UK COMPUTING RESEARCH COMMITTEE

# UK Universities Computing Research : From the 2001 International Review to 2006

**A UKCRC Briefing Document**

**September 2006**

The UKCRC is an expert panel of the British Computer Society, the Conference of Professors and Heads of Computing, and the Institution of Engineering and Technology, for computing research in the UK. This report was prepared by a working group whose members were Professors Steve Furber (Chair), Tony Hoare, Cliff Jones and Karen Sparck Jones. The UKCRC is grateful to all those who helped the group with the preparation of this report.

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# 1 Executive summary

In 2001, the EPSRC, the Royal Society, the British Computer Society (BCS), and the Institute of Electrical Engineers (now IET) invited an international panel of experts to report on the standing and potential of computer science research being undertaken at UK universities, to discuss its likely impact on the UK science base and on the nation's wealth and well-being, and to provide comparisons with computer science research internationally. This International Review (IR01) reported in June 2001.

The present document summarises the changes in the UK research scene between 2001 and 2006, in the context of the IR01 report. It has been prepared by the UK Computing Research Committee (UKCRC), a group of academic and industrial researchers serving as an expert panel for the BCS and IET. It is presented as background information to the members of the International Review panel which has been invited to report on information and communications technology (ICT) in 2006.

This document is focused on, and follows up, points made in the IR01 Report. It is primarily a presentation of relevant data. These data suggest the following conclusions, 1 - 9, about computing research in UK universities in the period from 2001 - 2006. These conclusions are headed by brief statements of the main points made in the IR01 Report.

*(1) UK computer science research, hitherto excellent, is in danger of decline.*
The UKCRC has devoted itself to fighting this danger. It has initiated a Grand Challenges exercise to empower researchers to make explicit their scientific goals, and to take control of the future of their own subject (see section 6).

*(2) The talent pool for academic researchers is shrinking through poor pay and conditions.*
Though the general situation is unsatisfactory, university pay and conditions for senior research leaders and for junior staff have improved. A survey of computing departments in universities visited by the IR01 panel shows that there has been no decline in the talent pool at different levels of recruitment, and in many cases there has been an improvement (section 5, 7).

*(3) EPSRC funding, in quantity and style, hampers effective computer science research because grants are small and inflexible; infrastructure and platforms are inadequately supported; funding discriminates against new area, high risk, interdisciplinary and large experimental proposals.*
Relative to 2001, EPSRC funding for computer science has improved in quantity, and grants are bigger. Interdisciplinary research and large experimental projects are better supported, and work in some new areas has been funded. EPSRC has introduced 'adventure in research' as a criterion for assessing proposals, but it is not clear whether this has improved the success rate for high-risk proposals. Our data suggest flexibility in projects has been about the same as in 2001 (section 3, 4).

*(4) The focus on industrial connectivity of scientific research is an irrelevancy.*
The situation is unchanged or worse. It is government policy that scientific research should be connected with industry, and this policy is pursued with especial vigour in computing as a highly visible area of technology, regardless of the actual industrial realities (section 4, 7).

*(5) Dividing the IT/CS Programme into one programme for computer science and one for physical layer technology would allow increased visibility, better control, and independent budgeting.*
This recommendation was not accepted, and the records do not sufficiently exhibit the real allocation of funding to computer science, physical technology, and communications (section 4).

*(6) Computer scientists should be more involved in formulation of EPSRC policy, and its day-to-day management.*
The EPSRC Strategic Advisory Teams enable computer scientists to express views on policy relevant to their subject; and opinions expressed by UKCRC have been valued by EPSRC staff. However there are rigid EPSRC policies dictating that day-to-day management of grant programmes should not be conducted by those familiar with the scientific area. This policy has been reinforced by frequent rotation of staff (section 4).

*(7) UK computer science research strengths, now at risk, are in formal methods and programming languages; software engineering and system security, architectures, artificial intelligence and human/*

*computer interaction, and bio-informatics.*
We have not attempted to collect data on these specific matters. We look forward to the views expressed by the forthcoming International Review.

*(8) Research in algorithms needs promotion. Opportunities for computer science research within the e-Science programme should be exploited.*
Research in algorithms has gained some support and is slowly improving. Computer Science is now playing a significant role in the e-Science programme, though the subject has not yet been recognised as an e-science in its own right (section 4).

*(9) The UK remains a world leader in some research areas, and a strong participant in many others, but its position is not assured.*
From the data we have been able to collect, UK computing research has been doing quite well. Is it good enough for world class status?

# 2 Introduction

## 2.1 Aims

The UKCRC submitted input to the EPSRC International Review of Computer Science 2001 (IR01). The IR01 Report made a series of comments on, and recommendations to, EPSRC about UK computer science research. This document presents the UKCRC's review of what has happened in UK university computing research since 2001 in relation to the IR01 Report points. Its aim is to show how the responses to the Report points, specifically by EPSRC but also by other relevant parties, have affected UK university computing research in the period 2001 - 2006, and to assess whether their effects helped UK universities maintain or improve on their position compared with that in 2001. We have not attempted to assess whether they have helped UK universities stay at the leading international edge in computing research: that is for the International Review 2006.

The UKCRC has also prepared a companion document on the present state of UK computing research: *UK Universities Computing Research : Current Issues and Research Landscape*.

The UKCRC is not restricted to those working in universities, and has the advantage of wider experience from its members. However since IR01 focused on the state of and support for university research, this document is also about university research 2001-2006.

## 2.2 Coverage

The IR01 Report was addressed to the EPSRC. But it also had implications for other funding bodies, and for the universities themselves. We have taken

a. the IR01 report itself as our primary input;

but have also used

b. the immediate responses to the IR01 Report by EPSRC and UKCRC itself;
c. information about subsequent developments and funding trends extracted from EPSRC's own publications, especially its annual reports and the awards data listed on the EPSRC's web pages;
d. information about other UK official support for computing research directly relevant to the IR01's recommendations;
e. data relating to their computing research supplied by a sample of computing departments at UK universities;
f. data on the UKCRC's own activities;
g. other information bearing on the IR01's findings and recommendations and UK computer science during the period 2001-2006.

Data supporting the text below, and full references, are given in Appendices.

# 3 Review of EPSRC policies and actions affecting UK university computing research 2001 - 2006

IR01 was on behalf of the EPSRC, and its recommendations were primarily (though not exclusively) directed towards EPSRC. The EPSRC responded at the time, in relation to its then policies and plans. We have attempted to see how far EPSRC's subsequent funding and programmes may be taken as operational positive responses to the IR01 points. The EPSRC is the main, indeed dominant, source of funding for UK computer science research, so the impact of EPSRC's policies and operations on UK computer science research is critical for the quality, range, and influence of that research, and for its international reputation.

## 3.1 Reference summary of main IR01 comments and recommendations

The main points made in the IR01 Report, as given in its Executive Summary, are:

1. UK computer science research, hitherto excellent, is in danger.
2. The talent pool is shrinking through poor pay and conditions.
3. EPSRC funding, in quantity and style, hampers effective computer science research because grants are small and inflexible; infrastructure and platforms are inadequately supported; funding discriminates against new area, high risk, interdisciplinary and large experimental proposals; and industrial connectivity is misconceived.
4. The EPSRC IT/CS programme should be divided, and more computer science researchers involved in programme operations.
5. UK computer science research strengths, at risk, are in formal methods and programming languages; software engineering and system security, architectures, artificial intelligence and human/computer interaction, and bio-informatics.
6. Research in algorithms, in experimental computer systems, and computer science research within e-science, need promotion.

## 3.2 Reference summary of the EPSRC responses to IR01

EPSRC's immediate response to the IR01 Report was a detailed Action plan with point-bypoint replies to the IR01's comments. These can be summarised as follows.

On funding: there is less rigidity in EPSRC than believed, but EPSRC will proactively encourage e.g. applications for larger projects, and experimental work. It is bidding (in 01) for more money for computer science, including for e-science and architecture work, and highlighting the need for algorithms and experimental research; it is allocating more money for platform grants and for envisaged portfolio awards; it is working to promote interdisciplinarity, and novel ideas through adventure awards. It wants and needs the research community to respond (in proposals and refereeing) to these opportunities. Though connectivity with industry is encouraged, it is not required. In evaluation, individual grant reviews can consider a range of outputs.

EPSRC can help project staffing by its flexibility on pay, and encourage PhD work through its flexible (upcoming) Doctoral Training Accounts. However university pay generally, and standard infrastructure support, are beyond its remit.

On organisation: EPSRC notes there is no community support for separating IT and CS, but is revamping to create an integrated Information and Communication Technologies (ICT) sector, with a substructure allowing computer science to interact with "other disciplines".

EPSRC adheres to its generalist staffing policy, but has computer scientists on top advisory bodies and has established Strategic Advisory Teams (SATs) for technical community interaction.

## 3.3 EPSRC policies and activities in computing 2001 - 2006

For our analysis we have used readily available public EPSRC materials. We do not have the resources for a fine-grained investigation. But we believe that the data we have used, and our interpretation of them, allow us to make appropriate comments on EPSRC's treatment of computer science research since IR01.

We have used:

1. the EPSRC Annual Reports 2002-2003 [AR2-3], 2003-2004 [AR3-4] and 2004-2005 [AR4-5]

2. the EPSRC Grants on the Web(GOW) pages, calendar years 2002 [GOW2] and 2005 [GOW5]

The financial data in AR4-5 include three-year comparative figures, and the combined data for (1) and (2) allows trend observation. However since the data differ in e.g. timing and, doubtless, detailed financial reporting conventions, monetary figures cannot be compared across (1) and (2). We note also that ICT subsumes both software and hardware and (post IR01) communications research, so it is hard to make a fine-grained assessment of computer science state. We nevertheless believe that the broad analysis we make is robust.

We have organised our analysis of this material within the context of the IR01 Report Executive Summary (IR01ES), and specifically the following comments there:

IR01ES, Paragraph 3, says:
'The level of EPSRC funding and the manner in which it is distributed make it unnecessarily difficult to be an effective researcher in a UK university. Funding is low by international standards, and responsive -mode grants ... are too small and lack the flexibility that would permit investigation of questions that had not originally been anticipated. Research infrastructure ... is inadequately supported; funding to build research platforms ... is also difficult to obtain. The process by which funding decisions are made discriminates against proposals in new areas, proposals involving larger experimental projects, and proposals that describe high-risk or interdisciplinary projects.'

IR01ES, Paragraph 4, says:
'Dividing the IT/CS Programme into one programme for computer science and one for physical layer technology would ... bring clear benefits.'

IR01ES, Paragraph 6, says:
'Two noteworthy imbalances should be redressed by encouraging research in algorithms and in experimental computer systems. ... given the opportunities that the recently announced 3-year e-Science initiative will create, the decline in UK research activity in high-performance scientific computing and the absence of funding within e-Science for longer-term computer science research seem ill-considered.'

The data we have drawn from the Annual Reports and Grants on the Web are given in full in Appendix A. The main points we make are as follows.

### 3.3.1 ICT support as a proportion of 'regular' spend

Considering ICT activity as a whole, ICT is the largest of 9 subject sectors: it amounts to nearly 20% of the whole over the three years reported. Moreover while some of the investment growth over the period reflects accounting 'forward', we understand there has been a real increase in ICT support.

Further, in core programmes, representing mainstream research support and specifically responsive mode awards, ICT is roughly equal largest sector with Engineering, at 20% of the whole.

We note that the research grant success rate for core programmes, comparing 02-03 with 04-05, is about 30%, slightly lower for the later period.

### 3.3.2 CS support within ICT

ICT covers a large range of work, both CS and 'non-CS'. We have used Panel names in the GOW data, checked against sample grants, as a means of allocating research support to CS and nonCS respectively.

We take CS to include, from the larger spend areas after grouping closely related panels, Software Technologies (GOW02), Computer Science (GOW05), People and Interactivity (02,05) and WINES (05), along with some smaller items. We have deemed half of Communications to fall within CS. NonCS includes, as major items, Photonics (02,05), Electronic and Functional Materials (02,05), Instrument Development (05), and Healthcare Engineering (a large sector, about 20% of nonCS, 02,05), again with smaller items, and with half of Communications. The CS/nonCS division is crude and may misclassify some projects, but is unlikely to affect the bigger picture.

In both 02 and 05 CS is a smaller proportion of the whole than nonCS. However when the two are compared over time, CS has risen from just under 50% of nonCS to nearly 75%, and CS proportionally more than nonCS (about 130% against 45%), though all these figures are only indicative given the rough subject division, lumpy initiative effects etc.

Considering individual grants, there are more nonCS than CS grants. However the number of CS as against nonCS grants has risen, and average CS grant size has increased relative to nonCS. Average grant size for both CS and nonCS has also risen. We understand that some of this is attributable to higher costs, but that projects have also grown in real terms, primarily by having more staff.

### 3.3.3 ICT/CS in other EPSRC activities

*a) Portfolio partnerships*
ICT portfolio projects figure proportionately to ICT in regular funding.

*b) Platform grants*
We know that there have been some CS platform grants. But the CS proportion within ICT cannot be determined without studying individual grants, at a level of detail beyond this study.

*c) Interdisciplinary Research Collaborations (IRCs)*
The EPSRC initiative in IRCs in ICT began at about the time of IR01. Five collaborations representing logical rather than physical research centres were funded (one jointly with MRC) from 2001 - 2006 for some £ 30 M. They are on Advanced knowledge technologies (AKT); Dependability of computer-based systems (DIRC); Technical innovation in physical and digital life (Equator); Medical images and signals (MIAS); and Ultrafast photonics (UPC). The IRCs each have many partners, and collectively range widely over computing. They have important, though variable, computer science content. They are currently winding up, and the lessons to be drawn from them, and form of any follow-up, as well as actual results, are significant for the conduct of UK computing research.

*d) High-performance computing (HPC)*
EPSRC support high-end HPC facilities, specifically hardware, and there is also some support for software through both Collaborative Computational Projects and individual grants. However provision for HPC extends beyond EPSRC and overall appears very ad hoc. It is far from clear how much computer science is involved; but it is likely that more joined-up provision would encourage, where appropriate, more effective computer science work.

*e) Science and Innovation Awards, IDEAS Factory, etc*
Other specific initiatives include Science and Innovation Awards and IDEAS Factory grants. There do not appear to have been any straight ICT/CS Science and Innovation Awards; we know of one IDEAS Factory grant.

*f) BAE/EPSRC Strategic Partnerships*
BAE/EPSRC Strategic Partnerships are devoted to academic/industrial collaboration and include one IRC-like centre engaged in computer science research.

### 3.3.4 ICT/CS in joint EPSRC and other council activities

*a) e-Science*
E-science is a multi-council operation. EPSRC's spend on e-science has grown substantially over the period. By definition ICT figures in any e-science operation, but this does not imply e-science projects must involve computer science research. The EPSRC has engaged with e-science in several ways: first, through the UK e-Science Core programme, which underpins e-science projects; second, through its own e-Science programme within ICT; third, through a CS in e-Science stream within this, worth some £ 9 M (GOW does not separate the the third from the second). Thus while projects supported by the EPSRC under the Core programme are not primarily about computing or specifically computer science research, they may have some computer science research elements. The e-Science in ICT programme includes again projects that are not computer science ones, but which may have some CS elements. However through its specific CS stream this programme has directly supported various CS projects including four large platform grants. This programme is a response to the recognition that the e-Science programme should address computing research and not just computing service, to which the IR01 Report's point that e-science constituted a challenge, and opportunity, for CS research may have

contributed. This recognition has been a positive development for computer science research.

Computer science also figures in e-science projects supported by other research councils, but we cannot readily determine to what extent it has figured or whether such other e-science projects have in fact stimulated subsequent computer science research. An overall assessment of computer science's role in the e-Science effort would be very valuable: there is certainly no reason to suppose that it will not continue to be needed in future.

*b) Basic Technology*
EPSRC spend on this cross-discipline research has also increased, and includes, apparently proportionately to regular funding, support for some ICT and specifically CS research.

### 3.3.5 Miscellaneous

To supplement this AR and GOW information we note the following.

*a) Wired and Wireless Intelligent Networked Systems (WINES)*
The EPSRC WINES programme, stimulated by a joint manifesto from the UK-Ubinet management committee and the EPSRC ICT Strategic Advisory Team, began in 2004. WINES projects are multidisciplinary, extending well beyond computing, e.g. to psychology, and finance. The twelve projects funded so far are large and represent a significant EPSRC contribution to both the multidisciplinary research and the large experimental research called for in the IR01 Report. The WINES activity has also fed into one Grand Challenge and helped it to hit the ground running (see further below).

*b) Algorithms*
There have been some positive developments in algorithms research. The IR01 Report highlighted the weakness of UK algorithms work, and recommended EPSRC promote the area. The algorithms community itself has successfully pressed for development, and has grown slightly overall, with substantial expansion in research at Durham and Liverpool. Further, EPSRC's recent Science and Innovation Awards covered the Mathematics/CS interface, leading to an award to Warwick that includes provision for algorithmics posts.

However, offsetting these improvements, it has proved difficult to build up algorithmics research because university departments are being squeezed by falling undergraduate numbers, and because algorithmics work does not call for, and hence cannot be supported by, lab-scale funded projects. The lack of projects makes it hard to fund doctoral students. As these are vital for future algorithmics research, the algorithmics community is proposing several 'grant-type' mechanisms geared to doctoral student support to EPSRC.

*c) Grand Challenges*
EPSRC has begun to support Grand Challenge-related research (see Section later), through networks and also some response-mode grants that fall within challenge areas.

*d) Fellowship schemes*
The cost of these is included in the AR-derived data on total spend under programmes above, but excluded from our detailed analysis of grants using GOW data. The role of fellowships in fostering computer science research is considered below in the context of other, non-EPSRC, fellowship schemes.

## 3.4 Assessment of EPSRC computer science support 2001 - 2006

Changes in labelling and reporting make detailed comparisons between 2001 and 2006 impossible. But taking all the data in this section together in relation to the IR01 Report's main points for EPSRC, we find the following[1].

*a) Funding*
The IR01 Report called for an increase in funding for computer science research.

[1] Full economic costing for research grants came in too late to affect our analysis. Its effects on all councils' research funding are likely to be far-reaching.

The figures for ICT support over the period show a very substantial EPSRC commitment to ICT as a whole. More specifically, for CS in particular (as we determined it), these data show a significant, and sustained, degree of support for CS research and, it appears, increasing support for CS as opposed to nonCS research within ICT, in the primary area of spend, core programmes.

However ICT funding as a proportion of EPSRC spend has remained roughly constant. The relative sizes of the EPSRC sector slices appear more determined by historical inertia than systematic (re) assessment. The static ICT funding has not matched the growing importance of computing in every area of science and life.

The IR01 Report called for the separation of computer science and physical layer technology within what was the IT&CS. They have not been separated, and including communications has made it even harder to assess just how adequate funding for CS has been, even when allowance is made for the many cross connections that reflect the intellectual development of the field as a whole.

But the static ICT sector funding implies that while CS against nonCS funding has risen within ICT, CS research is unlikely to have been supported to the extent that its foundational role for ICT, and hence eventual ICT applications, requires. Indeed though acceptance rates for ICT as a whole are about 30%, the Computer Science Panel (itself rather broad) has had acceptance rates as low as 17% (by value and number), with top-quality proposals not funded.

Grant sizes have usefully increased, but this also puts pressure on the number of grants that can be funded. With respect to more specific points made in the IR01 report, the IRCs have been significant interdisciplinary projects, and CS also has interdisciplinary connections through e-Science and more particularly the WINES programme. However it is not yet clear what will follow these major, time-limited initiatives. There has also been improvement in other important areas, notably experimental projects. However it is impossible to judge, from the data we have used or the publicly available project summaries, whether projects that have been funded have become more adventurous or high risk, as opposed to incremental, or flexible as opposed to rigid. EPSRC has been actively encouraging ‘adventure in research’ and making this an explicit criterion for assessing proposals, but it is not clear how far the peer reviewing community has taken this on board.

*b) Organisation*
As noted, EPSRC rejected the IR01 Report recommendation to classify computer science separately from physical layer technology, or even to call it Computer Science. (The recent specific Computer Science panel has had a narrower brief.) In 2001 the sector was labelled ‘IT and Computer Science’; it was subsequently adjusted to include Communications. This makes it difficult to establish that the extent and form of support for CS is adequate and appropriate.

There has also been no positive response to the IR01 Report recommendation to engage administrators with an acquaintance with or understanding of the branch of science that they administer. This has led to the general view that the selection of referees, and consequently the whole grants process, though scrupulously fair, is more random than it need or should be. The general demand for employees with ICT skills implies that EPSRC is unlikely, as a matter of course, to have staff with some generally relevant background, and secondment, which operates successfully (i.e. sufficiently objectively) elsewhere, may need reconsideration to ensure that as economically important a sector as ICT is managed at the highest level of expertise.

*c) Exploitability and technology transfer*
The pressure from overarching bodies through to EPSRC for industrial linkage is strong. Thus the Treasury has given EPSRC the objective of achieving industrial linkage in 50% of its funded research activity, and EPSRC has indicated that it expects this to be higher in ICT, and by implication therefore in computer science, to compensate for lower levels in less applied disciplines. Industrial linkage has little relevance to research quality, and this expectation may work against the need to develop this relatively new science and recognise its longer-term payoffs.

*d) Effects of the 2001 EPSRC Action Plan*
In general, EPSRC appears to have adhered to the Plan it produced in response to the IR01 Report, with relatively consistent follow through over the period to 2006. Taking the evidence of this section, especially in relation to research rather than organisational issues, together with that of Section 5 below suggests that the planned actions have had some effect, and this has been a positive one for UK

computer science research. But have EPSRC or the universities succeeded in maximising the potential benefits?

# 4 Other official UK programmes bearing on computing research 2001-2006

While EPSRC is the dominant funding agency for UK computer science research, there are other public and similar bodies that influence computing research and the manpower it needs, and hence complement, or enhance, EPSRC effects. The most important of these bodies are EPSRC's superior, OSI, and its peer research councils, and the societies and institutes that support research fellowships.

## 4.1 OSI and Foresight

Quite apart from OSI's role in allocating funding to the research councils, it has sought through its Foresight activities to identify major themes where significant, cross-disciplinary research is required. The expectation is that relevant research councils will actively encourage research effort related to the themes, though not necessarily by way of specific managed programmes.

In the period 2001 - 2006 there have been two themes with important implications for ICT generally and computer science specifically, namely Cognitive Systems, and Cyber Trust and Crime Prevention. The former was followed by an inter research council call for proposals, but without any specific earmarked programme. Foresight themes appear to have a positive impact in bringing communities together, and providing justifications for adventurous research proposals, though the overall longer-term benefits are hard to judge.

## 4.2 Other research councils

All of the research councils support research that involves computing. Though in many cases this is likely to be applications-oriented without a significant computer science component, in other cases the research may involve computer science. E-science involves other research councils including even AHRC, and while EPSRC owns the e-science core, the participation of the other councils is extending computer science connections in both grants and programmes, for example the joint AHRC/EPSRC programme on Designing for the 21st Century. Other research council topics where computer science has an actual or potential role are illustrated by research on bio-informatics, spatio-temporal databases, security, and the e-society.

There are no readily available data on the extent to which computer science figures in research supported by other research councils. But it is evident that these councils do not make a large contribution to support for computing research, and that EPSRC is by far the most important funding agency for computer science. The main role that other councils play is in fostering cross-discipline interactions as, for example, in Cambridge grants from AHRC and BBSRC and Manchester ones from BBSRC.

## 4.3 Other Government initiatives

The Department of Trade and Industry has funded some academic/industrial collaborations in the ICT area with shorter-term, closer-to-market objectives than usual EPSRC projects. The first phase on new wave technologies included computer science research on pervasive systems; the second, broader phase still included ICT projects. There are also several very substantial Defence Technology Centres, with joint academic/industrial participation and involving some computer science research.

We have not attempted a detailed survey of government-sponsored projects with ICT or computer science aspects beyond the EPSRC research funding programmes considered in Section 3, and particularly not in other Government departments. We believe that while there may be specific projects of value for computer science research, support from outside EPSRC is much less significant for computing research as a whole than EPSRC's own.

## 4.4 Fellowships and awards: EPSRC, the Royal Society, the Royal Academy of Engineering, and other bodies

Both EPSRC and other societies and professional bodies are important through the personal fellowship

programmes they support, which are of high standing and allow concentration, perhaps for as long as five years, on personal research. The societies thus provide opportunities for computer science researchers in addition to EPSRC's own senior and advanced fellowships.

*a) EPSRC fellowships*
AR4-5 (p 34) shows the number of Advanced Fellowships slowly rising since 2001, with nearly 200 current in 2005, along with a small number of Senior Fellowships (14 in 2005).

GOW data (at 7.06) lists 20 Advanced Fellows in IT, with slightly more than half in computer science. These figures suggest, though a correlation with sector programme spend is not necessarily to be expected, that there are fewer Advanced Fellowship holders in computer science than might be expected, and why this is so deserves more investigation.

*b) Other fellowship and award schemes*
The Royal Society has a range of fellowship schemes, e.g. Wolfson Research Merit Awards and University Research Fellowships. The former include 10 current holders known to work in computer science, the latter 6, and there are also computer science holders of other types of high-status fellowship awards.

The Royal Academy of Engineering has several fellowship schemes, including senior fellowships and, jointly funded with EPSRC, postdoctoral fellowships. Again, there are known computer science holders of these last which support researchers at a particularly significant career development point.

Other bodies, notably the British Computer Society and IET, have high-status prize schemes, for example the BCS Roger Needham Award for younger computing researchers established in 2003, that signal excellence though they do not fund the recipient's work.

All of these schemes have been offering slowly increasing opportunities for, and recognition of, high-quality computer science research, independently pursued over the long term. The fellowships have practical value in offsetting the teaching and administrative pressures on university staff, and are crucial for leadership in research. Detailed data are not readily available, but there is an impression that computer science is not yet sufficiently represented.

# 5 UK university computing research developments since 2001

The IR01 team visited eight universities' computer science departments/computing schools. For the present analysis, we returned to these universities, namely Bristol, Cambridge, Cardiff, Edinburgh, Heriot-Watt, Imperial College, Manchester Computer Science and Manchester Informatics (ex UMIST). We asked them to supply us with information about influences on computing research and how this has developed in their university between 2001 and 2006, in the context of the IR01 Report points. Seven out of the eight departments/schools replied (one was unable for independent reasons to respond).

By selecting the same representative sample for our survey as was used for IR01, and getting an almost complete response, we hoped to obtain fairly reliable conclusions about differences between 2006 and 2001. We further believe, on the basis of our general information about the situation, that the snapshot of trends in university computing research since 2001 that we provide, using the responses to our questionnaire, is broadly indicative of the larger picture.

We are very grateful to all those in the universities we approached who replied to the questionnaire.

The universities illustrate research in a range of institutions with different histories and concerns in the field. They vary in size from 25-74 faculty, and from 45-200 PhD students (with most having more than 100), and all have undergraduate, masters and doctoral teaching, with a wide range of courses.

Our survey questionnaire is reproduced in Appendix B. As it is geared to the IR01 Report, the questionnaire addresses

1. the issues of people supply, funding patterns, and matters affecting research infrastructure; and
2. the roles of programme types and other initiatives that affect broad areas and styles of computing research.

Thus with only a few exceptions, due to the IR01 Report itself, our survey does not report on specific technical subjects and the development of work in individual areas of computing theory, systems, or applications.
The Appendix also shows the totals for each response option (there were a few cases where respondents could not answer for reasons given). In general the responses show fairly clear trends, which allow us to summarise the situation, and specifically developments since 2001, in Subsection 5.2 below.

## 5.1 The form of the questionnaire

The questions asked all follow directly from the IR01 findings as summarised in the IR01 Report Executive Summary. As shown in detail in Appendix B, they fall into groups, with individual questions and subquestions seeking information on specific points prompted by the IR01 Report, as indicated by quotations, for the period 2001 - 2006. For example:

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IR 01, ES Para 3
‘‘... [EPSRC] responsive mode grants ... are too small ...’’

Q 7

a. Has there been any change in your average grant size since 2001
   (in research terms, ignoring inflation, pay rises, changed cost models) ?
   bigger / about the same / smaller
b. Have you had any ‘larger’ grants (more than 2 RAs or more than 4 years or vast equipment) since 2001 ?
c. Have you had any portfolio grants ?

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Comments:
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## 5.2 Summary of responses

### 5.2.1 People (Q 1 - 6)

The first set of questions deals with people: the IR01 Report was concerned with the manpower supply for effective UK computing research. Questions 1 - 6 ask about the supply of posts; about senior and middle-ranking faculty (assumed to engage in both research and teaching); junior research staff; and about graduate and undergraduate students. They ask specifically about changes in the pool size, quality, and sources (UK/nonUK) for staff and students, and about students continuation into academia.

The returns show that on the whole the supply of people for faculty posts, and their quality is better than, or the same, as in 2001. At the key research ‘feeder’ level, i.e. research assistant and doctoral student, the supply and quality is also better than or the same as in 2001. There appears to be a trend towards nonUK research assistants.

All the universities are suffering from a decline in the supply of undergraduates: this is a widely-recognised matter for serious concern.

The overall conclusion about people is thus generally positive in relation to 2001, except for undergraduates. The returns (including informal comments made) suggest that UK computing research is not generally held back by a shortage of suitable people. There may be problems in specific areas but we did not seek such particular information.

### 5.2.2 Funding (Q 7 - 21)

The second set of questions deals with funding, i.e. research funding at the level of whole departments. The specific questions again arise directly from the IR01 Report statements. They therefore ask about EPSRC funding for responsive mode grants, infrastructure support, and research platforms; about whether funding decisions recognise new areas, large experimental projects, high risk, and

interdisciplinarity enough; about specific grant lines such as Science and Innovation Awards, and e-science; and about forms of industrial funding and other company relationships, both within and beyond EPSRC contexts. The final set of questions seeks information about funding from other sources than EPSRC, especially public sources, from within or outside the UK, since this affects EPSRC's significance for research support, in both volume and style terms.

**EPSRC's own funding (Q7 - Q15)**

The questionnaire returns show (Q7) that grants have become somewhat larger in real terms since 2001, and have included a few portfolio grants.

There is no solid evidence about greater flexibility about the work done (Q8), though this is primarily because this is a matter for individual investigators and not known at department level.

There appears to be no material change towards significantly more support for infrastructure (Q9) than in 2001, though some departments have infrastructure grants. The same applies to platform grants (Q10).

However there seems to have been an improvement in support for research in new areas (Q11), though we do not know whether this refers to pure responsive mode funding or to special programmes. The same applies to larger experimental grants (Q12), though we do not know in particular how far the improvement is attributable to the WINES programme.

There appears to be only a slight improvement in grants for high-risk research (Q13). But the responses do show a gain for interdisciplinary research (Q14), and some departments are participants in the ICT IRCs.

Science and Innovation awards within CS (Q14) are conspicuous by their absence.

Finally, for support for computing science research within the EPSRC e-Science budget (Q15), there is again a blank, though this is likely to be due to our small sample size, since some UK departments are involved in e-Science projects.

The overall message of the responses to these grant questions is that, for the aspects of EPSRC research funding that the IR01 Report highlighted as needing attention, there has been some improvement in grant size, in support for research in new areas, for interdisciplinary research, and for experimental projects, along with a perceptible increase in risk taking. Some part of the change in new areas and interdisciplinary research may be due to natural shifts in the field as a whole. In relation to other points, e.g. platform and infrastructure grants, there has been a slight improvement.

**Relations with industry (Q 17-18)**

There is clearly industrial tie-in with EPSRC-funded projects, and an overall positive situation with respect to startups. However the extent to which either can be attributed to EPSRC policy specifically, the former directly and the latter indirectly, as opposed to intense government pressure for technology transfer in general, is unclear. The slight increase in industrial funding, whether from within or outside the UK, may also be at least partly attributable to the pressure for industrial relevance.

However, though the evidence we could obtain from the departments in our sample was patchy, it appears that non-trivial industrial contributions to EPSRC projects are well below the 50% expectation, for example only 10% even for a top-class department. It appears that there is considerable short-term variation, while long-term relations with a few partners may have a large-impact. There is no evidence that university computing departments are not actively seeking the industrial partnerships they are encouraged to develop, and we know individual departments have many and fruitful industrial connections. But these may not, and in some cases could not, naturally lead to immediate or significant industrial funding.

**Non-EPSRC funding (Q 19-21)**

The proportion of EPSRC funding as against other public UK funding (Q19) has increased more than decreased. In relation to non-UK funding sources compared to UK (Q20) there has been no common

change. More importantly, the individual ratios reported show that UK funding dominates, typically as more than 85%. The relation between independent industrial/business and other funding shows a slight increase for the former, but the individual numbers reported show that as a proportion of total funding it is, with one exception, low.
Taking the responses on industrial relations and non-EPSRC funding together, it is evident that EPSRC support for university computing research is far more important than any other, and that in absolute terms, industry's contribution is comparatively small.

### 5.3 Implications of the survey

Though, as noted, our survey was not on a scale to justify definite conclusions, it is possible to see indicative trends. Thus for many questions the majority of responses are either (better+same) or (same+worse). More importantly, the former predominate over the latter. The overall, broad brush conclusion that we draw is therefore that the situation for computer science, and specifically computer science research, in UK universities is better than it was at IR01. Moreover, as far as the questionnaire went, the responses suggest that, in relation to research funding, EPSRC has contributed to this improvement.

However this is strictly a relative conclusion. Our survey did not address, and does not provide information about, comparative international standing.

## 6 UKCRC's initiatives 2001 - 2006

The UKCRC started as an informal group of experienced computing researchers, with the preparation of a briefing document for IR01 as an early action. Since its foundation the UKCRC has established itself, increasingly broadly, as a voice for those engaged, in the UK, in computing research. As an expert panel jointly of the BCS, the CPHC, and the IET, it is supported by the major ICT professional societies in the UK, and it has members from UK universities, industry and business, and the public sector.

UKCRC has no executive powers and thus aims to promote computing research through informal initiatives within the community and the quality of the technically-based advice it offers others. Thus while UKCRC began by submitting input to IR01, and responding to the IR01 Report, it has recognised that to encourage UK computer science research it has to act itself and not just comment on others' actions. It has therefore undertaken two significant initiatives of its own. Working closely with the BCS and the IET, for whose support it is grateful, it has promoted the UK Grand Challenges in Computing Research, and it submits technical briefing documents on computing, communications and IT matters generally to government and other public and similar bodies.

### 6.1 UKCRC and IR01

UKCRC submitted a very substantial document, *UK Computer Science Research: Vision and Opportunities*, to IR01. The particularly pertinent points it made were:

a. that the UK academic community had a record of world-class research and successful industrial transfer, and a vibrant research agenda; but
b. that other countries were investing more in university computer science, UK industry was investing little, the university system had suffered long-term financial damage leading to staffing difficulties, and that research councils were not planning increased general investment in computer science apart from a few specific programmes.

UKCRC therefore called for long-term research funding, measures to attract students and improve staffing, and a study on the best ways of promoting effective academic/industrial relations.

In response to the IR01 Report, UKCRC welcomed the Report's emphasis on the importance of computing research and computer science as a distinct discipline, on the need to combat erosion in staffing and research funding, and on the need to encourage specific types of research, such as high-risk and experimental work. UKCRC also undertook to act to help renew UK computer science research

by identifying and developing new themes, by seeking to involve computer scientists more in policy and decision making, and by proposing means to encourage desired types of research project. It also called on EPSRC to divide ICT, to develop an appropriate model of academic/industrial relations, and to remove over-strong conditions on doctoral students.

## 6.2 UK Grand Challenges in Computing Research

Since the primary goal of the UKCRC is to promote the quality of computing research in UK, as judged by the highest international standards, it conceived the Grand Challenges exercise as its primary method for reaching this aim. The exercise is oriented towards raising the level of ambition of computing researchers in this country to make fundamental contributions to the basic scientific goals which characterise our subject; and where appropriate, to engage in, initiate, plan or even to lead international initiatives in the area. The intention is that, as in other branches of science, the Grand Challenges should address basic questions internal to the scientific discipline. They should therefore complement and co-exist with other current national initiatives: for example, in the UK initiatives that favour interdisciplinarity, e-science in general, commercial collaboration, etc, and consequently tend to treat computing as only a service discipline.

The exercise started with a website and a workshop in Edinburgh in November 2002. Through the Conference of Heads and Professors of Computer Science, the academic community was canvassed to suggest Grand Challenge topics. At the Edinburgh workshop these were classified under six headings. Panels were set up to conduct discussions under each heading. Each panel reported back to the BCS GCC04 Conference in Newcastle in 2004, at which the six Challenges listed below were officially launched. At the subsequent BCS-sponsored GCC06 meeting at Glasgow in 2006, the Challenges presented progress reports on their work since 2004, and considered and reported their plans for the future.

All the Challenge communities have been active in developing their goals in detail and in formulating research plans to move towards them, with particular emphasis on ways of making the kind of step-advance that significant progress towards the Challenges requires. The Challenge groups have held workshops, and have engaged with other relevant subject and international communities. Some have had network funding from EPSRC, and others have been collaborating with existing funded projects and programmes, including EPSRC, EU and US ones. Several groups have been developing proposals for shared data resources, for foothill projects, or for managed programmes, as next steps in their Challenge research.

For further details see http://www.ukcrc.org.uk/grand-challenges/index.cfm

The six Challenges are:

*GC1: In vivo-in silico*
In vivo-in silico (IVIS) lays down a major challenge to computing scientists: to model living organisms. It is a pressing problem that is becoming just feasible.

*GC2/4: Ubiquitous computing: experience, design and science*
This challenge proposes to develop ubiquitous computing by tackling social, technological, engineering, and foundational questions in a closely coupled manner.

*GC3: Memories for life*
This challenge is about the majority of people being able to efficiently manage their information stream, and all of us benefiting from our digital memories.

*GC5: The architecture of brain and mind*
This is concerned with the attempt to understand and model natural intelligence at various levels of abstraction, demonstrating results of our improved understanding in a succession of working robots.

*GC6: Dependable systems evolution*
The vision of GC6 is of a future in which all computer systems justify the trust that society increasingly places in them. Dependability is a multi-faceted notion which includes fault tolerance, requirements engineering and verification amongst other topics.

*GC7: Journeys in non-classical computation*
This challenge seeks to explore, generalise, and unify all the many diverse non-classical computational paradigms to produce a fully mature and rich science of all forms of computation, that unifies the classical and non-classical (natural) computational paradigms.

## 6.3 UKCRC technical briefings

Since 2001 UKCRC has submitted 33 technical briefing documents, listed in Appendix C, to House of Commons committees, government departments, the European Commission and other bodies, in response to calls for input or in comment on reports etc. The topics covered have ranged widely including, for example, ubiquitous computing, identity cards, and the 7th EU R&D Framework Programme. Members of UKCRC have also, for example, given evidence, or made presentations, to Parliamentary committees and government departments. UKCRC is increasingly approached directly for comments and expert names, or asked to provide oral evidence to amplify previous written submissions. This suggests that it has been successfully establishing itself as a voice for UK computing research.

## 6.4 Assessment of UKCRC's activities

We believe that through its briefings, UKCRC is helping to make policy and decision makers recognise that sound system and software engineering matters, that this ultimately depends on fundamental computer science research, and that continuing research is essential to meet new needs for solid systems as machine and communications technologies change.

More importantly, we see the current Grand Challenges exercise as a major research driver with two key properties. It comes from the research community itself, drawing on a wide range of inputs and making connections between different areas of computing as a whole; and it is a serious attempt to raise the game for UK computer scientists and indeed for the field in general. The major issue is whether each challenge, even with international involvement, can build the critical mass in participation that is essential if any significant progress is to be made.

EPSRC staff at GCC04 commented very positively on the Grand Challenge exercise. The challenge communities must therefore, in the near future, develop models of the style, range and quantity of funding they need to push their particular research forward effectively, and interact with EPSRC about this.

Thus in relation to UKCRC's response to the IR01 Report, the Grand Challenges and briefings activities from 2001 to 2006 have been very substantial. They have largely subsumed the UKCRC's undertakings to identify key research themes, stimulate research strategy initiatives, and ensure that computer scientists are available for technical advice. The Challenges protocol explicitly accepts that new challenges may be proposed and three initial suggestions were put forward at GCC06.

However since the Challenges are necessarily long-term, UKCRC could do more to develop computing research strategy thinking for the medium term. It also needs to address the question of whether computer science research could benefit from new types of project or funding mechanism.

Several industrial members of UKCRC have been prominent in advisory roles, whether via briefings or otherwise, and as UKCRC has become established and ICT spreads we expect more of this. But UKCRC has to consider how it can best consolidate its impact.

# 7 Other factors affecting computing research in UK universities since 2001

There have been changes since 2001 in some factors that interact with EPSRC's influence on UK computer research, either indirectly through context effects or directly by their impact on EPSRC's policies.

## 7.1 The Research Assessment Exercises (RAEs)

Under the traditional dual support system, HEFCE provided the persistent basic infrastructure support

for universities, the research councils the specific project funding. The RAE quality grading system was used as a mechanism for distributing HEFCE funding on a formula basis related to the grading. The last RAE, in 2001, followed this model, but allocated money more narrowly to the top-graded departments. The benefit to high-ranking departments has been both in the 'project-meriting' signal the grade in itself sends to grant funding agencies, and in the value for research itself of better infrastructure and larger research communities. Middle-ranking departments have to work harder for research resources and to improve their status.

It is not clear whether the 2001 RAE grades have led to a greater concentration of EPSRC funding in top-ranking universities, and what impact this has had on UK computing research as a whole, especially for the medium and long term future. We believe this deserves investigation.

The impact of the RAE on universities is very large, and can be expected to remain so regardless of whether the detailed assessment model changes. The arrival of the next RAE in 2008 is already being felt: universities are scrambling to hire staff likely to improve their grades, and to prune departments that might damage their grades. More significantly, there is a widespread perception that optimising for RAE position has promoted short-term, immediately-visible research at the expense of longer-term and more significant work, and multiple instant publications rather than fully-considered papers.

## 7.2 University-industry relations

Government policy, and hence research council action, has placed great stress on the importance of relations with industry and in technology transfer, and universities have been pushed into a more aggressive attitude to IPR ownership. But the Lambert Report in 2003 concluded that the government's view of what the relationship should be was incorrect and that its 'close-coupling' goal was misconceived. Universities' moves towards tighter IPR control have not always been well-received, and it is far from clear on the evidence from other countries that this strategy either encourages innovation and entrepreneurship or brings large financial returns: the bureaucracy involved may rather hamper than encourage commercialisation of university research.

For computing research specifically, changes in the ICT industry in the UK have had several important effects:

a. the dot-bust has made computing less attractive as a career base and hence less attractive as a university subject for students;
b. larger UK ICT companies have ceased to engage significantly in research;
c. with a few notable exceptions, multinational ICT companies no longer have leading-edge UK research centres.

In addition, while UK university computing research has been very successful in generating startups and spinoffs, these usually take university research only as their starting point and do not sustain continuing collaborative projects.

Thus while individual collaborations, including ones with companies interested in applications, may be productive for computer science research, pressure to be relevant to UK industry has become increasingly subversive of top-quality research. This is especially the case because many collaborations are oriented towards applications and not computer science per se.

## 7.3 European activities

Our survey of computing departments suggested that funding from European sources has not played a major part in supporting UK computing research, and hence has not added significantly to the pool of available resources. Individual researchers have been active in European projects, and in some cases have obtained very substantial grants. But whether there have been noticeable missed opportunities for UK computing research is not clear.

## 7.4 University pay and staff structures

The IR01 Report, and UKCRC's responses to it, emphasised the need to address both university pay and working conditions generally. These are not EPSRC's responsibility, but they certainly affect the

research state.

In the period since 2001 university pay, already static for twenty years and 40% lower relative to average pay, has barely improved overall. The main developments have been rises at the lower, starting-point levels for young staff, and greater flexibility allowing more attractive salaries for desirable individuals. The pay position affects not only regular university staff, but the contract research workers on whom grant research depends. The latter have benefited from better pay for younger staff, but little from flexible pay for individuals. Flexible pay is mostly operative at high staff ranks, and has served to make UK universities more attractive to research leaders. Fellowship schemes like those for highfliers mentioned earlier are financially rewarding but only for a few individuals. University pay and conditions are dominated by HEFCE, and ultimately DfES, policy and money.

Flexibility for individuals has also made it possible for universities to reward research leaders by insulating them from chores. However university staff in general have seen their workloads growing substantially through the combination of more teaching, more administrative bureaucracy, and less financial resource for universities in general. Moves to make contract research staff less vulnerable to financial insecurity and a lack of career opportunities have not been substantially implemented.

As our university survey suggests, the best departments have been able to recruit appropriate staff, but it is far from clear that the system as a whole is robust enough for the community overall to maintain and raise its research standing for the medium and longer term.

# 8 Conclusion

Taking all of the evidence referred to in this document together, it appears that computing, and specifically computer science, research has improved its practical position since 2001. The improvement is definite, though exactly how large is not clear. EPSRC has contributed to this with better funding support and a useful range of initiatives. However there has been little overall improvement in matters affecting the supply of researchers, and the drastic decline in undergraduate applications is a serious long-term threat to UK computing research.

This document has not attempted to assess the placing of UK computing research relative to the international leading edge over the period from 2001, and hence its position in 2006. The 2006 International Review team has the authority, and can get the detailed evidence to assess the position now, and thus the UK's computing research strength as a base for future world-class research: we await their judgement.

# Appendix A
## Data on EPSRC support for computing research relevant to the period 2001 - 2006

These data draw on
1. the EPSRC Annual Reports 2002-2003 [AR2-3], 2003-2004 [AR3-4] and 2004-2005 [AR4-5]
2. the EPSRC Grants on the Web pages, calendar years 2002 [GOW2] and 2005 [GOW5]

The financial data in AR4-5 includes three-year comparative figures, and the combined data for (1) and (2) allows trend observation.

A. ICT as a component of EPSRC activity as a whole

Research grant expenditure by programme (pounds M) [AR4-5 p26]

EPSRC own programmes: ICT is biggest sector of 9 subject sectors

| | **02-03** | **03-04** | **04-05** |
|---|---|---|---|
| **ICT** | 58.5 | 56.4 | 49.6 |
| **tot** | 325.8 | 248.5 | 249.7 |

Research grant investment by programme [AR4-5 p50]
Core programmes

EPSRC own: ICT is approximately joint largest with Engineering

| | **grant funding** | **net programme totals** | | |
|---|---|---|---|---|
| | | **02-03** | **03-04** | **04-05** |
| **ICT** | 77.7 | 44.1 | 63.6 | 80.4 |
| **tot** | 358.0 | 231.2 | 331.6 | 383.8 |

Note: the contrast between expenditure falling and investment rising is straightforward accounting. However we are informed there is also a real rise in investment in ICT from 02-03 to 04-05.

Research grant success rates [AR2-3 p41, AR4-5 p50]

| | **02-03** | | | **04-05** | | |
|---|---|---|---|---|---|---|
| | **proposals** | **funded** | **% funded** | **proposals** | **funded** | **% funded** |
| **ICT** | 1053 | 344 | 33 | 976 | 295 | 30 |
| **tot** | 4816 | 1551 | 32 | 4371 | 976 | 31 |

EPSRC contribution to joint programmes in which ICT appears [AR4-5 p50]

| | **02-03** | **03-04** | **04-05** |
|---|---|---|---|
| **Core e-science** | 4.8 | 6.2 | 13.1 |
| **Basic Technology** | 1.8 | 8.6 | 16.1 |

B. Funding within ICT programmes

These data summarise salient features of the ICT funding Panel activities, on our interpretation of Computer Science/non Computer Science, and for panels with major activity or sharing a broad area.

Calendar year 2002 [GOW2]

| **CS** | | **non CS** | |
|---|---|---|---|
| Software Techs | 8.5 | Photonics | 11.1 |
| People and Interact | 6.4 | OSI (opto) | 2.0 |
| Programmable Nets | 1.2 | Elec, Comms, Funct Materials | 15.0 |
| | | OSDA | 1.9 |
| | **16.1** | | **30.0** |
| Comms (half) | 0.6 | Comms (half) | 0.6 |
| Healthcare informatics | 1.4 | Healthcare engin, EPOD | 7.1 |
| | **18.1** | | **37.7** |

Calendar year 2005 [GOW5]

| **CS** | | **non CS** | |
|---|---|---|---|
| Computer Science | 18.6 | Photonics | 12.6 |
| People and Interact | 10.5 | Instrumemt Devel | 11.7 |
| WINES (expt arch) [AR4-5] | 8.3 | El and Functional Mat | 11.8 |
| | | Electrophot | 2.0 |
| | **37.4** | | **38.1** |
| Comms (half) | 4.1 | Comms (half) | 4.1 |
| | | Healthcare engin | 13.2 |
| | **41.5** | | **55.4** |

Note: e-science in ICT programmes not shown 02-03; for 03-04 it is 7.9.

Calendar year 2002 [GOW2]

| | **no grants** | **tot pounds M** | **av pounds K** |
|---|---|---|---|
| **CS** | 122 | 18.1 | 148.4 |
| **non CS** | 183 | 37.7 | 206.0 |

Calendar year 2005 [GOW5]

| | **no grants** | **tot pounds M** | **av pounds K** |
|---|---|---|---|
| **CS** | 156 | 41.5 | 266.0 |
| **non CS** | 180 | 55.4 | 307.8 |

Note: we understand the increase in grant size from 02 to 05 is partly attributable to higher costs, but also reflects larger projects.

C. ICT-pertinent specific EPSRC items outside the standard ICT programme

a) Portfolio partnerships [AR3-4,AR4-5]

There were apparently 2 ICT projects out of a total of 8 in 03-04, and 2 / 6 in 04-05.

b) Platform grants

Data for ICT/CS are not readily available.

c) ICT Interdisciplinary Research Collaborations [AR4-5]

Inaugurated in 2000, 50 pounds M over 6 years

> Advanced knowledge technologies; Dependability of computer-based systems; Technical innovation in physical and digital life; Medical images and signals; Ultrafast photonics

d) High-performance computing

CS-relevant data are not available.

e) the Core e-Science programme 'supports the investigation of fundamental computer science required to fulfil the e-Science vision' [AR4-5 p24]
[AR2-3,AR3-4,AR4-5]

2/6 pilot projects apparently with ICT-specific content in 02-03
18 projects in 03-04, 16 projects in 04-05, ICT-specific content unclear.

f) the Basic Technology programme [AR2-3,AR3-4,AR4-5]

There were apparently 2 / 7 ICT projects in 02-03, 1 / 9 in 03-04, and 1 / 8 in 04-05.

# Appendix B
## Questionnaire sent to computing departments visited for the International Review 2001, and responses

The questionnaire was sent to eight universities, but one was unable to respond. The cover note is shortened here to relevant points. Question groups are introduced by IR01 Report Executive Summary quotations. Responses sought were mainly of the form 'more/same/less' or 'yes/no'. Totals under each are shown. In a few cases the department could not reply to the specific question for a reason given. Each question offered opportunity for comments: these are omitted here. Departments were also asked for background information on staff and student numbers and range of courses.

*Extract from the cover note:*

*UKCRC input to the EPSRC International Review of Computer Science*

*We are gathering information in preparation for the UKCRC's submission to the upcoming review. We are anxious that the submission be well-grounded and are particularly interested in what has happened since the previous International Review, in 2001, on the particular matters that were signalled for attention in that review. The questions below about your department are therefore designed to see what has changed since January 2001 and what the situation is now.*

*Our questions are qualitative, but if you feel some numbers add point, please give them. We welcome any further comments. If your answer is Don't know, please indicate this under Comments.*

PEOPLE Questions 1-6

IR 01, ES Para 2

''... salaries and working conditions in the UK ... are not competitive. ... the talent pool is shrinking, with senior researchers leaving and students forgoing advanced degrees ... Some means must be found to reverse this exodus. Increased salaries should be considered - especially for junior positions ...''

Q 1
a) Has the supply of established posts in your department changed since January 2001 ?

| more posts | about the same | less |
|---|---|---|
| 7 | | |

b) Has there been and change in postholders leaving for positions outside the UK since 2001?

| more leaving | about the same | less |
|---|---|---|
| 1 | 5 | 1 |

Q 2
Professorial and other senior positions:
a) Has the pool of applicants for positions changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 4 | 2 | |

b) Has the quality of applicants improved since 2001 ?

| better | same | worse |
|---|---|---|
| 5 | 1 | |

c) has there been any change in recruitment from outside the UK since 2001?

| more recruited | same | less |
|---|---|---|
| 3 | 2 | 1 |

Q 3
Lecturer and similar positions:
a) Has the pool of applicants for positions changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 5 | 2 | |

b) Has the quality of applicants changed since 2001 ?

| better | same | worse |
|---|---|---|
| 5 | 2 | |

Q 4
Research assistants, fellows and other unestablished research posts:
a) Has the pool of applicants for posts changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 3 | 3 | 1 |

b) Has the quality of applicants improved since 2001 ?

| better | same | worse |
|---|---|---|
| 1 | 5 | 1 |

c) Has the source of appointed assistants, UK / nonUK, changed since 2001 ?

| more UK | same | fewer |
|---|---|---|
| | 3 | 4 |

Q 5
Doctoral students:
a) Has the amount of funding for PhD students in your department changed since 2001?

| more | same | less |
|---|---|---|
| 5 | 1 | 1 |

b) Has the quantity of applicants for research changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 7 | | |

c) Has the quality of applicants changed since 2001 ?

| better | same | worse |
|---|---|---|
| 4 | 3 | |

d) Has the source of accepted students, UK / nonUK changed since 2001 ?

| more UK | same | fewer |
|---|---|---|
| | 5 | 2 |

e) Have the number of completing students wanting to continue in academic life changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 1 | 4 | 2 |

Q 6
Undergraduate students (full time):
a) Has the pool of undergraduate applicants changed since 2001 ?

| more | same | fewer |
|---|---|---|

7

b) Has the quality of applicants changed since 2001 ?

| better | same | worse |
|---|---|---|
| | 4 | 3 |

c) Has the source of accepted students, UK / nonUK changed since 2001 ?

| more UK | same | fewer |
|---|---|---|
| 2 | 3 | 2 |

d) Has the number of graduating students wanting to continue to research changed since 2001 ?

| more | same | fewer |
|---|---|---|
| 2 | 3 | 2 |

FUNDING Questions 7 - 21

These questions are about your department's funding, not yours personally.

*** THE QUESTIONS BELOW ARE ABOUT EPSRC SUPPORT ONLY ***

IR 01, ES Para 3
''... [EPSRC] responsive mode grants ... are too small ...''

Q 7
a) Has there been any change in your average grant size since 2001 (in research terms, ignoring inflation, pay rises, changed cost models) ?

| bigger | about the same | smaller |
|---|---|---|
| 4 | 3 | |

b) Have you had any 'larger' grants (more than 2 RAs or more than 4 years or vast equipment) since 2001 ?

| yes | no |
|---|---|
| 4 | 3 |

c) Have you had any portfolio grants ?

| yes | no |
|---|---|
| 2 | 5 |

IR 01, ES Para 3
''... responsive mode grants ... lack the flexibility that would permit investigation of questions that had not originally been anticipated.''

Q 8
a) Has there been any change in flexibility in your grants since 2001 ?

| more | same | less |
|---|---|---|
| | 6 | |

b) Have you had any grants since 2001 where you, or the final report reviewers, reported inflexibility to EPSRC as a problem ?

| yes | no |
|---|---|
| | 6 |

IR 01, ES Para 3
‘‘ Research infrastructure (both staff and equipment) is inadequately supported.’’

Q 9
a) Has there been any change in your infrastructure grants since 2001 ?

| more grants | same | less |
|---|---|---|
| 2 | 5 | |

b) Have you had any infrastructure grants since 2001 ?

| yes | no |
|---|---|
| 3 | 4 |

IR 01, ES Para 3
‘‘... funding to build research platforms, so that artefacts can be distributed and studied across a community, is also difficult to obtain.’’

Q 10
a) Has there been any change in your support for platform building since 2001 ?

| more | same | less |
|---|---|---|
| 1 | 6 | |

b) Have you had any platform grants since 2001 ?

| yes | no |
|---|---|
| 3 | 4 |

IR 01, ES Para 3
‘‘Moreover, the process by which funding decisions are made discriminates against proposals in new areas, ...’’

Q 11
Has there been any change in your grants for projects in new areas since 2001 ?

| more grants | same | fewer |
|---|---|---|
| 4 | 3 | |

IR 01, ES Para 3
‘‘... the process by which funding decisions are made discriminates against ... proposals involving larger experimental projects, ...’’

Q 12
a) Has there been any change in your grants for larger experimental projects since 2001 ?

| more | same | fewer |
|---|---|---|
| 2 | 5 | |

b) Have you had any larger experimental project grants since 2001 ?

| yes | no |
|---|---|
| 3 | 4 |

IR 01, ES Para 3
‘‘... the process by which funding decisions are made discriminates against ... high-risk projects, ...’’

Q 13
Has there been any change in your grants for high-risk projects since 2001 ?

| more | same | fewer |
|---|---|---|
| 2 | 5 | |

IR 01, ES Para 3
‘‘... the process by which funding decisions are made discriminates against ... inter-disciplinary projects, ...’’

Q 14
a) Has there been any change in your grants for inter-disciplinary projects since 2001 ?

| more | same | fewer |
|---|---|---|
| 4 | 2 | 1 |

b) Are you a participant in an Interdisciplinary Research Collaboration ?

| yes | no |
|---|---|
| 2 | 5 |

Q 15
a) Have you had any Science and Innovation awards ?

| yes | no |
|---|---|
| | 7 |

b) Have you had any Adventure in Science awards ?

| yes | no |
|---|---|
| | 7 |

IR 01, ES Para 6
‘‘... the absence of funding within e-Science for longer-term computer science research seems ill-considered.’’

Q 16
Have you had any e-Science projects with a computer science research element ?

| yes | no |
|---|---|
| 5 | 2 |

R 01, ES Para 3
‘‘Expectations concerning industrial tie-in for funded research are counter-productive;’’

Q 17
a) Has there been any change in your [EPSRC] grants for projects with industrial tie-in since 2001 ?

| more | same | fewer |
|---|---|---|
| 2 | 5 | |

b) Have you had any [EPSRC] grants with industrial partners contributing non-trivial funding since 2001 ?

| yes | no |
|---|---|
| 5 | 2 |

c) Have you had any [EPSRC] grants with industrial partners contributing letters of support since 2001 ?

| yes | no |
|---|---|
| 7 | |

d) What is the ratio now between your EPSRC grants having non-trivial industrial partner funding and other EPSRC grants ? (supplementary question)

[ individual numbers all different, so not given here ]

R 01, ES Para 3
‘‘Truly significant industrial impact usually requires establishing new companies.’’

Q 18
a) Has there been any change in the prospects for startup companies arising from your department’s research since 2001 ?

| better | same | worse |
|---|---|---|
| 3 | 4 | |

b) Have there been any startups from your department since 2001 ?

| more than 3 | 1 - 3 | none |
|---|---|---|
| 3 | 4 | |

*** QUESTIONS ABOUT OTHER, NON-EPSRC FUNDING SOURCES ***

Q 19
a) Has there been a change in the proportion of your grant funding from other UK public sources (other research councils, Wellcome etc), compared with EPSRC, since 2001 ?

| larger proportion nonEPSRC | same | smaller |
|---|---|---|
| 4 | 1 | 2 |

b) What is the ratio now between your EPSRC and other UK public source funding ?

| more EPSRC | same | less |
|---|---|---|
| 4 | | 3 |

Q 20
a) Has there been a change in the proportion of your grant funding from other non-UK European sources since 2001 ?

| larger proportion nonUK | same | smaller |
|---|---|---|
| 3 | 2 | 2 |

b) What is the ratio now between your UK and non-UK public source funding ?

[ individual numbers all different, so not given here ]

Q 21
a) Has there been a change in the proportion of your direct funding from industry or business (whether UK or non-UK), independent of public grants, since 2001 ?

| larger proportion industrial | same | smaller |
|---|---|---|

4 3

b) What is the ratio now between your independent industrial and other funding ?

[ individual numbers all different, so not given here ]

# Appendix C
## UKCRC technical briefings and reports 2001 - 2006

| | | |
|---|---|---|
| 2006 | European Future and Emerging Technologies: Security | European Commission |
| | European Future and Emerging Technologies: Cognitive Systems | European Commission |
| | European Future and Emerging Technologies: Ubiquitous Computing | European Commission |
| | Scientific advice, risk and evidence | House of Commons Science and Technology Committee |
| | Government IT Strategy | CIO Council, Cabinet Office |
| | Personal Internet Security | House of Lords Science and Technology Committee |
| | EPSRC 2006 Strategic Plan | EPSRC |
| | Reform of Research Assessment and Funding | DFES/HEFCE |
| | A European Institute of Technology? | European Commission |
| 2005 | UKCRC Briefing for EURIM Parliamentary members on the National Identity Cards Scheme | EURIM |
| | UKCRC Response to POST Enquiry on Ubiquitous Computing | Parliamentary Office of Science and Technology |
| | Developments in information and communication technology relating to health and healthcare | Royal Society |
| | Letter to MPs regarding development of Computer Science | Various MPs in the House of Commons |
| | Response to European Research Council Identification Committee | European Research Council Identification Committee |
| | Strategic Science Provision in English Universities | House of Commons Science and Technology Committee |
| | Voter Registration | House of Commons Committee on the Office of the Deputy Prime Minister |
| 2004 | Effectiveness of the Civil Service | House of Commons Public Affairs Select Committee |
| | RAE Assessment Exercise | RAE |
| | Science and Innovation: Working towards a ten-year investment framework | HM Treasury |
| | 7th EU R&D Framework Programme | European Union |
| | Identify Cards | Home Office |
| | 2003 Review of the Research Assessment | Higher Education Funding Council |
| | The Sustainability of University Research | Department of Trade and Industry |
| | EPSRC Review | House of Commons Science and Technology Committee |
| | Lambert Review of Business-University Collaboration | HM Treasury |
| | UK Science and Europe: Value for Money | House of Commons Science and Technology Committee |

| | | |
|---|---|---|
| | Higher Education Funding Review | Department of Education and Skills |
| 2002 | Chips for Everything | House of Lords Science and Technology Committee |
| | Quinquennial Review of the Council for the Central Laboratory of the Research Councils | Office of Science and Technology |
| | Roberts Review of the Supply of Scientists and Engineers | HM Treasury |
| | Why British University Computer Research Deserves Better Funding | Report |
| 2001 | Under-investment in University Research Infrastructure | Report |
| | International Review of Computer Science | EPSRC |

# Appendix D

## References

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EPSRC:
Grants on the Web 2002, 2005; available at
http://gow.epsrc.ac.uk/. Referred to as GOw2 and GOW5.

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UK Computer Science Research: Vision and Opportunities, (Input to the EPSRC International Review Panel), 2001.

UKCRC:
UKCRC Response to the Report of the International Review of UK Research in Computer Science, 2001.

UKCRC:
Reports and submissions; Grand Challenges, via
http://www.ukcrc.org.uk

UKCRC:
UK Universities Computing Research : Current Issues and Research Landscape, September 2006.