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The Grand Challenges Exercise of the UKCRC.

Report to the UKCRC from the Programme Committee. May 13, 2003

Background

The UK Computing Research Committee is a joint expert panel of the British Computer Society and the Institute of Electrical Engineers. It is seeking an appropriate status with the Committee of Professors and Heads of UK Computing Departments (CPHC). It has undertaken as its primary goal that of promoting the good health and high international standing of UK research in Computer Science.

Inspired by the recently completed Human Genome Project, the Committee has noted that the progress of a mature branch of science can occasionally be accelerated by the promotion of a Grand Challenge Project. It has therefore embarked on an Exercise to explore the views of UK academic research scientists on possible topics for a Grand Challenge Project, and on the means for addressing it.

From the beginning, the Committee set severe criteria for judging the maturity of a project proposal for promulgation as a Grand Challenge: the aim was to distinguish a Grand Challenge Project from other kinds of computing research initiative that are promoted currently, or have been in the recent or more distant past. Such a project would be distinctive, but entirely complementary to the more familiar modes of conducting and organising research. A Grand Challenge should enjoy the widest support from the whole scientific community, though only a minority of the community will be actively collaborating in it.

Criteria of maturity of a proposal for a Grand Challenge Project

A Grand Challenge Project is a long-term, large-scale international research project, with clearly defined deliverables, mile-stones, and plans for development, evaluation, and validation of its research results. As a ball-park figure, we took a fifteen year time-scale, involving (say) fifteen leading research laboratories spread over several different countries of the world.

A Grand Challenge Project is a significant commitment of scientific resources, and its promotion needs justification by a strong case that the project, which has been infeasible in the past, can now succeed. This case must be based on a survey of the current state of the art, and its predictable development using known research methods and available research skills.

A Grand Challenge Project has as its primary goal the advancement of scientific understanding or engineering accomplishment in a particular branch of research. It may be specific to that single branch of science, examining its essential nature, its foundations and its limitations; the results of the research may be applicable only within that single branch of science or engineering.

The case for promotion of the Challenge may be strengthened by speculation about the relevance of the eventual research results to the welfare of human society. Any promise of achievement of these benefits should apply to the period which follows completion of the scientific research.

The adoption and promotion of a Grand Challenge Project is pointless unless it leads to a beneficial change in the attitudes and behaviour of scientists, including those not engaged in the project.

The strictness of these criteria, and their novelty in the context of UK computing research, explain why progress towards the emergence and general approval of a good Grand Challenge proposal will be slow. It is quite likely that no suitable Challenge will emerge in the early stages of the current UKCRC Exercise; such a deferred outcome would be far better than the waste of scarce scientific resource that would result from embarking on an immature Grand Challenge Project.

Progress to date

The UKCRC began the Grand Challenges Exercise by appointing a Programme Committee to organise and conduct it, beginning with a Grand Challenges Workshop. The Programme Committee consists of Malcolm Atkinson, Alan Bundy, Jon Crowcroft, Tony Hoare (chair), Robin Milner, Johanna Moore, Tom Rodden and Martyn Thomas. The Workshop was held in Edinburgh on November 2002, and discussed 109 submissions from the UK computing research community.

The details of the call for submissions, together with the planning and conduct of the Workshop and what should follow it, are all reported in detail on the website of the Grand Challenges Exercise:
(http://umbriel.dcs.gla.ac.uk/NeSC/general/esi/events/Grand_Challenges/)
In summary, a set of up to ten possible topics for Grand Challenges was identified at the Workshop for further development, and a champion for each chosen to carry the development forward. A drafting phase followed the Workshop, and in January 2003 several draft proposals were mounted on the website, each to be discussed publicly by email, moderated by the champion, with the discussion archived on the website. The Discussion, to continue until May 26 2003, was advertised to the research community via the CPHC mailing list.

A particular feature of the Exercise is that no submission from the community is ever rejected by the committee; thus, all 109 original submissions (except those withdrawn by authors) are still accessible on the website. Indeed further submissions may be made at any time.

At the date of this report, there are seven discussion group reports, each of which has been subject to considerable discussion both publicly and in private among its drafters. These proposals, with their moderators, are as follows:

In Vivo <=> In Silico: High fidelity reactive modelling of development and behaviour in plants and animals	(GC1)	Ronan Sleep
Science for Global Ubiquitous Computing	(GC2)	Robin Milner

"Memories for life" – Managing information over a human lifetime	(GC3)	Andrew FitzGibbon Ehud Reiter
Scalable Ubiquitous Computing Systems or just Ubiquitous Systems	(GC4)	Jon Crowcroft
The Architecture Of Brain and Mind	(GC5)	Mike Denham Aaron Sloman
Dependable systems evolution	(GC6)	Jim Woodcock
Journeys in Non-Classical Computation	(GC7)	Susan Stepney

The Programme Committee has considered these reports, and their degree of maturity as judged by the criteria, and makes the following recommendations.

Conclusion

In summary, the results of the Exercise to date have fulfilled our reasonable expectations of progress. We have discovered considerable enthusiasm for the concept of a Grand Challenge, and we have identified certain groups of researchers who are keen to work together towards the clearer definition of a common Grand Challenge Project.

In general, the reports of the Discussion Groups have addressed most of the points that distinguish a Grand Challenge Project from other kinds of research initiative. However, there is considerable variation in the depth and detail with which the various points have been addressed. In the following table, we assess very roughly the degree of coverage of each of the reports under the headings of:

Advancement of science or engineering
Planning for the project itself
Feasibility, current state of the art
Benefit to society expected from application

(GC7 is omitted from the table, since its originators have agreed the its research topic, though challenging and important, does not conform to criteria for a Grand Challenge we have adopted.)

	Advancement of science or engineering	Planning for the project itself	Feasibility, current state of the art	Benefit to society expected from application
GC1				
GC2				
GC3				
GC4				
GC5				
GC6				

(This paragraph to be adjusted according to what the PC think.) Most of the reports give a good account of challenging research problems and the potential of

advancement of science and/or engineering in the relevant area. They give a fair account of the long-term potential benefits to society. They vary in the depth and breadth of the survey of the state of the art. And most of them would need more work on a detailed project plan to justify promotion as a GC project.

Next steps

(This section to be scrutinised by CARH before it goes to the Programme Committee.)

The Programme Committee recommends that the Grand Challenge Exercise should now be split into separate streams, one for each topic of a discussion group report (though some topics may decide to merge). For each topic, we should recruit a small Topic Committee, to take its proposal further.

*[omit this first sentence*The draft proposals have yielded fruit in the form of several very promising directions for concerted research programmes.*]* We recommend that each Topic Committee should work towards producing, in due course, a revised and extended report that would include a comprehensive survey of the state of the art, a more detailed prediction of the phases and subdivisions to structure the work of the project, and an assessment of the expressed support and willingness to participate of the relevant research community, both in UK and outside. **The example of the Foresight exercise in Cognitive Systems may be a useful model.**

This recommendation allows maximum benefit to be obtained from the work of each of the discussion groups. Even if the format of the Grand Challenge Project **found inappropriate (as for example in GC7)** [appropriate to the case], a revised and extended report may advise other ways in which its particular research topic should develop, and may recommend how current research practices, policies, priorities and funding arrangements should be adapted **if necessary** to promote the topic for the long-term benefit to UK computing research and its international standing.

To address it task, each Topic Committee should be invited to organise a call for contributions and a workshop along the same lines as the Edinburgh Workshop last November, but taking into account the lessons learnt, and the progress made so far, and bearing in mind the alternatives to a Grand Challenge. To this end, the Topic Committee should be encouraged to solicit funds from EPSRC to support this Workshop, and perhaps subsequent ones, with the express aim of defining a long-term research initiative in its Topic.