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Dear Lord Krebs

## HOUSE OF LORDS SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY: Inquiry into scientific infrastructure

The Engineering Professors' Council (http://epc.ac.uk) represents the majority of academic engineers in the UK, with 76 university members comprising nearly 6,000 academic staff. We are grateful for the opportunity to contribute to this important inquiry and it is from amongst our members that we have garnered the views and evidence we outline below in response to the questions we adjudged to be of most relevance to our members.

At the outset, we would like to underline that all references to "*science*" encompass both "*science and engineering*". We would also wish to emphasise that we are fully cogniscent of the current pressures on the national finances and have attempted to suggest options which would reduce the cost to the exchequer wherever possible. Although some of the points raised do have cost implications, it is anticipated that these can be more than offset by either reductions in future expenditure on an even greater scale and/or the likelihood of additional national revenue accruing from the future exploitation of the products, processes and technologies developed from this infrastructure.

**What scientific infrastructure is currently available in the UK, do UK researchers have sufficient access to cutting edge scientific infrastructure and how does this situation compare to that of other countries?**

The experience is mixed. We can be proud of having a well co-ordinated infrastructure of information systems with access by the public, authorised staff and practitioners to protected sites generally well provided and co-ordinated. In terms of physical infrastructure, an example of good practice is the Natural Environment Research Council (NERC) Geophysical Equipment Facility (GEF) which provides short to medium term loans of larger numbers of instruments than could be obtained by an individual grant or institution. Related support is available from the NERC Airborne Research and Survey Facility and the NERC Field Spectroscopy Facility. Comparable or better infrastructure exists e.g. in the USA for GPS/GNSS geodesy and airborne laser scanning, and in Germany for seismology, but the UK is unique in having an integrated facility.

But with an increasing trend to "concentration" in research activity, we are now witnessing a move to high cost infrastructure being concentrated in only a few geographical areas (in particular, the so-called "golden triangle" of London, Oxford and Cambridge). For the UK science, technology and engineering research profile to regain its standing, the infrastructure needs to be nationally dispersed. Innovation is a dynamic phenomenon and new and challenging ideas need to be encouraged from a variety of sources. It seems that investment is required in the Midlands and the North particularly: major facilities such as Diamond, ISIS, and the Engineering and Physical Sciences Research Council (EPSRC) Nuclear Magnetic Resonance (NMR) centres at Durham and Warwick are of excellent quality, but require additional investment to remain internationally competitive. A further example is the loss of EPSRC funding for the tomography centre at Manchester which means that this is now much too expensive for general use by academics from outside Manchester.

**Is sufficient provision made for operational costs and upgrades to enable best use to be made of the UK's existing scientific infrastructure? Is it used to full capacity; and, if not, what steps could be taken to address this?**

In many areas, particularly high-performance computing, big data etc, it seems there is a willingness to make capital investment, but a reluctance to balance this with investment in the people needed to run the equipment. The traditional model of having postdoctoral researchers develop and maintain equipment and software is unsustainable. Skilled software developers and technicians are crucial to modern scientific endeavour so developing appropriate and appealing career paths and incentives and allocating appropriate operational budgets, taking these into account at the investment decision stage, and then committing to deliver them, are essential. We are becoming increasingly short term in outlook and a more holistic and longer term approach to return on investment calculations needs to be taken: "holistic" in that greater effort needs to be made for reflecting the need for on-going upgrade and articulating and taking account of the economic, social and other impacts of the investment. We also need to bear in mind that these impacts may only be felt by the next generation rather than in five years' time. Establishing a number of research centres that focus on potential outcomes rather than the technology inputs and which support particular communities for example, an Engineering Space Centre, would be helpful in this regard.

Turning to the issue of capacity, as outlined earlier, major facilities such as Diamond, ISIS, the NERC Geophysical Equipment Facility (GEF) and the EPSRC NMR centres are of excellent quality but appear to be operating at or above capacity. It does seem that if the operating infrastructure and costs were better planned and resourced, facilities could be run on a 24 hour basis to provide greater accessibility. The facilities could then be actively promoted for subscription-based use (contributing to the operating costs) by both private businesses and universities through the establishment of national and regional hubs of "science and technology users and facilitators".

**What substantial increases in scale would allow new areas or domains of science to be explored (analogous to Large Hadron Collider and Higgs boson)?**

Manufacturing (involving process and product innovation) activities are the most important wealth providers in any national economy and yet public funding for supporting fundamental and strategic research and development is rather limited and not sufficiently responsive to the level of demand that currently exists in small businesses and universities. More targeted and focussed public funding injections directly into schemes converting science and technology to business success over the long term are recommended. Scale is not the issue and neither does the UK necessarily need to host a flagship multinational facility - we need to maintain and advance world leadership in the facilities we already have but to focus on better collaboration, integration and accessibility with, perhaps, a cross sector body that facilitates communication and information transfer.

We further suggest that research aimed at long-term discovery and development programmes such as space, astronomy and nuclear fusion programmes could be established along similar lines as the privatised NASA research activities and the atomic particle splitting and accelerator research facilities in Switzerland that focus on collaboration and integration.

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**Are effective and fair arrangements in place for access and charging for public and private scientific infrastructure?**

The situation is highly inconsistent with some good and some poor examples of such arrangements. Some facilities are made available free of charge with steering committees that run full peer reviews of applications to use the facilities (for example, the GEF and NMR centres). There are, however, others (e.g. tomography) which are priced beyond affordability for most users - it is currently cheaper to fly to the US for 3 days of synchrotron tomography beamtime rather than using a laboratory instrument in the UK.

Greater use of financial incentives and tax relief could be made to make it attractive to companies to participate in national and regional infrastructures in more integrated and responsive frameworks. Universities need to be able to accept capital equipment from companies, with the companies being able to obtain real tax benefits from allowing them to do so. Public funding should be directed towards areas which can create jobs and income whilst attracting more direct private funding into research areas that can shape the future over a longer (>10 years) time frame such as space, astronomy and nuclear programmes.

**Are effective structures in place for funding of medium-sized scientific infrastructure and enabling sharing among Higher Education Institutions and Research Institutes?**

There are few incentives in place for universities to seek to overcome the practical barriers that exist to collaboration and equipment-sharing. Geographical accessibility will always be an issue to be overcome, particularly as concentration becomes more prevalent (see comments about the “golden triangle” above). Further, while total grant funding won and ownership of infrastructure rather than the efficient use of existing facilities remains as one of the indicators of a high quality research environment (HEFCE Research Excellence Framework) and hence university research reputation and allocation of quality-related research funding, each individual university will want its own research centres and equipment. Addressing this particular disincentive would be helpful and certainly, more innovative approaches to equipment "sharing" could be developed. For example, it should be possible for data and images to be handled at remote locations, especially if the appropriately skilled support is available at the physical location of the main item(s) of equipment - even physical samples can be sent then remotely manipulated. But the incentives have to be in place to do so.

As capital funding becomes ever scarcer, collaboration will become more important but needs to be properly co-ordinated and planned. SMEs appear to be even more disadvantaged with indirect and often convoluted channels of access to the research and development (R&D) infrastructure for which they can often not afford to pay. While sharing arrangements might work well on an *ad hoc* basis, national coordination in the form of a national infrastructure base may be needed. The suggested national and regional hubs of "science and technology facilitators and users" would ensure more direct and structured access rather than leaving much to serendipity and the individual initiatives of local universities or company directors.

**Are regional research alliances proving effective in enabling access to funding for medium-sized infrastructure? Should more be done to support or incentivise approaches to collaborative funding and sharing of medium-sized infrastructure?**

While the situation is improving, the UK still has some entrenched dividing lines between universities and other research organisations and industry. It has improved but they are still much more marked than in Germany, Finland and US for example. A key risk, certainly for the university hosts of such infrastructure, is that the increasing drive to “concentration” makes the formation of effective and innovative research alliances based on real complementary capability rather than the reputational rhetoric of the small number of larger institutions which benefit from this policy, increasingly difficult.

As outlined above, incentives need to be put in place to overcome some of the practical barriers and perceptions. One potential opportunity would be for Government to target Local Enterprise Partnerships (LEPS) to broker relationships between their local universities and businesses. That said, there is also a place for national-level infrastructure in certain areas to ensure a broad enough user base.

**To what extent do funding structures in the UK help or hinder involvement in EU and international projects, and should the level of UK involvement be improved?**

Access to EU funding is good and the UK does well from it. However, a) the burden of applying for and maintaining such funding is administratively heavy, b) the arbitrary need for projects to comprise pan-European partners means that it is often difficult to build projects involving multiple UK participants even where these are clearly the best placed to deliver the work and c) there is a necessity to apply for infrastructure usage separately from experimental operating costs, all of which are hindrances. Elaborating on the latter issue, international projects could, in theory, provide significant financial contribution to the costs of research and research training within universities and businesses. However, international networks rely heavily on the provision of equipment and facilities already established in the UK. This needs to change so that direct funding for establishing new research infrastructure for multi-purpose international use could be obtained directly with EU research funding, facilitating fuller and longer term mobility between the centres providing the research facilities.

**To what extent are EU and international programmes effective in promoting collaborative investment in scientific infrastructure projects?**

Ostensibly, the very nature of the system should force this to happen, however, it does not seem to be happening effectively for infrastructure projects. Projects tend to be created around partnerships for the particular project rather than creating infrastructure with any long-term usefulness. Furthermore, it is often necessary to contribute “matched funding” and this is difficult to attract in the UK’s financially constrained environment. That said, in addition to public funding provided through the partnerships between member states, EU consortia involving private business funding could be structured to provide the matching and supporting tier of investment in collaborative research. Greater focussed co-ordination than currently exists would be needed for this between the companies operating in the member states.

**Are Government policies successful in encouraging industry to co-invest in scientific infrastructure?**

As outlined in some of the sections above, more incentives and national co-ordination are necessary. Prioritisation of state support and tax incentives in line with wealth creation and further targeted incentives for SME and university-backed new technology areas through national/regional hubs would help to engage the private business more fully.

Private funding for high cost infrastructure might be better focussed through international partnerships. The European Space Agency is a good example that can be moved into other areas of activity especially in innovative manufacturing and sustainable/renewable energy projects.

**What impact does publicly funded scientific infrastructure have in terms of supporting innovation and stimulating the UK’s economy?**

Without a publicly funded scientific infrastructure, the UK economy would certainly struggle to deliver innovation. Many global science-based corporates are either moving their R&D bases to other countries or not investing to establish new facilities in the UK. There are a variety of reasons for this, with one possibility being that they are not sufficiently involved at either the investment case stage or in the on-going governance of these facilities so do not feel connected. The Catapult centres may be an improvement but, conversely, seem currently only to draw from a narrow range of academic input.

**Summary**

In summary:

- We emphasise that continuing, sustained investment in our science and technology infrastructure is essential and that, to remain internationally competitive, we support the campaign to increase our expenditure as a proportion of GDP to at or above the G8 average.
- That said, we believe that this needs to be done more efficiently and that incentives need to be introduced for both private sector investment and greater collaboration between universities (for which some perverse disincentives to collaboration exist), businesses and the research institutions to help overcome some of the practical barriers and perverse incentives to behave differently.
- A long term and rigorous approach to planning that takes into account, and commits to, initial investment, upgrade and operational costs, needs to be adopted with recognition that financial returns may not be seen for a generation. Sharing of the risks and rewards between stakeholders may make this more acceptable.
- A well-communicated national approach, delivered locally which seeks to avoid regional bias is needed.
- Skilled software developers and technicians are crucial to modern scientific endeavour so developing appropriate and appealing career paths and incentives and allocating appropriate operational budgets, taking these into account at the investment decision stage are essential.
- Establishing a number of research centres that focus on themes, market potential, sectors or outcomes and support particular science and engineering communities, rather than the technology and equipment inputs, would be helpful.

Yours sincerely

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President