. These are widely regarded as a waste of money and time, but I've noticed manoeuvering aimed as defining them as essential, front-line, or high social impact. At the same time outreach, unbelievably, is being given a hard time.]

3. This legalized form of corruption will therefore have the effect that cuts driven by political criteria will lead to the real front-line (ie teaching and research) being cut, and hence more and more inefficient academic institutions. Sadly this might only become evident when students start to go elsewhere because their best lecturers have left; or when in the future the UK suffers the humiliation of having squeezed funding from Nobel Prize level research (highly likely to be categorized as "low social impact" now).

4. The logical alternative would be to impose efficiency savings rather than cuts, and make sure that these are made at administration level (for example by legally limiting the percentage of institutions' budgets that can be used for management). This may require government bodies and academic management to have the honesty to admit that they should be the first to go, and that some of the gimmicks which they've employed to justify their existence, should be the first to suffer.

I'm afraid that if the latter suggestion isn't followed I can only predict an apocalyptic scenario for UK science and academia, with politically defined cuts translating into ever more wasteful institutions, the situation spiralling into collapse. It often happens that parasites only die with the death of the host organism.

DECLARATION

I declare I have no conflict of interests in this submission.

Professor Joao Magueijo

January 2010

Memorandum submitted by Professor Nancy Cartwright (FC 75)

REASONS FOR CONCERN ABOUT THE FEASIBILITY OF MEASURING RESEARCH IMPACT

1. Although the REF document describes some obvious measurement problems, I am concerned that it does not register the true level of difficulty in designing credible measures for even rough estimates of a feature like "social, cultural and economic impact" that:

(1) includes a great variety of very different kinds of effects which, moreover, matter very differently to different aspects of social, cultural and economic welfare and have only at best a very incomplete ordering of importance;

(2) includes important very long-term effects;

(3) includes contributions that are highly interactive, which makes it especially difficult to estimate what happens with respect to them over longish periods; and

(4) demands a "counterfactual" comparison, as impact does, of what is the case and what would have been the case had the research not been conducted.

2. The broad aim, to take account of the extent to which the HE sector builds on research "to achieve demonstrable benefits to the wider economy and society", is an abstract one. Designing measures for it requires two steps. First is getting clear what it amounts to in the concrete; second, finding ascertainable measures and indicators that can be shown to be reasonably correlated with the more concretely described aims.

3. The first step inevitably involves value judgements: What are the kinds of effects that should count as benefits and that we should thus wish to monitor? Often the first step is conflated with the second. Measures and indicators are proposed with only a rough, rather than a fully articulated and agreed upon, account of what the concrete benefits are that we aim to measure. This is dangerous since there is no way to avoid the value implications and consequences of adopting one set of measures over another. Conflating the two steps buries the value judgements implicated in the measures, making them untransparent and removing them from consideration and debate.

4. The second stage is also delicate, as the REF document acknowledges. I should like to stress the problems involved in finding indicators that can be shown to correlate with counterfactual differences. The measurement aims not to find out if some benefit occurred but rather, as the REF document indicates in

discussing contributions, to find out what difference the research made to the benefit. To estimate differences like this requires a model of what would have happened without the research in order to compare it with what benefits occurred with the research.

5. As with the first step, there is a tendency to move too quickly here, to offer measures that seem plausible without producing the requisite models that back them up. But even if we are willing to accept rough measures/indicators, there should be good reason to believe they correlate, at least roughly, with the feature to be measured. Without reasonable, if only rough, models it is difficult to produce credible reasons for thinking any specific indicator correlates with the counterfactual difference we are looking for. The requisite modelling, however, introduces an additional layer of uncertainty/unreliability, particularly when the measures have to take account of a large number of diverse kinds of effects. But winging it without modelling is to bet on what those models must be like and to do so without explicit defence and debate.

6. These problems raise considerable worries about how accurate results can be. There can be a tendency in the face of these problems to adopt measures with insufficient credibility; for instance, relatively easy-to-access indicators that seem plausible for picking up steps in a possible causal pathway for influence, without modelling how much of the research contribution to all the various different kinds of concrete benefits desired can be expected to flow through these pathways or whether what does flow through these pathways actually contributes improvements. The amount of collaboration with the kinds of users for whom collaboration makes sense is a possible example here; as is the amount of research funding from users of the type who fund research. In this regard I particularly welcome the REF document's commitment to developing indicators sensitive to contributions that flow through indirect routes.

7. I am not primarily worried that the results will be imprecise—that they will have wide error bars on each side, but rather that there will be insufficient reason for believing they track the collection of desired benefits even roughly. With insufficient discussion of concrete aims—what is to count concretely as a benefit to be measured—and insufficient reason to think the indicators and measures proposed track these specific benefits, the exercise will inevitably depend heavily on prior views and prior commitments about what research achieves and how; in which case it would be misleading to describe it as a measurement exercise.

8. Beyond general worries, I should like to raise two fairly obvious issues about the feasibility and effectiveness of specific REF proposals. The first is how to deal with long-term impacts. The document is alert to this but the proposal to consider "the impact of research undertaken over a sufficiently long time frame" is out of kilter with the rest of the research assessment. Moving back the time frame suggests assessing research outside the period of the rest of the exercise. Moreover, this will very often have been done by people who have changed units since doing the research. Nor does looking at the "broad impact of the unit as a whole" promise to help much with assessing long-term benefits if the "broad impact" is impact of the research within the assessment period; if it is earlier research, it suffers from the previous problem. I should like to stress the importance of solving these problems since it seems many of the benefits are, and should be, long term so failing to capture them in a reasonable way could give a much distorted picture of research impact.

9. Second, the case study method suggested in the REF document is to be applauded but can carry, I worry, a danger of "undercount". This method has the great advantage of allowing for diversity of benefit end-points and pathways for contributing to them. But these will have to be constructed for the most part by researchers not expert in thinking about pathways of influence. If panellists have sufficient expertise here they should be good at noting "overblown" submissions but generally could not be expected to be good at spotting swathes of routes for influences those constructing submissions have not had the ability to recognize. So there is danger of significant "undercount" even with expert panellists.

Nancy Cartwright FBA
Professor of Philosophy (specializing in methodology, esp. evidence for evidence-based policy)
London School of Economics and University of California at San Diego

January 2010

Memorandum submitted by the Royal Geographical Society (FC 76)

1. The Royal Geographical Society (with The Institute of British Geographers) is the learned society and professional body for geography. Formed in 1830, our Royal Charter of 1859 is for "the advancement of geographical science". We have more than 15,000 members and Fellows, of which a substantial number are academics and other researchers whose work we support through a range of activities. Our academic activities include holding the largest geographical conference in Europe, publishing three journals, one of which (Transactions of the IBG) is the top ranked geographical journal in the world, hosting research groups and providing funding opportunities for researchers at all careers stages.

2. As a discipline, geography is uniquely placed within the debate on science and scientific research, as a subject that combines physical science with social science and humanities. Since many of the scientific environmental issues facing the world have their causes and solutions in societal and individual behaviours,

geography occupies a key research niche. It spans both SET[108] and non-SET funded areas in scope. The discipline is at the forefront of the tensions between SET and non-SET funding streams and suffers from the inadequate manner in which such "interdisciplinary" subjects are funded.

3. The Society strongly recommends that before cutting/restricting science, engineering and technology (SET) designation/funding, the current arbitrary decisions on what is/is not SET classified need to be reconsidered. When it suits government geography is classed as a science; and vice-versa. A recent example of physical geography being considered SET is in skills and training.[109] However, currently it is funded entirely as a non-SET subject, which is placing unacceptable strains on properly resourcing the science-base of the discipline. It should be recognised for what it is, a part-STEM subject, and funded accordingly and with STEM protection for its 50% science component.

4. HEFCE has publicly stated that there are inconsistencies of funding scientific research at the STEM: non-STEM boundary. The same piece of science conducted from a Geography department attracts substantially less QR resource than had it been conducted from an Environmental Science department or another STEM designated subject. Thus the true costs of conducting quality science are not being covered under the non-STEM funding for geography. Unless the STEM lottery can be addressed, further reductions in UK Science and Innovation, in an area that is increasingly being profiled by NERC and others as important to the nation—the environmental sciences—seem inevitable. Geography makes a substantial contribution to research in the environmental sciences.

5. As the learned society representing and promoting the discipline we have sought evidence and considered opinions about the position of geography from across the academic community, including all departments of geography in the UK, our Fellows and members, and the Society's research groups. Much of this evidence has also contributed to our response to the recent HEFCE consultation on the Research Excellence Framework (REF).

6. *That evidence has shown the important contribution of geography to science-based research*

6. (a) The formal report of the Geography and Environmental Studies Panel in RAE 2008, concluded that 50% of geographical scholarship is scientific work—environmental science—of high quality. Science-based geographers are publishing in the same journals as other environmental scientists and attract as much research grant income per capita.

6. (b) Evidence of sustained, even increased, emphasis on the science base of Geography can be seen in the level of SRIF investment that occurred in the 2001–08 period, and is explicitly referenced in the RA5a returns for the 2008 RAE. In total, this reveals at least £30.7 million of SRIF investment in laboratory facilities and the scientific equipment needed as research infrastructure to support research-active staff working in Geography on environmental research. This figure is directly comparable to Earth Systems and Environmental Science, for which the total revealed SRIF investment was at least £34.4 million.

6. (c) Geographers work on some of the key environmental and societal issues challenging policy today: including climate change, its causes and effects, at local, regional and international scales; fluvial processes and flooding; glacier dynamics and processes of accelerated melting; and sustainable development. Specific examples of STEM related work by geographers include groups working at the core of international efforts to measure rates of sea level change (Durham, Plymouth); assessing environmental degradation in lake systems (UCL, Loughborough); developing polar and alpine ice mass models to understand how they link to global environmental systems (Cambridge, Edinburgh, Aberystwyth); understanding rates of abrupt climate change and how environmental processes and humans respond (RHUL, UCL); interfacing with climate modellers to develop Earth System Science models (Bristol); and mapping how humans have altered vegetation patterns and cover (Oxford, Southampton). This research has economic as well as environmental, social, cultural, and policy value and impact.

Examples of economic value from geographical science research

7. While it remains difficult to put a precise economic value on the impact of research in most cases, some geographical science research can be clearly linked to economic benefits. Among the many examples are: Professor John Thornes' (Geography, Birmingham) development of new technologies in the measurement, mapping and modelling of ice on road/railways has led to substantial reductions in the "cost" of road accidents, more efficient applications of salt and grit by local authorities, and the formation of two private spin-off companies (Thermal Mapping International). Estimates of the cost benefit suggest the new system saves £3,224 million (2006 prices) per year in the UK.[110] Dr Kevin Tansey and Professor Heiko Balzter's (Geography, Leicester), work on G-STEP (GMES Space and Technology Exchange Partnership), which supports and speeds up the use of Earth Observation (EO) data and information services, both by businesses

[108] We use STEM and SET interchangeably.
[109] Government commissioned CRAC to survey university students in STEM subjects, including geography and land-based sciences, about their careers thinking.
[110] Economic benefits of environmental science. A study of the economic impacts of research funded by the Natural Environment Research Council November 2006.

and policy makers. Dr Hannah Cloke's (Geography, King's College London) development of an early flood warning system has been demonstrated successfully in the Upper Severn catchment in the UK and subsequently applied in the Upper Huai catchment in China.

Balance of science and social science/humanities research in Geography

8. Geography has long been recognized as a part-science discipline. It has been assigned, for example, a subject cost-weighting for research for a "part-laboratory" subject. At 1.3, this weighting is mid-way between that for social science/humanities subjects at 1.0, and science subjects at 1.6. This accurately reflects the evidenced 50/50 split in geography research between natural science and social sciences/humanities and recognizes the significant laboratory-based research needs in physical geography and IT needs of modelling and sophisticated applications of GIS. A similar approach applies to support for teaching.

The only circumstances in which this does not apply is in the HEFCE allocated research funding—where geography is not STEM recognized and does not receive STEM funding

9. This needs to be rectified with the physical science research within Geography being afforded STEM designation, in a similar manner to Environmental Science, thus protecting the breadth of the environmental science research base, especially at a time when the environmental issues that physical geographers are working on are some of the most pressing ones facing society and government. Published evidence demonstrates that there is a 50:50 balance between research which is physical geography and human geography (including social science environmental studies), and it would be appropriate to provide 50% STEM protection to Geography.

10. Thus, in conclusion:

(a) Before even considering cuts in STEM funding, it is critical that there is a level playing field and those subjects that rightfully deserve part STEM funding are recognized and funded as such.

(b) In our view all STEM areas, including physical geography, are important, as are both blue-skies research and more directly applied research. We see no robust, future-proof and readily identifiable basis on which one area of STEM research should or could be chosen above another for cutting. All should be treated equally and, if cuts are to be made, these should be the same across the board.

(c) The needs of science must be balanced with the needs of social science too. While funding needs for social science research are less, so too is the current budget allocation to social science research. Research issues relating to crime, social cohesion, employment, the environment, sustainable lifestyles, security, economic development and many more demand quality social science research. Robbing Peter to pay Paul will not foster a strong and vibrant UK research base as a whole.

Royal Geographical Society

January 2010

Memorandum submitted by Professor Gordon Davies (FC 77)

IMPACT OF RESEARCH

1. Regarding the discussion over assessing the impact of research, please consider the following case.

2. There is currently intense interest in "quantum computing", and in related activities in using quantum physics for encrypting data.

3. One system that is being investigated seriously for quantum information processing is based on the use of a particular impurity in diamond.

4. The structure of that impurity was discovered as a piece of basic, curiosity-driven research by me in 1976 (published in Proceedings of the Royal Society of London, series A, vol. 348, pp 285–298).

5. In the first five years (a typical RAE/REF period), the work was cited 8 times—not very exciting.

6. Thanks to the use of the impurity in quantum information processing, in 2009 alone the work was referenced 27 times, and 68 times in the last five full years. Since its publication, it has been cited in the refereed literature 197 times, which is very respectable. The paper is evidently significant.

7. Basic research generates information for the long-term future, as well as training scientists for the immediate future.

Professor Gordon Davies

January 2010

Memorandum submitted by the Association of Medical Research Charities (FC 78)

The Association of Medical Research Charities (AMRC) is a membership organisation of the leading medical and health research charities in the UK. In 2008–09 AMRC's 120 member charities spent approximately £935 million on medical and health research in the UK.[111] Working with its membership and external partners, AMRC aims to:

— Provide services and support that enable member charities to be effective research funders.

— Demonstrate leadership in developing solutions to key issues and challenges facing the sector.

— Influence the external environment so that it is enabling of the work of medical research charities.

We are pleased to respond to the Committee's inquiry. Our comments are based on evidence-gathering from, and interactions with, member charities during the course of the economic downturn thus far. We have necessarily concentrated our submission on those issues most pertinent to our members and are aware that a number of our 120 members intend to submit their own evidence to the Committee.

Medical Research Charities in the Recession

AMRC has been tracking the impact of the recession on medical research charities through a regular six-monthly online survey. Our latest survey conducted in the autumn of last year highlighted the following:

— 68% of member charities who responded to the survey described the impact of the recession as "very significant" or "significant"; 28% described the impact of the recession as "not very significant at all".

— In terms of income, investments and corporate giving were quoted as being most affected by the recession followed by public donations and legacies.

— Member charities have employed a number of tactics to mitigate the impact of the recession including: co-funding/collaborative partnerships (29%); decreasing the number of awards (19%); decreasing the amount for new awards (19%) or; delayed new initiatives (14%). A number have adopted more than one of these tactics.

— 54% of member charities said that they had not changed or revised their funding profile or streams as a result of the recession. However, of those charities that had, most (35%) cited project grants as the focus for any change in approach.

— Looking ahead to the new financial year (2010–11), 63% of charities expect to keep their research expenditure at the same levels as this year, 21% plan to increase research funding and 8% plan to reduce their funding.[112]

The last finding suggests a slightly more optimistic outlook within the sector than suggested by our previous survey in March 2009 when under a tenth of member charities who responded (9.3%) said they expected to increase their funding in 2009–10, approximately half (51.9%) planned to keep research funding at the same level as the previous year, and a quarter (25.9%) planned to reduce their funding.[113]

However this optimism is tempered by continuing concerns about the impact on members of a lengthy and/or double-dip recession scenario which could exhaust current strategies they are adopting to maintain funding and/or the impact of public funding cuts not only in higher education but public services provision. Many of our members are provide care services for patients as well as fund research and may face significant dilemmas as to how best to apportion funding to meet patient needs. In sum, the current economic climate is very difficult for charities as it is for other sectors, and the expectation is that it will remain so for the foreseeable future.

Government Strategies in the Recession

AMRC continues to support the overall thrust of the "Science and innovation investment framework 2004–14" and believe that the Government has made progress towards achieving its stated objectives in this document. However, our members have three broad concerns at this time:

— The lack of discernible policy discussion or engagement about what comes next after the 2004–14 framework which is compounding funder uncertainty in the current economic climate. It will be important that Government lay down a framework which is consistent with the current approach and which articulates clear objectives and expectations for the future.

— The lack of transparency about the key determinants of spending cuts on science and research and where they will fall. For instance, in the field of medical and health research, the Government has yet to publish the outcome of its National Ambitions and UK Health Priorities exercise co-ordinated by the Office for the Strategic Co-ordination for Health Research (OSCHR). If these are to be influential in driving future funding decisions then they should be published and open to

[111] Based on AMRC Member Subscription Data collected in 2008–09.
[112] AMRC online survey of member charities conducted in October/November 2009.
[113] AMRC online survey of member charities conducted in March 2009.

scrutiny. Not least because it will enable medical research charities to make considered choices about their own funding, whether to align with these priorities or invest in and support those areas which fall outside of them.

— The ongoing reluctance of the Government to commit to mechanisms that support charity funded research—such as the Charity Research Support Fund (CRSF)—is a concern for many of our members. This message was echoed in the Research Councils UK/Universities UK review of fEC[114] in 2009 as well as by the representative associations in the higher education sector. Charities are integral funders of research in the UK and we believe that the CRSF is fundamental to the ongoing partnership between the charity sector and Government.

THE ECONOMIC AND SOCIAL IMPACT OF RESEARCH

While the current concern over estimating economic impact is understandable, AMRC would urge that the science community as a whole look to articulate and demonstrate impact in much broader socio-economic terms as explored in the Wellcome Trust and Academy of Medical Sciences 2008 report "Medical Research: What's it worth?"

The Committee may be aware that AMRC submitted evidence to the ongoing House of Lords inquiry into funding priorities and, as part of this, conducted a survey with member charities. Almost half the member charities who responded to this survey (48%) said they did not feel that public funding is sufficiently aligned with societal needs and only 16% did. However, the primary concern expressed in member charity comments focused on the need to ensure that funding was focused on long-term objectives rather than short-term aims. As one member charity, Cancer Research UK, said:

> The primary objective for publicly funded biomedical research should be to improve the health and well-being of the nation now and in the future. Whilst improving health and well-being should always be the priority for biomedical research we recognise that biomedical research in the UK also provides skilled employment, attracts inward investment and generates revenue.
>
> When public spending cuts are likely, there is a risk that Research Councils will over-prioritise research more likely to make an impact in the short to medium term in an effort to maximise budget allocation from central Government. Ultimately any sudden response could starve the biomedical research pipeline of innovation, and could damage the UK's reputation as a destination for investment. Government must recognise the importance of basic and public health research when allocating budgets.

The Committee may also wish to note that many medical research charities are now conducting increasingly robust impact assessments and evaluations of their funding stream.[115] Examples can be provided to the Committee if helpful.

Simon Denegri
Chief Executive
Association of Medical Research Charities

January 2010

Memorandum submitted by Dr Paul Craze, Acting Editor, Trends in Ecology and Evolution (TREE) (FC 79)

I am the editor of Trends in Ecology and Evolution (TREE), nationally and internationally the highest cited journal in the fields of ecology and evolutionary biology. The Trends journals cover the whole range of biological sciences and specialise in producing reviews of important emerging ideas in research written by the current and future leaders in their respective fields. These reviews cover both theoretical and applied aspects of the subject. I therefore feel I am in a good position to comment on the effect of funding philosophy on world-leading science and technology.

1. It is quite clear from the material submitted to TREE that almost all of the leading innovative ideas in applied science result from previously unexpected applications of fundamental science to practical questions. Let me give you two examples from the current journal pipeline (in confidence since the articles are as yet unpublished):

(a) New ways of understanding the emergence of novel disease organisms are being developed by applying ideas from fundamental research on the factors influencing the origin of species (speciation). This has only been possible due to the large body of basic, theoretical knowledge that has been developed on speciation; it is almost impossible to imagine how a specific application to disease organisms could have been used to drive research in this area. The ideas being applied could not have been developed had they had the aim of understanding disease. They could only have been

[114] Research Councils UK and Universities UK. RCUK/UUK Review of the Impact of Full Economic Costing on the UK Higher Education Sector 2009.
[115] See AMRC blog on 'Research Impact' on January 15th 2010: http://ceoamrc.wordpress.com/

developed with the aim of better understanding speciation in general. Evaluating the future impact of speciation research in terms of its economic and social outcome would, therefore, be impossible. However, without this field of enquiry the current applications to emerging diseases of crop plants and humans would not be happening.

(b) Biologists are currently experimenting with applications of ideas from fundamental physics to questions of population biology. Novel insights into areas such as fisheries, disease epidemics, population fluctuations due to climate change etc. are expected to result from this. The ideas being borrowed from physics are basic, theoretical ideas and mathematical methods derived from areas such as cosmology, quantum physics and thermodynamics. These are topics which have few direct applications in physics let alone biology and yet they are finding an application in highly applied areas of environmental science. Again, this has only become possible now that a large body of basic, theoretical science exists in these areas of physics and so the likely similarities to questions of population biology have become apparent. Trying to forecast this a priori and using it to evaluate research into fundamental physics would have been impossible. Important insights into applied biology would once again have been lost.

2. The examples given above are just two from very many that I could have chosen but they all point to exactly the same conclusion: attempting to evaluate and restrict scientific research based on imagined economic and social outcomes would without any doubt be a serious impairment. It is simply not possible to effectively evaluate scientific research based on expected or immediate economic and social outcome. Attempting to do so would significantly restrict the base from which new, unforeseen applications can be drawn with inevitable consequences for the UK's technological position and knowledge-based economy.

3. I challenge anyone to show that the founders of quantum mechanics imagined an eventual application of their ideas to fisheries management. It is difficult to imagine that such a link would have motivated them to come up with quantum theory and even if it had, it is unlikely that the utility of quantum physics across a wide range of technology would have been recognised. There is simply no need to tie scientific research to tangible outcomes at the funding stage; the applications inevitably come as a result of the scientific process, exactly as I see daily in the articles submitted to TREE.

Dr Paul Craze
Acting Editor
Trends in Ecology and Evolution

Memorandum Received from the Parkinson's Disease Society (FC 80)

1. The Parkinson's Disease Society (PDS) is delighted to submit the following evidence to Science and Technology Committee Inquiry into the impact of spending cuts on science and scientific research.

2. The Parkinson's Disease Society (PDS) is the largest charitable funder of Parkinson's research in the UK. Through its collaborations with other research funders, the PDS has played a pivotal role in shaping the research agenda.

3. Before any cuts are made to SET spending we believe the Government should assess where they can get greater efficiency from the existing expenditure. For example, by greater collaboration and co-ordination of neurological research programmes through Dementias and Neurodegenerative Diseases Research Network (DeNDRoN), part of the National Institute for Health Research.

4. We believe the process of cutting research investment should be transparent and the criteria used are open to scrutiny by the research and patient communities.

5. We also believe that there should not be an assumption that the charity sectors will be able, or willing, to fill in funding gaps. The Parkinson's Disease Society's funding priorities have been set by our trustees after detailed consultation with international leaders in Parkinson's research and with our membership, and are fixed for the next five years.

6. The UK is a global leader in Parkinson's research, particularly in areas such as brain surgery, bio engineering and sequencing the Parkinson's genome. Significant investment has already been made into the scientific and clinical workforce in these research areas and also in the necessary infrastructure to carry out this research. Any cuts in funding would jeopardise the return expected on this investment and the internationally recognised position the UK holds.

7. Professor Steve Gill at the Frenchay Hospital in Bristol has developed an international centre of excellence in neurosurgery. The expertise developed in his team has enabled research into treatments such deep brain stimulation surgery for Parkinson's. The same expertise will be necessary in the future when the new generation of therapies such as gene therapy are developed.

8. Prof Gill has raised his concern over potential cuts with the Parkinson's Disease Society. He said, "If we do not invest in the infrastructure and research programmes to continue our investigations into the brain, this county will very soon loose its position as a world leader in neurosurgery. This will mean people with conditions such as Parkinson's are the ultimate losers, as the UK will not be equipped to offer groundbreaking new treatment". He also pointed out that, "Centres of research excellence such as the Frenchay encourage investment from the pharmaceutical and bio engineering industry, which is good for our economy. This investment could all too easily move oversees and other countries benefit from R&D undertaken in the UK".

9. Prof Gill will be available to give oral evidence if asked.

10. About the Parkinson's Disease Society.

11. The Parkinson's Disease Society (PDS) was established in 1969 and now has 30,000 members and over 330 local branches and support groups throughout the UK. The Society provides support, advice and information to people with Parkinson's, their carers, families and friends, and information and professional development opportunities to health and social services professionals involved in their management and care.

12. This year, the Society is expected to spend £4 million on research into Parkinson's Disease. The Society also develops models of good practice in service provision, such as community support, and campaigns for changes that will improve the lives of people affected by Parkinson's.

Memorandum submitted by Dr Marta Mazzocco, Dr Alexander Strohmaier and Professor Eugene Ferapontov, Loughborough University (FC 81)

As previous investigations into the subject have shown (see the article by Jaffe, SIAM review vol 26, no 4 October 1984 prepared for the Ad Hoc Committee on Resources for the Mathematical Sciences, chaired by Edward David, USA) that the impact that mathematics and science in general has in the long term can not be predicted at all. The use of number theory in modern cryptography, or the use the differential geometry in GPS systems, were not foreseen at the time in which these theories were developed. These two examples are typical (as shown in Jaffe article).

The scientific peer review process already now deals with questions like:

> "why is the research important or interesting" and the scientists are well aware about the role their science plays in the public. There is no need at all for any additional impact measurement. On the contrary: Any such measurements will result only on the focus on short term turnaround.

The current banking crisis was caused by a system that rewarded bankers for immediate turnarounds and short time successes. Introducing additional impact measurement implements the same failed system in science.

We would like also to mention the recent article by Douglas N Arnold, president of SIAM (Society for Industrial and Applied Mathematics, where the negative effect of the "impact factor" (a way to measure how interesting a scientif publication is) is analyzed. http://www.siam.org/news/news.php?id = 1663.

Dr Marta Mazzocco

Dr Alexander Strohmaier

Professor Eugene Ferapontov

Loughborough University

Memorandum submitted by University of Leicester (Professor Kevin Lee, Pro-Vice-Chancellor (Research and Enterprise)) (FC 82)

I am pleased to provide the University of Leicester's response to the call for submissions on the impact of spending cuts on science and scientific research as set out in your email dated 14 January.

Taking the issues set out in the call for comments in turn:

1. *The process for deciding where to make cuts in SET spending*

At the moment it is not clear that there is any process. While the cuts to HEFCE budgets have been announced in the secretary of state's letter to HEFCE, how these will translate into reductions in grants to University remain unclear. Furthermore, the level of "protection" that might be afforded to SET subjects is unknown.

2. *What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)*

In general, there is a long time separation, often decades, between the original scientific research and eventual exploitation and economic impact. Often particular economic benefits may result from a combination of discoveries that could not be forseen at the outset of the research. Therefore, it is hard to make a strong connection between specific expenditure on research and benefit to the economy. Individual case studies are useful for illustrating how exploitation can be pursued effectively. However several attempts to assess the overall impact of research (or individual disciplines) never seem to provide useful answers for relating total research spend and its distribution across subjects to economic impact.

3. *The differential effect of cuts on demand-led and research institutions*

Although potential cuts have been signalled where these are likely to fall is not yet known, with the exception of STFC (discussed below). Therefore, it is not possible to comment in detail on this question. However, there are a number of warning signals in terms of the balance between funding of "blue skies" research and research where the potential economic impact may be more evident. There is a danger that funding for the former will diminish. It could be argued that, in the current financial climate, a short term reduction in "blue skies" would not be damaging, but this is not true. Current research capabilities have been established over decades, with strong stimulus during the past 10–12 years. Proposed funding cuts will lead to rapid loss of expertise and capability, through redundancies and closure of facilities. It is clear from the experience of the 1980s and early 1990s that recovery from such a policy takes a long time. In particular, the fact that some countries are putting more money into science as a fiscal stimulus will lead to a drain of talent from the UK.

4. *The implications and effects of the announced STFC budget cuts*

The STFC budget cuts are the most immediate example of the risks outlined above. The STFC was created without sufficient funds to cover the programme it inherited and the situation has been made worse by a difficult CSR outcome for the Council and the financial pressures of the economic downturn (mainly the exchange rate effects on the large subscriptions, but also the inability to provide extra funds to solve the problems). The recent programmatic review, while not perfect, was carried out in a more consultative and effective way than previous attempts to balance the budget. Nevertheless, it was carried out without a clear, published science strategy and the effect is a transfer of funds from the particle physics, astronomy, space and nuclear physics areas into the support for facilities such as Diamond and ISIS. While the rationale, to fully exploit these large national facilities is a valid one, it does mean, conversely that the UK is not reaping the full reward from its international investments as it withdraws from telescopes, space projects and particle/nuclear physics experiments.

One of the most damaging effects of the STFC cuts will be in the severe reduction of the science exploitation grants to Universities. How the cuts will be distributed will be a result of peer review of individual programmes, to be announced later. However, it is clear that smaller research groups may fall below the critical mass needed to function. STFC supports around half of the research carried out in UK physics departments. Therefore, it is inevitable that overall physics departmental finances will be damaged by the cuts and some may no longer be viable. The reduction in exploitation funding will lead to those areas of science within STFC's portfolio where we are competitive with the USA or ranked second, losing that competitiveness and position, thereby downgrading the international profile of the UK. This will exacerbate our ability to compete with our European partners in ESA.

This also puts at risk the government's goals for increasing student numbers in physics and STEM subjects in general. There is already anecdotal evidence that A level students are starting to avoid disciplines which are related to STFC. This will have consequences for these areas of science in the short, medium and long term, if something is not done to change the view.

5. *The scope of the STFC review announced on 16 December and currently underway*

It is hard to find exactly what the terms of reference of the review are. However, there are clearly some areas that need to be considered in any review process:

— The impact of currency fluctuations on subscriptions (ESA, ESO, CERN etc): The science budget would be better protected if these were dealt with, as in other countries, outside the science budget as part of high level international commitments. However, it should be noted that any change now would "freeze" into the STFC budget the current lower level of cash available for grants. Any change should take into account what has happened to exchange rates since the financial crisis began and build in some budgetary compensation for this.

— The balance between facilities operation and exploitation grants: At the moment the facilities operation costs are dealt with by STFC on behalf of all the research councils. Like the subscriptions, these costs are not entirely within the control of STFC and as they increase the apply pressure to the only remaining flexibility; the science grants. Any new structure needs to prevent the continual reduction in the science grants line, which has a damaging effect on Universities and the supply of young scientists into the economy.

6. *The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets*

All areas of research will be undermined by the proposed cuts to HEFCE. Many subjects outside STEM are economically and culturally important, so it is very difficult to argue for protection of STEM subjects within the HEFCE budget at the expense of these. Nevertheless, if STEM provision is not protected in some way, this will add to the difficulties of STEM departments as income from the research councils seems bound to fall. Ideally, the government should reconsider its rationale for targeting higher education for cuts while protecting schools. The production of graduates is a strong driver of the economy, so if the HE system is undermined there will be significant economic damage.

7. *Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–14: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation;*

Until spring 2009, considerable progress had been made towards meeting the objectives of the 2004–14 framework. However, the imposition of the cap on all student places also limited the number of STEM students that could be accommodated without incurring fines. Therefore, in individual subjects the intake of home/EU STEM students either remained static or declined. Therefore, no further progress towards government objectives was achieved. Furthermore, this effective limit on the number of STEM places risks discouraging students from pursuing STEM subjects at A-level and could undermine the genuine progress that has been made in increasing A-level numbers in the physical sciences.

8. *Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses*

No! STEM subjects are expensive to teach and all these places were unfunded. Therefore, this University did not have the capacity to accept any of these additional places.

9. *The effect of HEFCE cuts on the "unit of funding" for STEM students*

Had we accepted any of the additional student numbers, this would have been a de facto acceptance of a lower unit of resource. However, it could be argued that the STEM unit of resource is already too low. Even under recent funding levels it has been difficult to invest appropriately in important facilities and support that underpin teaching programmes. Therefore, any proposed cut to the unit of resources would make this situation worse and might prevent delivery of all or parts of some science programmes. Some of the consequences may be:

— Larger class sizes as a result of a poorer staff/student ratio will make certain types of lab work which requires intensive supervision or specialist small lab facilities near impossible or at least very costly to teach. This may lead to an unintended effect on the STEM curricula.

— In field based disciplines such as Geology and Geography, a poorer staff/student ratio and a loss of resource may impact on the number and quality of field courses that are currently on offer, due to shortages in staff who could supervise the students abroad, leading to a narrower learning experience.

Kevin Lee
Pro-Vice-Chancellor (Research and Enterprise)
University of Leicester

Memorandum submitted by Professor Luc Bovens (FC 83)

MEASURING THE IMPACT OF PHILOSOPHY

1. The question of concern for this inquiry is "what evidence is there on the feasibility or effectiveness of estimating the economic impact of research" in this field? There is a current tendency to think that evidence consists only in empirical studies. But what matters is warrant, and for warrant what matters are the reasons and valid arguments that support the conclusion being warranted. Empirical studies are only a small part of the body of reasons necessary to license a conclusion. There are a number of theoretical and methodological reasons to believe that estimating the impact of philosophical research is not a feasible project.

2. The impact that a body of research has made on an outcome is the *difference* in that outcome supposing that the research occurred versus what would have happened had the research not occurred. This makes finding evidence for the impact of philosophical research especially difficult since philosophical impacts are likely to be felt primarily over the middle to long term; they are likely to be indirect rather than direct; and they are likely to have more cultural effects than economic ones, at least in the near to middle future, and cultural effects are in general both harder to articulate and harder to measure than economic ones.

3. Perhaps a vivid example can help. What effects could be expected on culture, thought, politics and the economy in 25 years time from cutting funds for philosophy research by 25% during the next five years? Or, instead consider the easier after-the-fact question: Had overall available funds for philosophy been 25% less 25 years ago and onwards, what economic and cultural differences would there be now? What differences would such cuts have made on the effects of research contributions from Britain's great and well-known post-war philosophers, such as Isaiah Berlin, Bernard Williams, Karl Popper, Amartya Sen, Mary Warnock, AJ Ayer or Michael Dummett? And what would have been the difference in the effects from the research of the large number of fine but lesser known philosophers doing the "normal science" of the field.

4. We will first present a number of respects in which the contributions of philosophy to social, economic and cultural life will remain under the radar of any measure of impact. Subsequently we will turn to some more formal reasons why this is to be expected in the current state of scientific knowledge concerning what kinds of impacts might occur and how these are to be predicted.

5. Effects likely to be missed in measuring the impact of philosophical research and practice:

(i) *Political debate*. There is no doubt that philosophers like Rawls, Nozick and Sen have had a huge impact on the political landscape and their names often occur in newspaper columns. Does this mean that only Harvard should score on impact? The fact that these thinkers have had an impact on the political landscape is due to the culture of discussion and reflection that philosophy departments offer to their students through their research and teaching. These students then go on in journalism, politics, policy-making etc. The agents of this type of impact, ie philosophy faculties around the world, will sadly remain under the radar.

(ii) *Argumentative skills*. Philosophy department train students in logical reasoning, critical thinking and scientific method. Our students then export these skills in the pursuit of law, scientific research, medical diagnosis etc. But the philosophers that provided these tools will remain under the radar. The situation can be compared to the relationship between calculus and engineering. The mathematics department may have a low score on impact, because their impact in the provision of tools to the engineer would be lost in the measurement of impact.

(iii) *Professional ethics*. Professionals face moral dilemmas throughout their careers and are called upon to make principled morally defensible decisions within their respective roles—be it business, medicine, human relations, etc. In introducing cohorts of aspiring professionals to the history of moral theory, we provide our students with the tools for moral reasoning that will be invaluable in their future careers. Such impact is of great importance to society, but is bound to get lost in measurement.

(iv) *Culture*. It is not uncommon for successful writers, film directors, entertainers, . . . to have an undergraduate degree in philosophy. A society's cultural achievements is often assessed in terms of its philosophical depth. But once again, the chain of impact from the philosophical work to the actual cultural output is simply too long to be measured by impact factors.

(v) *The Good Life*. Last but not least, we live in a culture in which so many people face episodes of mental health—often in need of direction in their lives. Religion has lost its relevance for many people in today's increasingly secularised world. Communal support is often lacking due to the anonymity of the metropolis. Counselling services are of great importance, but they are a cure rather than a prophylactic. C S Lewis famously wrote "We read in order to know that we are not alone". Philosophy has by no means a monopoly on the task of providing insight in the eternal questions that touch on the meaning of life. But it cannot be denied that it is a substantial contributor. When we do lectures and run discussions on the eternal questions and some of our alumni tell us many years later that these courses "made a huge difference in their lives", then have we, as professional philosophers, had "impact"? We think so. But no impact factor has any chance of measuring this.

6. There is a tendency to think that only empirical studies, journalistic contributions or actual physical or cultural artefacts count as impact. But there is a long chain that comes into the creation of these achievements. Now it is easier to measure at the end of the chain, since in tracing the chain backward, it does become more and more difficult to assess the weight of all the agents of impact. And this is precisely the danger. The agents of impact at the beginning of the chain are forgotten, but they are no less real and provide no less of a contribution then the person who signs off on empirical study, the newspaper column, or the creator of the artefacts. In ignoring the agents at the beginning of the chain, we would be only rewarding the workers of the last hour.

7. General methodological difficulties for the feasibility of impact studies for philosophical research in the current state of knowledge.

(i) A first issue to consider with respect to economic and cultural impact is what kinds of effects there might be. This already presents a major obstacle to the feasibility of impact measurement for philosophy since there has, as yet, been no serious work devoted to addressing this issue. We do not have anything like a reasonable starting list of the kinds of effects that the presence or absence of philosophical research could make. Without a reasonable list of the kinds of effects to be studied one can of course not even get started on devising practicable measures and indicators of the size of these effects.

(ii) The necessary tools are not available to calculate even roughly what the difference in these effects would be with and without various levels of philosophical research as input. Nor is it likely that reasonable tools can be constructed before the REF exercise. There are a number of obvious reasons for this: a) the time period over which changes in the amount and quality of philosophy research would produce its most dramatic effects on culture, thought, politics and the economy is probably fairly long term; b) prediction gets harder as time goes on since models of evolution for almost any phenomenon tend to work best short term and because it becomes harder and harder to predict other factors that matter to the impact of the starting differences in research input; c) the possible effects of philosophy research are probably highly interactive so what difference in output might result from differences in input will depend heavily on other factors that are themselves very uncertain and extremely sensitive to large and small scale future developments.

Luc Bovens
Professor of Philosophy

Nancy Cartwright FBA
Professor of Philosophy

Department of Philosophy, Logic and Scientific Method
London School of Economics

Memorandum submitted by Peter Merrill (FC 84)

I am the Head of the Forensic Science and Technology Branch (FS&TB) of the Serious Organised Crime Agency (SOCA).

1. I would respond to the Government's objectives set out in the Science and innovation investment framework 2004–14 and make reference to the need for:

— Increased business-university collaboration[116] with law enforcement agencies in harm (individuals, communities, society) reduction initiatives and projects.

— Controls when new ideas and products are brought to the market for use in the criminal justice system.[117]

— Focus on the changing and developing academic environment[118]in response to course demand and its cause and effect to establish and funded programmes, knowledge transfer and student access.

— Core funded initiatives within the Science and Engineering Ambassadors programme for Higher Education Institutions (HEIs) to assist student access into the law enforcement community.

— To support the Joint MRC/DH Health Research Delivery Group[119] through research collaboration with law enforcement on the analysis of pathological, biological samples.

2. Collaboration

It would be helpful for the needs of law enforcement to be captured within Research Councils' public services programmes. The ability to ensure the challenges that faces the end users and investigators of technology used in crime, enabling crime and the detection of crime are inclusive.

Strategic direction through the allocation and funding exercises would help incentives the law enforcement agenda and assist with strengthening the linkages between the public and private sector research bases. The opportunity to promote science and innovation within law enforcement as a key driver for improved public services, cross-government priority setting and strategy formation for law enforcement to meet the challenges ahead would be of benefit.

3. Controls

There is also a need for commercial products being introduced into the market to be underpinned by robust quality standards, validated systems and against technical specifications developed in partnership with the end users. Those regulatory and ethical issues that need to be considered at the emerging stages are often not addressed until the market introduction phase causing difficulties within the criminal justice system. This would be avoided if criminal justice and law enforcement were embedded within the tasking frameworks.

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[116] IIF 2004-14 Ambitions for UK science and innovation.
[117] Public confidence in and engagement with science and technology agenda.
[118] IIF 2004–14 A strong supply of scientists, engineers and technologists by achieving a step change.
[119] To ensure stronger synergies between the MRC, the Department of Health and NHS on the translation of R&D into patient benefit.

4. Change

The number of UK forensic science courses available continues to increase whilst employment opportunities in the forensic sector are diminishing.[120] Currently only 15 universities are accredited by the Forensic Science Society (FSSoc) resulting in a large proportion of the courses offering poor preparation for a career in forensic science[121] and no coherent national strategy around innovation and research with forensic disciplines.

Whilst forensic science higher education is undergoing rapid expansion, other branches of science have been experiencing a marked drop in popularity. There have been some closures of chemistry departments whilst other institutions now only offer the true sciences in support of forensic science courses. There is an opportunity to harness the excitement surrounding forensic science and technology (computers) to promote interest in science more generally while providing students with the analytical skills and scientific background required by employers. It is also worthy of note that women outnumber men on forensic sciences courses[122] by a ratio of 2:1, making forensic science the most popular science-based degree course with women.[123]

5. Core Funding

There is a need to improve higher education student access (with specific reference to PhD students) at a local and national level in the physical sciences and engineering. It would be helpful for HEFCE funding to universities to also be made available to end users.

It is also important to acknowledge that in pushing forward the boundaries of science and breaking new ground in new technology there is also a criminal investigation requirement to recover, analysis and present evidence that needs to develop in parallel. Often this is not the case and criminals are able to stay "one step ahead" by exploiting technologies.

6. Health Research

Build knowledge and understanding of the harm drug missus causes and of the most effective ways of tackling harm are key drivers for law enforcement and government. This is a priority to which everyone can contribute; improved knowledge and understanding are not ends in themselves but will allow informed decisions to be made.

The analysis of pathological-biological samples (not those taken for diagnostic purposes) retained for medical research purposes and other collections kept for teaching or reference purposes have not been subject to research against law enforcement databases. This could provide a clearer understanding of substance abuse and provide medical researchers, the pharmaceutical and biotechnology industries, academia and government with knowledge and understanding of the harm caused by drugs.

Memorandum submitted by Marco Ripani and Paul Stoler (FC 85)

The anticipated cuts of funding for Nuclear Physics research in the UK have left us deeply concerned. We fear that the UK, one of the leading nations in this field, risks the demise of one of its scientifically and strategically most valuable areas of science.

The CLAS collaboration, which we represent, is a large-scale multinational research collaboration of 244 scientists from eight countries and performs leading edge and next generation nuclear physics experiments utilizing the powerful electron accelerator available at the Thomas Jefferson National Accelerator Facility (or Jefferson Lab), located in Newport News, Virginia, USA. We are investigating the structure of atomic nuclei, which are at the very heart of all matter in the universe.

The nuclear physics groups in Glasgow and Edinburgh have played an important role in this cornerstone field of modern physical sciences from the very beginning, and in the CLAS collaboration since its inception more than 10 years ago. If these severe reductions in the UK's funding for Nuclear Physics were implemented, there would be a great deal of scientific excellence lost, or at least severely damaged. Projects like CLAS play an essential role in the recruitment and training of new young talent for future scientific and industrial innovation, which are put at risk by severe cuts in physical science budgets.

During the past decade the CLAS collaboration has produced numerous publications of experimental results in high impact peer-reviewed scientific journals, and UK scientists have been the leading authors on many of these experiments. In addition, UK institutions have played a significant role in many major European nuclear physics projects.

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[120] House of Commons, Science and Technology, Seventh Report—Education and Training & Select Committee on Science and Technology Fourth Report.
[121] Lambert Review: . . .ensure high quality information is provided to prospective students on course quality and employment. . .
[122] Widening participation in higher education—Public Accounts Committee andHouse of Commons Business, Enterprise and Regulatory Reform Committee—Jobs for the Girls: Two Years On.
[123] SEMTA, Forensic Science: Implications for Higher Education 2004, November 2004.

At this time, Jefferson Lab is undertaking a $300 million energy upgrade which will be completed in 2014. This will allow us to expand significantly on our potential for unravelling the structure of strongly interacting particles (hadrons) and find out how quarks and gluons bind together to form protons, neutrons and nuclei. The JLab upgrade project, and in particular the CLAS12 experiment, provides an important bridge between Europe and the USA. European institutions, in particular those in the United Kingdom, have been playing a very significant part, both with respect to providing manpower and funding. A withdrawal of the United Kingdom at this stage would mean pulling out of a highly successful and promising enterprise. It would severely damage the UK Nuclear Physics groups that participate in CLAS and CLAS12.

We hope that serious consideration will be given to the consequences of these dramatic budget cuts for this, as well as for other prominent activities involving nuclear scientists in the UK.

Marco Ripani

Paul Stoler

Memorandum submitted by the Met Office (FC 86)

1. Science and scientific research is a dynamic discipline rarely undertaken in isolation by any single institute. The strongest progress is often made through continuing collaboration and dialogue across a wide community. The UK is a strong force in the international science arena and in some areas, particularly weather forecasting and climate science, the UK is recognised as truly world-leading.

2. The Met Office is a scientific organisation employing around 400 of the world's leading experts in climate science. It is arguably the Government's largest single science research institution and provides objective and robust climate advice to decision and policy makers across Government. Although not funded through research council grants, we undertake and facilitate significant research in the fields of weather forecasting and climate science.

3. Results of research undertaken by NERC and other institutes funded through the research councils is fed into the Met Office and used here in furtherance of the science and its direct application. It is this healthy community, in which collaboration and openness is encouraged, that has ensured the UK is able to take its place on the international science stage.

4. The future of the UK's science community is of course dependant not only direct grants for specific research but also on the pull-through of science and engineering skills from universities through to research institutes and industry. The Met Office, for example, relies on the supply of quality STEM graduates. It is important therefore to consider spending holistically, including those aspects that contribute to maintaining and developing a healthy science community within the UK; one that is strong enough to perpetuate our international reputation and capability for collaboration.

Memorandum submitted by Durham University (FC 87)

Durham University Input to 1994 Group Response

We append below responses to the specific questions. We should declare a strong interest in STFC funding, holding a 10-year (renewable after five) programme grant for the Institute for Particle Physics Phenomenology, and large grants in the Institute for Cosmological Computing and in Observational Astronomy.

Tom McLeish
PVC Research
Durham University

The process for deciding where to make cuts in SET spending

This question needs to be divorced from political and organisational issues within RCUK. A high-level review should ask:

— What are those fields within SET of high future promise in both fundamental breakthroughs in understanding and technological promise, that are non-incremental in nature?

— In which of those fields is the UK internationally leading or potentially internationally leading?

— Prioritise the intersection of those two classes of fields.

What evidence there is on the feasibility or effectiveness of estimating the economic impact of research, both from a historical perspective (for QR funding) and looking to the future (for Research Council grants)

There have been recent reports by HEFCE on the effect of QR funding, and by EPSRC on the effectiveness and economic return of grant funding. Both proceeded by a sample of case studies carefully researched. In the EPSRC case, the connectivity of partnerships in industry and academic projects in the polymer science sector was followed, and used to identify products and improvements over a 10 year interval. A 10-fold return on investment for the UK economy was found in that case. This methodology (one could call it "phylogenetic tracking") could be used more widespread.

The differential effect of cuts on demand-led and research institutions

It is essential to recognise the plurality of the higher education sector in the UK, and to recognise equally that the performance of the UK's research-intensive universities has delivered for the nation the most efficient producer of research on the planet. Per £, the UK produces more citations, so changes the way more people and institutions think and behave, and creates more innovation, than anywhere else, including the US. This is a huge national advantage but is very fragile. This sector is very exposed to national research funding and teaching funding for its financial viability.

The implications and effects of the announced STFC budget cuts

There are three classes of effect for these cuts:

(1) impact on physics departments;

(2) impact on specific fields; and

(3) impact on UK science and brain drain.

1. It is clear that the amount of money being distributed to physics departments as part of the domestic programme is being reduced. The areas covered by PPAN—Particle Physics, Astronomy and Nuclear Physics—are being reduced by about £30 million per year. That is money that would be going to physics departments. We expect that some physics departments may be forced to close.

2. The size of the financial problem has a number of implications for the long term health of the fields. There is a delicate balancing act between exploitation of the current facilities/experiments and R&D for future projects. In particle physics, the need to exploit the investment at the LHC is tensioned against the need to keep the expertise for future projects like the Linear Collider. Given STFC's decision to fund only (at reduced levels) the PPAN alpha5-ranked, and most of the alpha4-ranked, projects there is concern about the resulting overall balance and options for the long-term future of the UK particle physics programme.

The impact on astronomy is very severe. Astronomy grants are reviewed every year and the results of last year's round are now being finalised. The effective funding cut this round is 20% which, added to the 25% cut suffered in the previous two years, makes a 45% cut in total. Should similar cuts be repeated over the next two years, we will reach a point at which it arguably no longer makes any sense to have an astronomy programme at all in the UK. Yet this is a field that one would certainly seek to maintain under the criteria proposed by the first question above.

3. Already two of the particle physics staff in Durham have left the UK- Professor Weiglein and Dr Moortgat-Pick. The main reason for coming to the UK was the support for Particle Physics through PPARC, and the UK contribution to the International Linear Collider. The main driver behind them leaving was the dramatic change in the UK position on the Linear Collider as described in the STFC delivery plan from 2007.

Despite the best attempts of the community to properly plan for the long term science facilities needed to explore the fundamental nature of the Universe, the STFC era has been an unmitigated disaster. Over the past decade, the UK has recruited from the best available international talent, and as opportunities and funding in the UK dries up, the very best will return to their own countries—who ironically are increasing support for education and science.

The scope of the STFC review announced on 16 December and currently underway

STFC, as it stands must be restructured. The chief executive should be removed.

There are four main problems:

(1) year-to-year changes in international subscriptions beyond the control of the UK;

(2) there is a separation between the funding of national facilities and the RC funding the users;

(3) there is a major conflict of interest between an organisation which runs its own national facilities and subscribes to international ones; and

(4) no functional forum exists in which a national strategy for investment in facilities with appropriate representation for the major stake-holders can be formulated.

To solve (1) and (2), there should be an alignment of the budgets used to support a particular area: the RC with the predominant use of an international subscription takes responsibility for this and the volume part of the subscription is transferred into their budget. Future volume changes in the international subscriptions should come out of the research programme of that RC, but everything else, *which includes currency fluctuations and the inflation compensation built into the international agreements* are dealt with centrally. In year, the non-volume changes for each subscription are compensated centrally at the highest possible level, preferably above RCUK. This proposal follows the suggestion of section 8.9 of the Wakeham review.

To solve (3) and (4) we should develop a national laboratory on multiple sites with the director reporting to a stakeholder Board- to support Diamond, ISIS, etc. It would provide large-scale engineering and computing facilities for both public and private sectors. Subscriptions from RCs are set by the Board on an annual basis in a rolling process with a three-year horizon. The peer review processes of the contracting research council to allocate this time are unchanged. A properly constituted National Laboratory would naturally take its place alongside other national laboratories overseas providing reciprocal free access to facilities.

The operation and definition of the science budget ring-fence, and consideration of whether there should be a similar ring-fence for the Higher Education Funding Council for England research budget and departmental research budgets

There is a problem with "ring fencing" as a policy—as the cuts in higher education currently under consideration amply show. It allows cheap access to "high moral ground" in the media, while abdicating responsibility from a difficult but necessary balancing of priorities. The result is that non-"ring fenced" areas receive disproportionate cuts that follow no strategic thinking. Setting research budgets should be done according to the national value placed on their outputs and consequences, and tensioned properly against other priorities.

In an economy such as the UK's where future manufacturing is an absolute necessity to maintain our balance of payments, yet where this manufacturing base will have to be build on high-added value technology in emerging areas, research is clearly a priority in both public and private sectors. This is especially so in the medium to long term, so it is essential that strategic decisions on research support are not set by measures and mechanisms constrained by the short term.

Whether the Government is achieving the objectives it set out in the "Science and innovation investment framework 2004–2014: next steps", including, for example, making progress on the supply of high quality science, technology, engineering and mathematics (STEM) graduates to achieve its overall ambitions for UK science and innovation

There is some evidence that able young people are being attracted back into STEM subjects at university and from thence into teaching, but there are many obstacles still to overcome. In particular the core numerate science of physics is irreplaceable in the school context if we are to meet the demand of excellence in teaching in the future. The sub-disciplines of astronomy and particle physics regularly appear at the top of the list of attractions to young people considering the subject. The repeated battering received by these subjects under the STFC era of support has damaged this goal, and the current cuts threaten to damage it further.

Whether the extra student support, which the Government announced on 20 July 2009 for 10,000 higher education places, delivered students in science, technology, engineering and mathematics courses

The announcement of the extra support came too late in the admissions cycle to have any influence on recruitment to these subjects. We had already received all our applications and made all our offers well before this point so the extra support had no impact on our planning. The additional support provided allowed us to accept a small number of students in excess of our planned numbers without incurring a fine for over-recruitment, where those students had in any case met the conditions of their offer.

The effect of HEFCE cuts on the "unit of funding" for STEM students

There is a threat to STEM students arising from cuts in HEFCE funding for teaching. If the overall teaching grant starts to fall, there are two ways universities can protect the unit of resource per student. One is to simply reduce the number of home/EU students, which (within the $+/-5\%$ tolerance band) increases the unit of resource. Reducing numbers in lab-based subjects has a greater impact than reducing numbers in classroom based subjects. The other is to move students out of high cost (lab-based) science subjects and into lower cost classroom-based subjects. In this scenario, the institutional income and therefore the average unit of resource remains the same but the students are much cheaper to teach.

Furthermore, to compensate for reductions in HEFCE funding universities are also looking to increase international student numbers. The only way to do this economically in many HEIs who are already "full" is to displace home/EU students. Clearly reducing home/EU numbers in high cost subjects like STEM and replacing them with high fee paying students in the humanities where the "net surplus" is greatest, makes good financial sense in straitened financial times.

So even if the unit of resource for STEM subjects were to be nominally protected in some way, if there is an overall drop in teaching funding there will remain an incentive for universities to reduce the number of students being taught in STEM/lab-based subjects because of the way the overall funding model works.

Memorandum submitted by Hyder (FC 88)

Hyder Consulting is one of the UK's largest engineering consultancies and we provide technical services to clients in the nuclear industry and employ a number of physicists.

We are very concerned that on 16 December 2009, the Science and Technology Facilities Council announced a cut in its support for nuclear physics research to only £6 million per annum. This reduction of 29% for nuclear physics is totally out of line with the much smaller reductions in support for particle physics (4%), astronomy (10%) and space science (6%).

At present, the UK nuclear industry is positioning itself for a new nuclear build programme. This programme will inevitably be dominated by the French (EdF and Areva), Germans (E.ON and RWE), Americans (Westinghouse) and Spanish (Ibderdrola) who will dominate the utilities and vendor roles for the programme. However, we have been optimistic that there will be many opportunities for companies such as ours on the civil design, environmental and safety fronts—all of which require highly qualified physicists and engineers.

At such a crucial time in the new nuclear build programme, it does seem perverse for the STFC to take such a decision. Companies such as Hyder Consulting need to be able to rely on a stream of highly qualified people emerging from the UK's universities for the future health of our businesses and our reputation on the world stage. Around 20 academic staff will cease to work in nuclear physics as a result of these cuts. But the impact on physicists at all levels in terms of the loss of this capability and the message it sends will be much more severe.

In 2008, the (then) Department for Business, Enterprise and Regulatory Reform commissioned Ernst & Young to assess how attractive the UK was to international utilities from the perspective of investment in new nuclear. The UK was ranked third (behind China and the US and just ahead of European countries). Decisions such as the STFC's undermine the steps that are being taken to make the UK attractive. The consequences for security of supply and our competitiveness could be severe.

At such a time, I would strongly urge the Science and Technology Committee to demand an increase to funding to help remedy the shortfall in skills capability. We need the sort of skilled nuclear physicists emerging from the UK's universities to help ensure that investment in the UK's nuclear programme can lead to as many jobs as possible in this country, rather than the need to use overseas supply chains.

John Priestland
Executive Director

January 2010

Memorandum submitted by Vice-Chancellor Professor Cantor, University of York (FC 89)

Please find attached a few comments. I should stress that these are my personal comments, although they reflect my position as Vice-Chancellor of the University of York. It may be worth noting that the University of York was ranked eighth for research in the 2008 Research Assessment Exercise, with over half of its departments ranked in the top 10 for their subject, and with one of the highest proportions of research income per staff in the UK. It is one of only a handful of young universities which is ranked in the top 100 worldwide.

I have four main points that I wish to make.

1. The importance of science funding for the UK economy.
2. The importance of funding fundamental and applied science in an integrated way.
3. The importance of using a broad definition of science.
4. The importance of balancing support for excellence wherever it is found with the need to concentrate funding to ensure critical mass.

I hope my comments are helpful. I am not submitting background evidence but would be happy to supply further details if the Committee felt it would be helpful.

The importance of science funding for the UK economy

The UK is second only to the USA in research output and leads the world in research output per pound spent. Building on this strength will be essential for the UK to rebuild its economy as the global recession comes to an end. The UK is coming out of recession more slowly than many countries across the world. At the same time many of these countries are investing heavily in science and technology in order to rebuild their economies.

I visit regularly countries such as China, Korea, India, Germany and the USA, all of which are serious competitors to the UK and are beginning to grow substantially. I regard it as essential for the UK economy and the health and well-being of UK citizens for us to invest in science research and the knowledge economy. At the same time this investment will, of course, make a substantial contribution to solving major problems facing the world such as climate change and health care.

The importance of funding fundamental and applied science in an integrated way

There has been a long-standing debate in the research community about the relationship between fundamental and applied research. I believe we must transcend this debate and understand that an integrated development of fundamental and applied research is needed. On the one hand blue sky thinking frequently leads to unexpected opportunities to solve major problems. On the other hand applied research frequently leads to the identification of new fundamental problems. We would be foolish to ignore the value of free thinking and we should not be conducting fundamental research without considering potential applications.

I find that when these issues are discussed carefully and sensibly researchers can agree on the value of an integrated approach. At York we created the first science city in 1998 which has since then developed about 3,000 jobs and over 100 technology-based businesses. Science City York was set up to build explicitly on the collaboration between fundamental researchers, applied researchers, business people and policy makers.

It is important, however, not to underestimate the difficulties in trying to measure impact. Robust metrics have not yet been identified. In addition, there is a misconception that the requirement for impact statements in research grants implies an expectation to predict the impact of research rather than a prompt to consider potential applications. The development of impact statements for research grants and metrics for the new Research Excellence Framework is catalysing cultural change and enabling researchers better to identify and articulate the potential effects of their research. I welcome this cultural change.

The importance of using a broad definition of science

There are two ways in which it is important to interpret science in a broad sense. Firstly there are many areas of social science and humanities research which can lead directly to important technological developments. One example is the use of clinical trials to identify how best to deliver improvements in health. Deciding, for instance, how best to administer a new drug requires an extensive research programme, and is of enormous benefit to our health and economic well-being. Another example is the development of new media, which requires fundamental research in the creative arts as well as the underlying computer and IT technology. Secondly most modern scientific and technological developments cannot be implemented successfully without associated investigation of social impact as well as policy formulation. Examples include climate change, genetic modification and stem cell research.

The importance of balancing support for excellence wherever it is found with the need to concentrate funding to ensure critical mass

There has been another long-standing debate in the research community about the relative merits of letting research excellence flower wherever it appears, and developing research in a concentrated way within large research-intensive universities. I believe again that we must transcend this debate and do both. On the one hand excellence should be supported wherever it appears, often in unexpected places. On the other hand some of the most exciting areas of research can only be developed in the context of a large and supportive research environment. We need both independent scholars and large research teams for good intellectual reasons, as well as to ensure value for money and economy of scale.

At York, as at other good universities, we have many individual researchers working in interesting and imaginative fields on their own. However we also work hard to ensure that our research focuses on our particular areas of major strength. For instance, our world-leading plant biology has allowed us to develop new drugs and manufacturing processes. Similarly our world-leading heath science research has allowed the development of new clinical interventions, and our world-leading neuro-imaging research is finding ways to prevent and treat mental diseases. We would not have been so successful if we had not made a strategic decision to concentrate a large number of researchers and a substantial amount of supporting infrastructure into particular fields.

QR has been one of the main facilitators of the exceptional performance of the best UK research universities. The Higher Education Funding Council's decision to spread QR funding much more broadly across the sector after the 2008 Research Assessment Exercise was laudable in a positive funding climate, but the principle of funding excellence wherever it is found can be taken too far. I applaud the recent statements from the Department of Business, Industry and Skills and the Higher Education Funding Council reiterating support for research concentration where appropriate. The most innovative research

often takes place where there is critical mass of excellence and where inter-disciplinary research can also be nurtured. The higher education sector needs to reorganise more explicitly differentiation in research and teaching missions.

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