UK COMPUTING RESEARCH COMMITTEE

Response to "Science and innovation: working towards a ten year investment framework".

The UK Computing Research Committee (UKCRC), an Expert Panel of the British Computer Society, the Institution of Electrical Engineers and the Council of Professors and Heads of Computing, was formed in November 2000 as a policy committee for computing research in the UK. By contributing to policy formation within these three key national bodies, UKCRC enables UK Computing Research to speak with a single voice. UKCRC's members are leading computing researchers from UK academia and industry.

UKCRC welcomes the Government's commitment to developing a ten-year strategic investment framework for science and innovation. We agree that the effective exploitation of science and technology will be critical to sustaining the UK's economic growth and quality of life, and that the Government must play a major rôle in supporting and developing the SET base and in stimulating the flow of research knowledge into the wider economy.

In responding to the consultation questions, we have focussed on our primary area of expert knowledge: computing science and engineering.

Q1. Are these the right areas for the Government and its partners to target over the next ten years? What are the underlying components of success in these areas and what roles do Government and other funders of the science base need to play in achieving these aims?

- World class research at the UK's strongest centres of excellence

We agree that research resources need to be concentrated in the best research groups. In the past decade, the RAE has achieved a substantial redistribution of resources towards the top-rated groups; we believe that this process has gone far enough, at least for the time being, and that any further redistribution threatens to damage the emergence of talented researchers in lesser-rated institutions and the diversity of innovative research ideas. We therefore recommend that the current position is maintained for a period, to assess the consequences of the redistribution that has already occurred.

- Sustainable and financially robust universities and public labs across the UK

We support the Government's encouragement to universities and public laboratories to recover the full economic costs (FEC) of the research they undertake. Nevertheless, this is a radical change and the additional funding provided to Research Councils does not yet allow them to pay FEC for research proposals without greatly reducing the volume of research they support. At a time when there are many more high-quality research proposals than can be funded out of available resources, we would be opposed to any change that reduced still further the probability that an excellent research proposal will be funded.

- A continuing step-change in the responsiveness or the research base to the needs of the economy and public services

Whereas the charters of the Research Councils include wealth creation and quality of life, we observe that this paragraph refers to innovation and the improvement of public services. We encourage the Government to make explicit that quality of life is an important objective, and that SET have a major role to play in sustaining and improving quality of life.

This paragraph also appears to contain some conflation between applied research and technology transfer. It is important that these are distinguished and that technology transfer is recognised as a vital but separate activity that needs stimulation and encouragement across the whole economy.

- Increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent

This is enormously important in our areas of information and communications technologies (including electronics) [hereafter ICT]. The science base has great strengths in ICT that are not well exploited by the wider economy. We believe the Government has a major responsibility to stimulate the take-up of ICT skills, because the public sector is the major UK purchaser of IT Services and Systems, according to data quoted in the Innovation Review.

- A more responsive supply of science, technology, engineering and mathematics skills to the economy, and greater flexibility within schools and universities to attract the skills they need

We agree. At present, the best the education system can do is to try to solve the skills shortages that existed in the recent past. It would be very helpful to have some co-ordinated forecasting of the future demand for graduates in different areas of SET and with different skill levels. Such forecasting might influence students and parents in their views about which courses would lead to longerterm employment opportunities.

- Confidence across the economy in scientific research and innovative applications

The Government can give a lead by basing its policies on scientific consensus, having ensured that sources of potential bias in scientific opinion have been identified and disclosed. The most powerful evidence that Government is treating scientific opinion seriously comes from Department's purchasing decisions, because this involves spending substantial money in areas that are often quite political. In ICT, scientific opinion is not yet influencing procurement policy : there is a strong consensus among scientists and engineers that there is a need for radical change in the way that system requirements are analysed and in the way that systems (and especially software) are designed and shown to be dependable. Government, as customer, and the supply industry have failed to exploit the substantial advances in computer science that have occurred in the past two decades; the result is evident in the cost overruns and high rate of failure of new ICT systems. UKCRC has recently had a meeting with OGC to discuss this problem and we have offered help; we hope that this offer will be taken up.

Q2: Which strengths of the UK science base could be further developed; what are the weaker areas that need to be addressed; and what are the risks to the UK's continued production of internationally competitive levels of research? What criteria should the Government use to help determine its overall commitment to science?

Q3: In which key technology-based sectors does the UK have the potential maintain and grow internationally competitive value added over the coming decade? What are the barriers to capitalising on our strengths and addressing areas weakness in business innovation and R&D? How can investment in the UK science and Government support for business R&D best contribute to that growth?

Answering questions Q2 and Q3 together: the 2001 International Review of Computer Science (IRCS), commissioned by EPSRC and the Royal Society, said that the UK was still internationally competitive in most areas of computer science research but that we had fallen back over the past decade and were likely to slip further in international competitiveness unless steps were taken to reverse the decline. In view of the importance of computer science to wealth creation and quality of life over the coming decades, UKCRC believes this is a situation that requires attention, even though UK computer science and engineering still leads the world in many areas of research. The IRCS highlighted a decline in work on experimental computer systems, which may be closer to industrial requirements but which needs more substantial funding than theoretical work. They also highlighted an imbalance in algorithms and complexity research, where the UK has some excellent people and groups but where the volume of research in the UK is low by international comparisons. The UKCRC has already taken steps to rectify this imbalance, and looks forward to further progress in collaboration with mathematicians.

The recent EPSRC International Review of Mathematics (IRM) draws attention to the importance of the interface between mathematics and computer science, for example in areas such as cryptography, security, game theory, numerical algorithms, compression and data mining which lie (to varying degrees) at the interface between Computer Science and Mathematics. Moreover, as noted in the IRM, there are tremendous opportunities for the application of both Mathematics and Computer Science

within the Life Sciences and e-Science. We expand on these topics below.

UKCRC further agrees with the Wade report that the UK has significant industrial and research strengths in microelectronic system design that are of considerable economic significance and that could be further developed.

Q4: In order to inform decisions on the future investment framework, and building on the Research Councils' extensive consultations with stakeholders, in what areas are there opportunities for the UK research base to excel and contribute to the economy and society, which might form the basis of future strategic research programmes over the next ten years?

Complex, computer-based systems perform vital functions, such as air traffic management, the infrastructure for the proposed ID card, and patient record systems in the NHS. However, the recent Royal Academy of Engineering and British Computer Society report The Challenges of Complex IT Projects indicates that 84% are considered failures. The complexity will increase in future pervasive systems with computers embedded in our environment and interacting with people as they move around in their normal daily lives, at home, at work, while travelling, for medical monitoring, entertainment or education. UKCRC believes that further research should be undertaken on the issues of how to capture user needs and to design and build complex dependable and trustworthy systems which can easily adapt to changing requirements and new technology.

Other high-priority research areas with great economic potential are system-ona-chip design and verification methods, and the Maths/ICT interface discussed above.

As pointed out by both the IRM and the IRCS, there is tremendous potential for algorithms and computational complexity research as the world becomes ever more digital and data sets and computational resources become increasingly more massive. We fully endorse the views espoused in both the IRM and the IRCS, and feel that building upon the existing scientifically strong, though sparse, research base in algorithms and computational complexity, in a coherent manner and embracing the related mathematical communities, is a strategic priority.

EPSRC has made a significant investment in IT-centric Interdisciplinary Research Collaborations (IRCs). These are typically 6-year, £10m research projects that involve several institutions and several disciplines: the Dependability IRC, for example, involves computer scientists, economists, social scientists, psychologists and ethnologists, working together to understand the reasons why some complex IT-based systems are very successful whereas others fail dramatically. Other IRCs include Knowledge Technologies (AKT), Pervasive and User Centered Computing (EQUATOR), image and signals processing (MIAS),and Photonics. The IRCs have just passed their mid-term reviews, and it is timely to consider how the most successful aspects of their work can be taken forward beyond their six-year funding period, to maximise the benefits to the economy from the very successful investment in interdisciplinary research.

Similarly, the large investment in eScience has seen the deployment of advanced computational methods and infrastructure in most or all of the physical and biological sciences and the UK is clearly at the forefront of Grid-based computing. These achievements will grow into new areas of science with great economic potential; they need to be cherished, consolidated and enhanced as part of the science strategy.

Another area of current research that will have a huge impact is the interface between the Life Sciences and ICT. For example, the recent Foresight programme in Cognitive Science focused on one sub-topic that shows considerable scientific and economic potential.

Language and information processing, as illustrated by Web engines, has become a crucial and pervasive form of computing for the public, for companies and for government, as well as for the whole scientific research community. Current search engines exploit research ideas developed and tested over long periods, including ones originating in the UK. Autonomous agent technology seems likely to develop rapidly in the near future. Modern systems for managing unstructured or semi-structured material, ranging from plain text to formatted records and including speech and images, go far beyond conventional database technology and support such key tasks as document retrieval, message filtering, text categorisation, information extraction, summarising, and interactive inquiry and instruction. These tasks are now integral to the whole business of computing and the use of information technology

throughout society and can no longer be treated as peripheral applications. The UK has a long tradition of research in this area, with international distinction. The rapid growth of electronic material and the rapid changes in the underlying computing and communications technology mean that this will continue to be an active and demanding research field which needs positive encouragement.

UKCRC has been working on six “Grand Challenge” topics in Computer Science: long-term (15+ year) programmes of research that have the potential to revolutionise parts of computing, that have significant economic potential, and where the scientific foundations seem ripe for rapid development. These include novel approaches to computation and nature-inspired computing. We would be very pleased to provide further details of these Grand Challenges on request.

Q5: In the light of the changes to be made to the next RAE, how can funding mechanisms build on existing resources and research assessment reforms to reward excellence and underpin sustainability?

No reply.

Q6: What are the main barriers or challenges to the achievement of a sustainable public research base in the medium term? What further action could the Government take, in partnership with universities and other funders of research, to create robust incentives on all parties to work together to deliver greater financial sustainability of the UK’s research base?

In ICT research, there is a significant problem with recruiting and retaining the best people, because the conditions of employment in universities compare badly with those offered by industry. There is also a problem sustaining longer-term research programmes and in finding the travel budgets that would enable the UK to benefit from participation in major, long-term US (and other overseas) research programmes. We can see no solution other than a significant and sustained increase in funding for ICT research. Experience from other countries shows that this would be an investment that returned high dividends to the economy.

Q7: How could funding for universities provided by Government and other funders create stronger incentives for the effective creation management and usage of the research base infrastructure over the next decade?

Future funding under SRIF and similar capital schemes should reward those institutions that are able to show a strong return on investment from earlier capital expenditure.

Q8: What is the optimal means of developing access to large research facilities at national and international level? How should funding of large facilities be prioritised?

Access to large facilities is essential for some research projects; access to the data generated by past experiments using such facilities is sufficient for other projects. It is important that the return to the UK from investment in large facilities, in terms of wealth creation and improved quality of life, is evaluated competitively with the return generated by the same investment in research projects that do not need such access. Otherwise there is a danger that some lines of research may be sustained at a cost that far outweighs their value to the UK.

It is often overlooked that software platforms and software collections are facilities too. For example, the Open Middleware Infrastructure Institute is as important as a synchrotron for the sustainability of a research base.

Q9: The Lambert Review was based on extensive consultation during 2003. Reactions to the analysis and proposals set out by the Lambert review, and in particular to the Government’s proposed response, are very welcome.

UKCRC supports the Government’s proposed response to the Lambert review.

Q10: Following the 2002 review by Sir Gareth Roberts of the supply of scientists and engineers and the Government’s response, what is the emerging evidence on the prospects for the supply and demand of science, technology, engineering and mathematics skills? What further steps could the Government take to ensure that the supply of these skills is responsive to the demands of the economy over the coming decade? How could women and other low participatory groups be more encouraged to pursue

higher education in science, technology, engineering and mathematics and to pursue careers in these areas?

We believe that it is difficult for students to understand the true nature of the work that is undertaken by scientists, engineers and mathematicians. We recommend a sustained programme, starting in primary schools and continuing through Year 12, that exposes students to the nature of work undertaken by SET graduates.

Q11: Do UK business leaders and managers have the necessary skills and knowledge to exploit new technology and research to maximum effect? Where are the areas of greatest weakness and opportunity in terms of sector size of enterprise and level of management? What can and should be done to bridge the gap?

SET skills take many years to acquire. It is very difficult for managers to maintain the knowledge necessary to exploit research in fast-moving subjects such as ICT. This is true in all sizes of enterprise and even in the major management consultancies. UKCRC believes that companies should be encouraged to use specialised SET and R&D consultancies to maintain their “technology watch” and related programmes and to interact strategically with company managers.

Q12: What should the role of Government be in improving the interaction between science and society? Are there areas where Government could improve the promotion of science in society? How can we improve public confidence in the Government’s use of science? What should we be aiming to achieve in this area in the next ten years?

The public understanding of science is a major and growing problem, because SET concepts and technology are becoming more complex every year, to the point where few people really understand the potential, and the risks, in the technology they use.

We believe that there is a major rôle for SET professions and professional societies in helping to bridge this gap, to build and sustain a culture of professionalism so that scientists and technologists deserve, and receive, the trust of the public. No amount of public engagement with science can replace the trusted expert, because expertise is increasingly necessary to understand complex technologies.

Q13: What is the outlook for business investment in R&D over the next decade? How can business investment contribute to the success of a ten year frameworkfor science and innovation?

We believe that the Government has a responsibility to use the power of public purchasing to create a market demand for greater use of SET knowledge in products and services. Government is the major purchaser of IT services and systems, for example, and decades of experience have shown that Government cannot rely on the supply industry to carry out the R&D to make the necessary improvements in their products and services.

Q14: What are the research aspirations and funding plans of the medical charities over the coming next decade? How best can Government and charity funders work together to enhance the impact of their complementary research efforts on national and global health outcomes and contribute to the development and maintenance of a sustainable UK science base?

No reply.

Q15: Are there ways in which Government support for medical research – in terms of both institutions and the distribution of funding - could be better structured in order to maximise the benefits of investment from partners in industry and the medical charities? What should Government and the NHS be doing over the ten years of the science and innovation framework to ensure successful partnership working in medical science in the long term?

No reply

Q16: In light of the second Wanless Report, where are the weaknesses in public health research capacity? How can we improve the links between academics and deliverers of public health, to ensure a strong evidence base both on causality and on effective, well targeted interventions? How should the roles of the various research bodies be better coordinated in relation to public health, to ensure the

public health research requirements are met in a structured and coherent way?

UKCRC is concerned that the emphasis on new ICT systems in the health service will not be matched by an equal or greater commitment to using wellfounded science-based methods for developing secure and appropriate requirements for these systems and implementing them. Without such a commitment, these ICT projects will be very high risk.

Q17: What are the public service objectives and priorities for science and research over the next decade to contribute to policy development service delivery and the wider economy? How can the wealth creation potential of investments in R&D across different Government programmes be increased?

Computer security is one area of particular importance for public confidence in Government programmes. Assuring security in the presence of a skilled adversary requires continuous investment, because new technologies and new attacks are constantly emerging to breach previously secure systems (and because best practice in computer security is rarely followed). The security challenges are changing all the time and it is very important that Departments do not believe that security is a solved problem or that specifying an appropriate assurance level under the Common Criteria will guarantee medium term security of their systems or data. The science strategy should recognise the need for continuing long-term computer security research.

Q18: How can Government best secure greater synergies between research funding, investment and strategies across different public programmes, and link the Government's overall objectives for research outputs with the capabilities in the UK science base?

UKCRC believes that ICT has enormous potential to contribute to almost all public service objectives and priorities, from counter-terrorism and public health to eGovernment, innovation and sustainable development. We recommend that ICT professionals are engaged in helping Government to set strategic goals, and to initiate, manage and evaluate programmes.

Q19: How can the Government and the Regional Development Agencies and their equivalents in the Devolved Administrations help integrate funding of science research on a predominantly national basis with development and delivery of regional economic strategies? In particular how can Government and RDAs strengthen partnership working to facilitate more effective knowledge transfer and research collaboration?

We believe that it is desirable to keep the regional agenda and the science strategy separate. If there is a need to build up the research capability in a particular region, for reasons of regional policy, this should be funded out of regional development budgets and should not distort the science strategy.

There should be no difficulty in RDAs working in partnership with universities in their region, or with universities in other regions where specific expertise is needed that is not available locally, to support regional development agendas. The UK is a relatively small country with good physical and electronic communications.

Q20: Are there barriers facing business and the science base in effective engagement with EU research programmes? How can the UK more effectively influence and benefit from EU research funding and policies? In what ways can action at Community level add value to UK science and innovation policies? How can national and community funding complement each other more effectively?

There is a serious conflict between the EU levels of overhead funding and allowable costs for research and the Government's policy that the FEC should be recovered. Either the EU funding structure should be reformed, or the UK Funding Councils should automatically top-up EU research grants to FEC for admissible institutions. The latter option requires additional resources for the RCs, because it would be catastrophic to reduce the funding available for research proposals in responsive mode and under the existing RC managed programmes. If either of these alternatives can be achieved, we believe that the current mechanisms will work quite effectively to ensure complementarity.

The conflict referred to above is illustrative of a more general lack of consistency between UK funders of research and the EU. For example, several universities were wrong-footed by EPSRC's introduction of Doctoral Training Accounts, where the number of research studentships is allocated by a formula

related to the current level of EPSRC-funded research grants. Universities that had followed advice to bid for EU research funding and that, having been successful, applied for less EPSRC funding, found they were effectively punished for this success by being allocated fewer studentships. Ideally, the UK should adopt a holistic research strategy that is independent of the sources of funding.

Submitted on behalf of UKCRC.
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