UK COMPUTING RESEARCH COMMITTEE

UKCRC/2011/1

EPSRC ICT Next Decade

UKCRC Response to the EPSRC ICT Next Decade Survey

The UK Computing Research Committee (UKCRC), an Expert Panel of the British Computer Society, the Institution of Engineering and Technology and the Council of Professors and Heads of Computing, was formed in November 2000 as a policy committee for computing research in the UK. Its members are leading computing researchers from UK academia and industry. Our evidence reflects the experience of researchers who each have an established international reputation in computing.

Q1: What do you think are the key features of the current ICT portfolio in the UK?

- A focus on applications and application tools. This reflects the fact that the UK IT "industry" is mostly embedded in other businesses (such as finance, aerospace, medical, etc) and/or consultancies.
- Application technologies such as machine learning, computer vision, databases and information retrieval.
- Core aspects of systems architectures such as safety and security.
- Strong on theoretical computer science - broadly, mathematics applied to systems and software engineering.
- Human computer interaction in its broadest sense. Convergence of "computing", "communications" and "creative media".
- Computer systems engineering (operating systems, distributed computing, networks, computer architecture, electronics/photonics, socio-technical systems) - relatively few places, but all centres of excellence, seen as world class internationally. Ii is important to protect this as it gives UK ICT a window on future technologies and systems for larger applications oriented part of the community to intercept.

Q2: What do you think currently are the important areas in ICT globally?

- Concurrency and distribution – to maintain the growth of computing productivity in the face of physical limits to processor speed, it has become essential to exploit multi-core computers via concurrent programming. Similarly, exploiting the growing power of the web, cloud, mobile computing, and sensors requires distributed programming. This requires languages and tools that support concurrency and distribution.

- Cloud computing - both systems engineering and applications aspects, application to large scale scientific computation.
- Long term data preservation, migration, scalability and repurposing.
- "Natural" user interfaces - touch, gesture, speech, object recognition and tracking, 3D, robotics, etc - from Kinect and iPad to Holodeck.
- Autonomy - the ability of software/systems to take their own decisions.
- Dependable/secure hardware/software systems - i.e. systems that can be justifiably trusted not to suffer unacceptably frequent or severe failures, even in the presence of faults, whether accidental or malicious. Depending on requirements, dependability/security can cover such issues as reliability, availability, safety, integrity, maintainability, confidentiality and human interaction.
- Software correctness - Design automation and analysis tools to speed progress of software production and enhancement. Verification, as a complement to testing and software diversity, for applications in which the prospect of failure due to software faults is intolerable.
- Inference not algorithms - as our daily lives are more and more mediated by computers inference techniques are replacing algorithms to make systems more intelligent, more perceptive, more adaptable. Inference over large scale data and with massive computing resources (cloud plus web). Machine learning combined with heuristic optimization techniques to steer between alternative "partial solutions".
- Mobile systems & sensors - connecting the world of things to the Internet and through the cloud providing them with persistent scalable background computing resources.
- Sustainable computing – the ability to continue growth in computing without growing the demands it makes on our environment.
- Novel approaches to computational modelling supporting a broad array of interdisciplinary interactions, particularly (though not exclusively) with biology and biomedicine.

Q3: What priorities can you identify now both within your area of expertise and across the ICT portfolio as defined by the areas listed above (please indicate)

- Better connection between CS and electronics / materials for devices and sensors.
- Ready availability of cloud provision for research.

- Turning concurrency and process distribution within devices (multicore) and across networks (cloud/web) to our advantage in building larger scale, higher performance, lower power systems.
- Support for on-going maintenance of data and tools generated by previous research (capitalizing on previous investments).
- Increasing the competence of developers and programmers, particularly for large-scale systems and safety-critical systems.
- Processing and interacting with large datasets, from both technical and human use perspectives.
- Resolving the tensions between pervasiveness, openness and autonomy in systems versus the need for safety, reliability, security and trust in such systems.
- Promotion of multi-disciplinary and interdisciplinary research that aims not just to build more applications but to advance fundamental science (either directly or by preparing the ground in new interdisciplinary areas).

Q4: Are there any areas of research or approaches to research within ICT which you feel may be becoming less important?

- Grid computing and supercomputing (as a paradigm for eScience) - local HPC and global Cloud facilities meet most scientist's needs. Grid is mostly a particle physics application. (By contrast "super data centre" engineering and inter-operability is crucial but should align with Cloud not Grid).
- Middleware and "me-too" academic cloud systems engineering.
- Standalone mobile phone applications, as opposed to cloud enabled ones.
- Software engineering processes to support traditional software development methods.
- Machine learning on small data collections.
- Tinkering with Linux (or Windows, or Mach) features and extensions.
- "Classical AI algorithm" approaches to: information retrieval, natural language processing, computer vision.

Q5: Under the following four headings, describe the opportunities associated with the priorities you've outlined above?

- **Political**: Enabling, understanding and governing an "information society" IT as a competitive advantage for UK PLC, positive vector for productivity. Early warning of IT related policy issues - e.g. Cloud and data protection / national security.

- **Economical**: Tools and technology for use by industry. Enabling key UK industries to exploit IT innovations to be more competitive in their own domains. Continue to create talent that will form future companies (like ARM, Autonomy, Plastic Logic, etc.); maintain the competitive advantage of existing companies (many of which are not "IT companies"); and help create new sectors through innovation.
- **Societal**: IT enabled approaches to more efficient delivery of public services, healthcare and well-being, education, smart energy management, environmental monitoring and management. Support for the cultural fabric of society, from improved access historical and heritage information through to the influence of IT on the leading edge of cultural development. Adaptability to changing demographics (e.g. in interfaces adapted to an ageing population) and empowering citizens through access to and learning from well presented data / information.
- **Technical**: Tools to enable others to do research more efficiently - building on each other's work. Tools for use by industry and in interdisciplinary collaborations to enable new approaches to scientific porblems, e.g. "in silico" experimentation.

Q6: What tools are needed by the ICT research community to be better positioned to respond to the priorities identified above?

- More ability to plan and bid for "programmes" rather than depending on a succession of project grants.
- More ability to create consortia to work on bigger challenges.
- Better ways to match potential industry users and participants in research, with incentives to build enduring relationships.
- Support to help researchers to overcome the barriers to interdisciplinary research.

Q7: How do you see the ICT portfolio evolving over the next decade and can you identify any key changes which need to happen?

- Research that produces tools others use, with papers seen as a stepping stone, not an end product of research.
- More ambition, more collaboration, more risk.
- Better tracking of the pipeline from early stage research through to downstream exploitation.

- Retention of the principle of smaller (responsive mode) to stimulate creativity and spark ideas outside of larger, directed research programmes.

Q8: Have you ever considered the ethical implications of your research when you have applied for funding? If yes, please describe.

- Most/all universities have sign-off processes that include scrutiny of ethical implications of research but these typically are most stringent where they impinge on other areas with longer established ethical procedures (e.g. medicine).
- The output of IT research now has a profound influence on our capability to change individuals and societies. With this comes a need to consider more carefully the ethics of our research, although it is unclear whether this is best achieved from the perspective of IT itself or in conjunction with key application areas.
- As systems (and research on those systems) become more ubiquitous and pervasive it becomes more common to involve humans and their personal information within empirical experiments, raising ethical issues. This has been a feature of areas such as HCI for some time but is extending into security, privacy and other areas of study.