COUNCIL FOR THE MATHEMATICAL SCIENCES

The Institute of Mathematics and its Applications | The London Mathematical Society | The Royal Statistical Society

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Dear Dr Wilson

EPSRC Strategy and Planning Consultation

The Council for the Mathematical Sciences, comprising the Institute of Mathematics and its Applications, the London Mathematical Society and the Royal Statistical Society, is pleased to enclose its response to the Engineering and Physical Sciences Research Council's *Strategy and Planning Consultation.*

Yours sincerely,

Professor J F Toland FRS

Chair, Council for the Mathematical Sciences

COUNCIL FOR THE MATHEMATICAL SCIENCES
Response to EPSRC's Strategy and Planning Consultation

Introduction

The dti, RCUK and EPSRC can make some strategic choices now that will shape the future – and specifically some choices that will determine what kind of research and innovation environment we will have, here in the UK, in 2014, at the end of the Government's planned Investment Framework. Shall we continue as now with science funded largely in response to requests (proposals) from providers that are stimulated by calls, initiatives and programmes? Or shall we be proactive and create some fresh ways for science to progress?

Two types of research activity

The model of teaching (training), research, and (not to be neglected) subject scholarship all happening side by side works very well within those universities and subject areas where progress is long-term, capital/equipment un-intensive, and progress highly shared and cooperative (locally, nationally and internationally). It creates a culture of intellect and knowledge. Mathematical activity is a rather good example of such. Progress on hard problems is made through individual contributions, and is shared, disseminated, publicised even as those responsible move from job to job, or even country to country. Timeliness is rarely of the essence!

Modern computing power (at low cost) and rapid communications technologies might have led to the growth and diversity of our research communities – being less reliant upon central facilities, and location blind. No doubt this has happened – it is easier than ever to share ideas, to instantly access the research of others, and for researchers to get moving within new (to them) fields (both near and far from their current research). This "research access" has arrived and is a benefit to all – nationally and globally.

Particle physics or astronomy is almost the opposite of "research in the community" – there must be some large investments made in order to get to the party. Similarly with HPC and Diamond: there is a necessary high cost of entry, and there is no logic to making such a vast down payment and then not maximising the use of the assets. This centralised model is also prevalent within other research councils such as MRC and NERC. The EPSRC has rightly funded the resource, or facilities, rather than funding the centres as institutes - remaining flexible and avoiding long term liabilities. This should continue as now.

So we need a funding model that admits both types of activity: research that is dispersed and community based, and research that is centred and facilities/ resource based.

We also need a model that is prepared to make hard choices for the future. Outside of a true "responsive mode" mechanism – funding for proposals that bubble up in a timely way from the communities – there is no compelling logic to continuing funding for all fields and facilities as previously, or as now. All activities have a lifetime: nationally we have been consistently slow to recognise this.

Furthermore the facilities funding model is interesting for other reasons. It represents a commitment, rather than an interest. Such investment should represent both a vision of achievement and a mission (the activity necessary) to make it a reality. Let us return to this commitment issue later.

Three restraints – that are holding the UK back…

a) Lack of perspective

From outside of the academic community it is obvious that one of the greatest sources of inertia comes from the research communities themselves. They have been trained too well by the past twenty years to seek to maximise their own precious advantage, and that of their own institutes. Rarely it seems do communities come together and decide what is right of the UK, or even for the science. It is the research procurement and supply market, with its impact on the other leg of HE funding, that has created a highly competitive, but sadly short term, risk averse and uncreative culture. This has been recognised many times and in many ways – but the fundamental point is that rarely will individual scientists suggest and do the right thing for the nation as a whole. We need to face this bluntly.

b) Working pressures

The workload on research "stars" to continually draft, respond, review, apply, and propose in order to generate research support and income is not conducive to innovation. As a result EPSRC has rightly created some mechanisms to provide longer term support – critical mass funding, Science and Innovation awards, fellowships and so on. These are important and sought after – but even for the winners, the resource is soon if not immediately allocated to tasks and progress ensured. With an immediate and canny eye on the next opportunity, no PI can afford to be incautious: research will be de-risked and horizons and expectations suitably managed. Does adventure and risk fly away too soon? How can individuals who are measured as individuals share the portfolio view taken by the EPSRC, the Government and the economy?

c) Parochial view

How aware are we all of the world trends within science and research, and exploitation? The rise of dominant giant technology companies like Microsoft, Google, Oracle has been extremely rapid compared to their forbears such as IBM, GEC-Marconi and RR. Timescales are shortening (companies rise and fall now at the timescale of a single doctoral training grant). These companies are world players addressing huge consumer markets: consumers (like blind monkeys) that are innovative and rapid adopters of new technology and the companies have a choice as to where they operate and what they will do. Their value (market value to owners) is based on their projected future revenues; and that often means projections of their future (rather than current) capabilities, technologies products and services. How do their own business road maps look: what is their need for people, for technology, for economic infrastructure and KT activity? If universities and university departments had a mission and a priority to build a role in supporting the economy, rather than competing and measuring themselves against each other then KT, adventure, and innovation would be seen as mission critical, rather than bolt-ons or accepted side effects of their bread and butter research agendas. What of India and China with their massive numbers of trained graduates and economic pull? How will our institutes measure up in 2014, especially in the eyes of those considering inward investment to these shores? Do we spend enough time understanding the world in which we are living? Do the research councils need to show some leadership, and the university departments and research leaders have a mission that is aligned to advancing the UK's interests?

Supply-side constraints

This issue largely concerns the flow of trained people from school pupils to undergraduates, to postgraduate study or careers within the public sector, industry and commerce. How can we ensure that the next generation of scientists emerging within our system will be the equal of the last? Despite all the reasons for individuals not to study hard subjects – for many the heart rules the head and they seem compelled to follow their chosen path and succeed in science and technology despite enormous odds. It is all about who they are and who they want to be. There is nothing particularly British about this either. Yet we in the UK do have the peculiar advantage (within the EU) of the English language – the lingua franca(!) of technology and the sciences, and we have a long distinguished history in science. It seems reasonable to conclude that folk from abroad will continue to visit and wish to study here; and that we will develop our share of potential research stars, prize winners and geniuses. But will they realize their potential and will we keep hold of them?

The EPSRC only owns a small part of this supply side problem so perhaps we can limit ourselves to the numbers game as applied to postgraduates students and their first destinations. How many PhDs does the country need? How many by discipline (subject)? Currently we are more likely to ask "how many can we afford?" We cannot answer this question properly since we believe that evidence of current demand for postgraduates is not the right way to measure it. We have to make a forecast based on our future view of the economy. This will inevitably be wrong – but may well have the right plus or minus signs attached. Make no mistake this is a jeopardy for the UK and we should have a public target set as much for debate as for future funding and budgeting.

The Reverse View

Let us look at the problem from the other end of the telescope. What do we need to have in place in eight years' time?

Stimulating creativity and adventure…

In the mathematical sciences much research is inherently risky and adventurous – proofs and methods have to be found sometimes from scratch – so it is the desire to broach a certain problem that is the driver – and usually the journey is open-ended. The difficulty in funding this is that there are few if any milestones or time scales – so "returns" are vague; even worse there is no point of decision or closure (either way). The good news is that most of this research requires little funding – the bad news is it is invisible (until a result or two bursts forth), and is rather unaccountable in terms of delivery. What we need as a nation is that our best people become adventurous – indeed the more excellent they are, the more adventurous we would like them to become. This means that there must be a strong mechanism to build groups – long term around key players. In which fields? The Science and Innovation award model is of interest since it specifies fields from which bids can be made (across all EPSRC's remit). The amount of support for each award is considerable and must be matched by a commitment from the host HEI. It is proposed that such awards are extended well beyond the current remit (which presently includes "multidiscplinarity" as a qualification gate). The research communities should propose and justify sub-topics for research or, more importantly, very specific problems to be tacked by an Science and Innovation centre in the light of three qualifying attributes: (a) building international competitiveness and reputation for the UK (b) inspiring young researchers and building the esteem of science and technology within the wider public view (c) the impact downstream on other sciences or economic activity.

Sadly in specifying (a), above, (where most of the academics' effort and passion will be focussed) it is hard for communities to make such proposals to EPSRC without widening the range of possible participants (so as to avoid excluding others), and this blurs the main objectives and focus of the call. Therefore the more focussed the proposal is the better. Proposals that are too wide should be filtered out. The aim is to have maybe four or five groups in the UK that might fit the bill and be able to respond fully.

The creation of Science and Innovation centres located within HEIs is another highly desirable feature of this spending. There is a halo effect that is valuable for research students. It is essential to have a strong commitment from the HEI and a clear identity and engagement targets. The brands may often be available: for example in Manchester there is a desire to create a better profile, and to secure ongoing funding, for the/an Alan Turing Institute operating across mathematics, ITC and engineering disciplines – to date with little success, most likely as the skills and remit have failed to win within the various existing calls' prescribed parameters. But the identity/branding and marketing/outreach of all critical masses is essential. This is how the spending resonates locally and nationally with the public and with industry. We believe that the outreach activities of funded centres to date is generally poor, and such S and I or critical mass building grants should contain at minimum 15% of the spend for outreach and engagement. Otherwise (b), above, simply does not get the priority it deserves. This is not limited to centres and topics where there are obvious and existing interfaces (known collaborations) to potential users and/or the public. It is essential to build in a culture of engagement even to highly theoretical centres.

Science and Innovation grant-holding centres are empty without people, and qualification criteria should include the career commitments of recognised leaders within suitable fields and, say, 80+% of their time and their dedication to the centre's activities and success over the first 5 years. They should be largely bought out of teaching and proposing and managing other any research grants (public and private, including EPSRC responsive mode) for the duration, and then given a suitable support team. For continuity and risk mitigation a succession plan including other researchers should be discussed at the outset.

We propose supporting more such topic/problem-focussed spending over and above any increase in responsive mode. We would support allocating some of EPSRC existing funds alongside any new Science and Innovation funding to create three or four times the number of awards – 15 per year for 3 years at £7M each (plus the HEI commitment etc) spread over 5 years. That's a £315M investment over 8 years. The large current investments in facilities, such as HPC, should be much more critically and independently reviewed (Who are the users? How many? What is the net benefit to the UK?) and this

funding diverted to Science and Innovation initiatives as necessary. If half of 45 such centres become recognised internationally as centres of excellence, envied across the world, with a profile across industry sectors then this can be considered a success. EPSRC has the model – now we all must show the one-off commitment. Some such centres should be "pure", focussed on theoretical and scientific questions, whereas others can be multidisciplinary (as now). For example (in my own fields) the whole position of inference, modelling, and (bio)informatics within post-genome work – even within systems biology – remains ill-defined, ad hoc, disconnected and confused (compared to work in Germany, for instance); and the UK lacks a recognised internationally-leading centre in the "Scientific basis for risk assessment and regulation" – where science meets management science and public perception.

Developing a shared vision of tomorrow's major challenges…

We all want the EPSRC to be a partner of choice – an enabler – for businesses of all kinds. Put simply the EPSRC should begin by engaging with national and global industry players at a strategic level (perhaps hand in hand with dti), as well as a technical one (which they already do through individual contacts and networks). The most senior directors should visit the HQs of all major global companies for formal information exchange meetings – understanding their vision, understanding their road maps, positioning the EPSRC as partner for getting science and technology done within the UK, pointing to current and future opportunities, asking what they will require and how they will decide what will be done where. This engagement task should be given a higher priority. To do this EPSRC will need one or two visionaries – to be authoritative and provocative - as well as exiting demonstrable highly competent management. This interaction offensive can be extended to other sorts of partners, both national and international. EPSRC is flexible and professional and it can support and broker industries' attempts to make contact with and participate in UK research. Indeed EPSRC could be very much aligned with wealth creation in the national interest – and therefore success of exploitation within the UK – much more so than the academic "provider" communities.

The changing demography of science

A strategy is needed to deal with (a) the rise in new economies (India, China, and then Africa and South America) whilst presiding over the age profile of the university research base. A coherent view seems to be lacking – this is a challenge and an opportunity – so there needs to be a debate about attracting the best scientists to the UK and the development of partnerships between HEIs in the UK and "twins" abroad. Is it safe to just leave things to the HEIs to sort out within the talent market, or is support justified?

Knowledge Transfer

We applaud the Knowledge Transfer Centre (KTC) concept that was tested within the recent call – locating KTCs on campuses and/or science parks. This model probably needs refining so that bids have some external (qualification) pressure and business vision and planning. Novel aspects should include making external venture funds available to share the risk-return of the pilot/prototyping. This means that individuals or small SMEs with a great idea for a device or application, but no resource (cash!), could get the work at a world leading institute by sharing the potential IP both with the host HEI and the venture funder. In this way – perhaps for the first time – basic science would not only be open to an exploitative step but there would also be access and a route to concept test, prototyping, and demo for external inventors and entrepreneurs, with their own knowledge of potential markets, sales and exploitation routes. Such an idea could be developed further through direct partnerships between a VC fund and EPSRC (through the host HEI). The external players would bid with projects and ideas to the KTC/VC project board in each case. That way VC is released (on top of the EPSRC funds) directly into the pre-development "gap". It is essential that such projects be proposed and managed by committed people (not those with faculty positions) tensioned by their own, capped, resource (both their time and money) – that way the failing things or un-exploitable get stopped quickly. Can EPSRC actively consider this model further?