Summary Digest of Statistics

Executive Summary

General issues

- Data on the following aspects of University Computing Research is presented:
  - the resource inputs
  - the additional knowledge generated
  - benefits to the national economy from exploitation of applicable research results
  - the supply of MSc and PhD qualified people to the UK labour market

- This data is compared with figures for both:
  - comparable disciplines (Applied Mathematics, Physics, Electrical Engineering)
  - comparable countries (USA, Canada, Germany, Japan, South Korea, France)

- Commentary is provided on the policy context and position of University Computing Research in the UK.

- Annexes provide background to interpretation issues, the design and development of the digest, and additional statistics which could be incorporated on request.

Scale and funding of University Computing Research (including comparisons)

Research base and assessment

- The vast majority of computing research takes place in Computer Science (CS) departments, but the multi-disciplinary applications of computing research can make boundaries difficult to define.

- Figures for CS departments alongside comparable disciplines are presented below:

Subject	**Depts submitting to RAE**	**Total staff in depts submitting to RAE**	**Average size of depts submitting to RAE**	**Number of depts with 5/5* rating in 2001 RAE**	**Percentage of depts with 5/5* rating in 2001 RAE**	**Total staff in depts with 5/5* RAE rating**	**Percentage of staff in depts with 5/5* RAE rating**
Computer Science	80	1560	20	24	30%	698	44.7%
Physics	50	1668	34	26	52.0%	1283	76.9%
Applied Mathematics	58	734	13	31	53.4%	370	50.4%
Electronic & Electrical engineering	46	863	19	18	39.1%	552	64.0%

Resource inputs

DfES funding via Funding Councils

- A 'dual support' system (combining money from the HE Funding Councils and the Research Councils) provides the core government funding for university research in the UK.

- HE Funding Councils give each university an annual 'block grant'. Part of this is 'earmarked' for research, at a level determined by each department's performance in the most recent RAE. It is assumed that the majority of such 'earmarked funds' is received by the relevant departments.

- This provides broadly comparable funding levels (c. £1m per annum) to the disciplines considered.

Comment: I find it practically impossible to identify the basis for the assertion in the original that: 'The nominal totals from this source for the four disciplines considered, based on the HEFCE 'QR' rate for each RAE grade, appear broadly comparable in recent years at around £1m.' This simply isn't the case: the nominal earmarked totals vary between £1,225,411 (CS in 2002-3) and £694,521 (E&EE in 2003-4), which isn't anywhere near 'broadly comparable' to the former sum. The figures for each discipline are fairly stable year on year, with no variation greater than £100,000. The figure which is 'broadly comparable' is the *average* level of funding per department, which varies from £20,212 (Physics, 2003-4) to £25,296 (Applied Mathematics, 2003-4). Variations here are due to the balance of departments between rating 4 and rating 5/5*.

DfES funding via Research Councils

- Research Councils pass funding from the Office of Science and Technology (OST) to individual departments. The Research Council most relevant to computing is the Engineering and Physical Sciences Research Council (EPSRC), whose support is structured around a set of programmes, of which the most relevant is the Information and Communication Technologies (ICT) Programme.

- ICT Programme resources can be allocated to disciplines beyond CS, and CS departments receive funds from other EPSRC Programmes. Research Council funding is allocated n the basis of research proposals submitted by departments and centrally assessed.

- EPSRC funding for CS departments in 2001-2 totalled £26.33m. £22.27m of this came from the IT&CS/ICT Programme. This represents 9.4% of the EPSRC Programme budget.

- The total expenditure of the EPSRC IT&CS/ICT Programme in 2001-2 was £53.21m. £22.27m of this was allocated to CS departments. This represents 19.1% of the EPSRC Programme budget.

- The success rate of grant applications submitted by all departments to the ICT Programme in 2002 was 30%, compared with a success rate of 32.1% for grants submitted to all Programmes of EPSRC funding. The average size of grant proposals funded within the IT&CS/ICT Programme was £139,053, compared with an average of £157,785 for all EPSRC grand proposals funded.

- In the period considered by the 2001 RAE (1996-2000), the contribution to total research funding in CS from central government core science base investment (OST and Research Council funding) was £102.82m. This compares with £1.057bn for Physics, £162.75m for EE&E, £33.5m for Applied Mathematics and an average of £148.87m for all Science and Engineering units of assessment considered by the RAE.

Funding from other sources

- Other sources of research funding considered in the RAE include: Research Council finding relating to the Use of Central Facilities, the Joint Infrastructure Fund (JIF), the Joint Research Equipment Initiative (JREI), UK based charities and central government bodies, UK industry, commerce and public corporations, EU Government bodies and other EU funding.

- All figures below relate to the period (1996-2000) considered in the 2001 RAE.

- CS received a total of £253.5m from all sources. This compares with £1.2bn received by Physics, £321.83m received by EE&E, and £63.34m received by Applied Mathematics. The average for all Science and Engineering units of assessment considered by the RAE was £245.85m.

- EU Government Bodies provided £56.86m to CS. This compares with £44.3m for EE&E, £35.3m for Physics, £7.21m for Applied Mathematics and an average of £23.1m for all Science and Engineering units of assessment considered by the RAE.

- Funding from other central government sources (Departments of State such as the MOD) provided £25.5m to CS. This compares with £34m for Physics, £32.8m for EE&E, £6.7m for Applied Mathematics and an average of £19m for all Science and Engineering units of assessment.

- Funding from private industry and public corporations provided £37.5m to CS. This compares with £47.6m for EE&E, £23.1m for Physics, £3m for Applied Mathematics and an average of £28.2m for all Science and Engineering units of assessment.

- Total funding from all sources per staff FTE as considered by the 2001 RAE was £162,265 over the five years. This compares with £727,002 for Physics, £373,075 for EE&E, £85,964 for Applied Mathematics and an average of £329,109 for all Science and Engineering units of assessment.

Studentship volumes

- 4,017 research studentships in CS were funded from all sources in the period considered by the RAE. This compares with 4,089 in Physics, 3,534 in EE&E, 1,049 in Applied Mathematics and an average of 2,303 in all Science and Engineering units of assessment.

- 25% of research studentships in CS were funded from the core science base investment as defined above. This compares with 63% in Physics, 53% in Applied Mathematics, 28% in EE&E, and an average of 38% in all Science and Engineering units of assessment.

- 32% of research studentships in CS were funded by the HEIs in which they were held. This compares with 26% in EE&E, 16% in Applied Mathematics, 11% in Physics, and an average of 23% in all Science and Engineering units of assessment.

International comparisons

- Variations in definitions and statistical scope make precise International comparisons difficult. A broad picture of national commitment to Computing research can be gained by comparing the percentage of science base investment allocated to IT programmes as opposed to other fields.

- Data from the 2001 EPSRC/IEE/BCS *International Review* is used. However, it is unclear whether the most appropriate comparison for each country is with the 19.1% of the EPSRC budget allocated to the ICT Programme or the 9.4% which comes to CS departments.

- Countries where a figure for Computing/IT research as a fraction of the total Science and Engineering budget is available are: Germany (19%), Denmark (15%), Norway (14%), the USA (13.6%), Italy (9%). Countries where a figures for Computing/IT research as a fraction of the total university research budget is available are: Hong Kong (7%), Canada (6%), Australia (6%).

Comparisons between HEI research and private sector R&D activity

- Defining the precise scope of the 'IT sector' in industry is problematic because of the very wide range of businesses to which computing and IT are relevant.

- OECD figures (1997) indicate that, alongside comparable economies, the UK had the lowest Value Added by R&D in the ICT sector (3.9%) and the second lowest share of ICT R&D in all business sectors (21.8%). The highest figures are, respectively, 17.2% (Japan) and 43.7% (Canada).

- Total investment in university Computer Science research by UK industry was around £50m per year from 1996 to 2000. This compares with UK industry's total R&D expenditure on 'Computer and Related activities' (as defined by the DTI) of around £700m per year during this period.

Output measures

Contribution to additional knowledge

- ISI statistics (2001) based on citation rates indicate that UK CS research has an average impact rating comparable with that of other OECD nations.

- The relatively low rating for CS research compared with those of Physics and Applied mathematics is attributable to the breadth of the discipline and the exclusion from these figures of conference proceedings, which were recognised by the 2001 RAE as crucial to a field as fast-moving as CS. Similar subject disparities are observed in all countries.

Market impact

- Mechanisms for, and rates of, technology transfer between the commercial sector and university research vary considerably between different academic disciplines. Both formal and informal routes are influential.

- The almost universal relevance of IT results in an unusually large number of applications.

- Software is easily copied. It is therefore difficult to track, protect, and even define intellectual property rights.

- Formal University-Industry links in the USA are very strong. A study at Stanford University (2000) noted the importance of technology transfer and provision of highly qualified graduates in transforming the economy, the contrasts between sectors in rate and type of contribution, and the different contribution of the HE and industrial partners (universities normally produce technologies but not products, while industry can produce both).

- A DTI-commissioned report in 2001 noted that:

    - the UK's large ITEC sector contains an unusually large service sector, which may explain the relatively low R&D spend by UK ITEC companies.
    - 53% of R&D effort in the UK occurs in communications, internet user applications software, middleware, photonic components and microelectronics.
    - ITEC R&D accounts for nearly half of all recorded R&D effort in the following sectors: defence, transport, e-commerce, manufacturing and robotics, finance, banking and accounting, education and training.
    - respondents considered the overall quality of R&D workers to be a major UK strength.
    - respondents were concerned about the ability of UK HE to provide sufficient numbers of R&D workers to meet the requirements of industry.

- Much interest focuses on the development of new products and services and techniques that improve the efficiency and effectiveness of existing technology.

- Concern is growing about software quality issues and a commercial market in software testing is emerging. However, current market incentives are generally in the opposite direction.

- A USA study identified potential cost reductions resulting from feasible software testing infrastructure improvements of around $10.6bn for the supply side and $11.7bn for the user sector.

Supply of experts to the Labour Market

- Graduates from postgraduate research degrees enter employment in the private sector, the public sector and academia, while some may undertake further training.

- In 2001, 27.6% of graduates from EPSRC-funded Postgraduate (Masters and Doctoral) Studentships in IT and CS entered private sector employment, 8.7% entered fixed term academic appointments, 3.4% entered public sector employment and 5.15% undertook further training. This compares with 31.3% entering private sector employment from Engineering, 31.95% entering private sector employment from Physics and 32.25% entering private sector employment from Applied Mathematics.

- It is assumed that the majority of these individuals become IT strategy and planning professionals, software professionals, and ICT managers.