University of Oxford Submission to the House of Lords Science and Technology Committee Inquiry into scientific infrastructure

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Current availability and status of scientific infrastructure

1. Access to cutting edge research infrastructure is vital to maintain the UK's world-class research performance and for experimental development of new or improved products or services. Science is highly competitive and there are powerful early acquisition advantages so it is important to be at the cutting edge in terms of infrastructure.
2. Funding for scientific infrastructure must take adequate account of operational costs and planned upgrades. There is a need for investment in capability, capacity and recurrent to go alongside capital investment.
3. Universities, research organisations, and industry groups, with the support of the Funding Councils, the Research Councils and TSB, must continue to take every available opportunity to share equipment and facilities.

Long-term needs, setting priorities and funding

4. Government has a key role to play in consulting to identify needs, setting long-term strategy, and coordination.
5. Planning should be evidence-based and involve all major parties, incl. BIS, the Funding Councils, the Research Councils, universities, TSB, the Association of Medical Research Charities (AMRC), industry bodies, learned societies and Chief Scientific Advisers. Because large infrastructure is costly and takes time to deliver it is critical that Government leads, working in partnership with other stakeholders, to envision and help meet future needs (including through European-wide or broader international initiatives).
6. Planning mechanisms must take into account important relationships between the NHS and other sectors, and in particular higher education. The quality of scientific infrastructure will have a direct impact on the future of the NHS. The NHS provides crucial scientific infrastructure for biomedical research, including medium to large scale equipment for clinical trials, clinical imaging and clinical diagnostics and increasingly therapeutics (e.g. proton beam), and data management.
7. Strategies need also to be nuanced for other research areas. For example in mathematics and other computational disciplines this includes access to computing resources (HPC, grid, cloud,

regional) and data, and security issues which need all relevant parties to discuss and agree a way forward. Government support for HPC investments has been crucial. To make the most of the big data opportunity, the UK should build on the excellence of its numerical and computational disciplines. There is a lot of international competition – there has been considerable investment in the US, for example, not just into large scale computing but also the development of algorithms for large scale data and even new computing paradigms (such as research into probabilistic chips funded by DARPA).

8. Since the last Comprehensive Spending Review (CSR), a series of additional announcements have been made on investment in scientific infrastructure. This funding is very welcome, enabling new projects with particular goals that attract new partnership money. However, the reduced focus on developing the broad research infrastructure has damaged the UK's ability to plan strategically and to instil confidence in the UK research base, so that the country may continue to attract and maintain world-leading scientists.
9. The irregular appearance of capital to be allocated at short notice tends to militate against sustainable strategic investments in research infrastructure.
10. It is not clear why capital spend was removed from the ring-fenced science budget.
11. Timescales for proper planning investment and delivery of infrastructure exceed normal CSR and political cycles. Building infrastructure takes time. The recognition of the need for long term sustainability is exemplified in the Diamond Light Source Joint Venture with the Wellcome Trust and UK Government, which was established as a 30 year project. Long term planning for upgrades, expansion and decommissioning may extend the timescale to 50 years.
12. There are key areas of current and future biomedical science where increased funding/investment to develop crucial underpinning scientific infrastructure will be critical. For example:
    - E-infrastructure for biomedical science - from simple to complex 'big data' and of relevance to genomics, imaging and healthcare (i.e. human epidemiological) data. Investment is essential at national level to establish computing power, software, data analysis, and data repositories and to facilitate integration with other national and international data centres.
    - Biomedical imaging - critical to all biological and medical disciplines and where EU competitors e.g. France and Germany, are investing significantly to establish national imaging infrastructure.
    - Nanotechnology and nanomedicine - especially new investment in targeted diagnostics and therapeutics development of advanced generation drug delivery systems.
    - Regenerative medicine and biomedical engineering - investment to develop high throughput and robotic technologies at the medical and physical sciences interface for human tissue repair and replacement.
    - Synthetic biology - investment in synthetic genomics infrastructure and e-infrastructure.

    The current level of reduced funding will have a damaging effect on UK productivity and competitiveness unless the situation is redressed with long-term certainty.

13. Research in Physics requires both large-scale and intermediate scale apparatus in order to remain competitive internationally. The UK already has world-leading capability in several national laboratories, and it is important this capability is maintained at the cutting edge of performance. This will continue to attract researchers from around the world. Of particular importance are the following:
    - The 10PW upgrade to the Vulcan laser at RAL is vital to a wide range of laser science in the UK (and in fact it would be the leading facility of its type in Europe).
    - The UK should re-engage with European X-FEL in the short to medium term (in the longer term construction of a UK based next generation X-FEL should be considered a priority).
    - In the longer term the development of technologies that might supersede current X-ray generation technology at facilities like Diamond is crucial for sustainability in this science area and for UK credibility.
    - Target station upgrades and enhancements are much more effective than the proposed power upgrades at ISIS (resources and the experience acquired from Target Station 2 should be used to optimise Target Station 1 for the next ten years). Japanese universities and companies are collectively the second largest users of ISIS, indicating the international importance of this facility, and its capacity for extra-UK income generation.
    - The availability of facilities where more than one element is involved e.g. X-FEL and high power laser, or neutron scattering and high power laser, will enable science that cannot be done with the facilities individually. Therefore co-location of major facilities will be vital in the future.
14. It is, of course, not just within the STEM disciplines where investment in scientific infrastructure is a pre-requisite in enabling UK research to maintain its global competitiveness. The availability of so-called big data represents a step-change in how the research community is able to address social science questions. Recent capital investments in areas such as the Administrative Data Research Network, facilitating access to de-identified administrative data routinely collected by government departments and other agencies, and Business Datasafe, which will provide access to a range of sensitive and extremely rich datasets held by commercial organisations, will underpin research with real societal and economic impact and utility. It will be essential that investments in areas such as these and the UK Data Service are maintained.
15. The UK must ensure it has leading-edge capabilities in e-Science, applying advanced digital methods in and across disciplines; harnessing the capabilities of new hardware, and innovating in digital methods. The July 2010 report on e-infrastructure commissioned by BIS asked

    > *Do we build on the great success of the last few years and exploit the opportunities of the future or do we stand on the side lines and watch the UK's global advantage dissipate and fade?* [Emphasis added]
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    > E-infrastructure is essential to high quality research and contributes to the international position of UK science. Rather than being a research by-product, it represents a critical national asset in its own right.[1]

[1] http://www.rcuk.ac.uk/documents/research/esci/e-Infrastructurereviewreport.pdf

16. Hand-in-hand with investment in equipment/facilities, there needs to be more investment in open data (including infrastructure to disseminate/share) and in understanding the relationship between the two (as re-use of data generated from new facilities should be encouraged). National facilities including subject-based data services provide critical support to universities to make their data open and are crucial to achieving further progress. Such facilities must be placed on a sustainable financial footing for the long-term.

Governance Structures

17. Governance at the highest level(s) appears, to many, opaque and fragmented across government.
18. Some senior officials in government who influence or take key decisions can often seem separated from knowledge of the capabilities and capacities of the research base, and how to best utilise them.
19. The UK Research Councils have done a great deal to consult with universities and, where possible industry, and plan (incl. through developing the *Strategic Framework for Capital Investment*)[2] but we need to find robust mechanisms to also involve other key interested parties in the UK and not ignore or duplicate the Research Councils' high quality work.
20. There needs to be sufficient scope for "science push." Requirements-led, managed programmes address known unknowns; whereas expert-driven science provides "game changing" knowledge, fresh early opportunities, and a climate of excellence which attracts people, investment and innovation. Scientists must be given a lead role in identifying infrastructure needs.
21. Specific projects need different governance and ownership models, depending on the aims, discipline(s) and the national/international perspectives.
22. It is vital that the UK play a leading role in international forums and consortia with oversight/governance functions, such as the European Research Infrastructure Consortium and the OECD Global Science Forum, and that the UK's representatives consult with and inform the UK scientific community about key issues, opportunities and future plans.
23. There is a need to plan over short, medium and long term to assess what activity should be independently UK-led and in what areas we should make strategic collaborations (e.g. CERN, European X-FEL, ESFRI projects), to ensure that UK scientists have access to cutting edge facilities.
24. Regional research alliances in the UK *are* helping to provide greater access to medium-sized infrastructure.[3] Examples include the work of the N8 Research Partnership and of SEESEC (now Science and Engineering South Consortium (SES-5)).[4]
25. EPSRC funding to Framework Universities to enhance intra and inter-institutional equipment sharing was modest in scale but extremely welcome and effective – further such funding not only by EPSRC but also other research councils would be welcome. (See Appendix 1 for a brief profile of the Oxford Use and Sharing of Research Equipment Project).

2 http://www.rcuk.ac.uk/research/Infrastructure/Pages/lfr.aspx

3 See section 3.2 of the *MAKING THE BEST BETTER, UK Research and Innovation: More efficient and effective for the global economy*, Report for Department of Business, Innovation and Skills, March 2013 – http://www.n8research.org.uk/assets/files/EfficiencyReportFinal.pdf

4 http://www.timeshighereducation.co.uk/news/research-heavyweights-deny-ganging-up/2003702.article

Partnerships

26. It would be very useful to commission research on what precisely are the barriers (perceived and actual) to
    - Small, medium sized and large enterprises accessing publicly funded scientific infrastructure in the UK; and
    - Universities and public research organisations accessing equipment and facilities in UK industry and the NHS
27. One of the problems in the UK is that industry itself is much undercapitalised and it is taking time for the idea of investing in infrastructure and engaging in Open Innovation to "catch on."
28. The N8 Report on 'Benefits, barriers and cultural factors' in equipment sharing reported on interviews held with industry representatives within multinational companies whose work is reliant on state of the art research equipment. There was 'general enthusiasm for greater equipment sharing with Universities. This is mostly due to the view of enhancing collaborations in science and to keep costs of equipment purchasing and maintenance down.'[5] That report suggests the value of doing more work to examine challenges and opportunities.
29. It would be interesting to see if one standard form (legal) agreement could be developed to facilitate equipment sharing not only between universities and research organisations but also with industry; perhaps a Lambert-style[6] specific purpose agreement. One senior colleague advised she had spoken with an executive from a major multinational company who "would like to be able to sign one facilities sharing agreement that would allow them to work with all universities in the UK ... it is too tedious [and costly] to do this multiple times ... Getting such an arrangement set up with Research Councils for RCUK-funded projects would be a possible way to start." We note that some university research consortia (such as N8 and SES-5) have also highlighted a similar opportunity.
30. The UK Research Partnership Investment Fund (UKRPIF) has seen significant co-investment in infrastructure; the Minister for Universities and Science, David Willetts, recently announced that the Government's £300 million investment had secured over £855 million from business and charities - a total investment of £1.15 billion in 20 projects so far.[7] This helps illustrate the catalytic and multiplying effect of government funding.
31. Research commissioned by the Science|Business Innovation Board (AISBL), whose members include the ESADE Business School, INSEAD, Microsoft , BP, SKF, Foley & Lardner LLP, Aalto University and Imperial College London, found that the best ways to make university-industry partnerships work, in general, were to
    i. *Keep the ship steady*. Policymakers need to ensure a predictable, stable environment of funding and regulation for long-term strategic partnerships to thrive.
    ii. *Give universities the autonomy to operate effectively, and form partnerships.*
    iii. *Reward activist, collaborative universities – and encourage more to be that way.*

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[5] http://www.n8research.org.uk/assets/N8%20WorkstrandreportsJune2012.pdf

[6] http://www.interface-online.org.uk/2357

[7] http://www.hefce.ac.uk/news/newsarchive/2013/name,82019,en.html

iv. *Help universities strive for excellence.* Companies want to work with the best – and so Europe must take care always to feed and promote its best universities, in order that more job-creating partnerships can be formed.[8]

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8 http://www.sciencebusiness.net/Assets/94fe6d15-5432-4cf9-a656-633248e63541.pdf

APPENDIX 1

The Oxford Project on 'The Use and Sharing of Research Equipment'

1. At the whole-of-University level, Oxford established 'The Use and Sharing of Research Equipment' in June 2010.
2. August 2012 saw the 'soft launch' of Oxford's Research Facilities & Equipment Online Searchable Database which allows researchers, technicians and others to search for a piece of equipment or facility, refine by location and Institution, and also search by category. The database (developed with co-funding from the EPSRC) is being used by researchers and others to help establish whether there is spare capacity, make the case for funding (to meet usage charges or for new equipment where current facilities cannot be utilised) and by groups of researchers who are discussing and planning how to meet future needs. This database is now pulling in data on selected equipment and facilities for Cambridge, Southampton, UCL and Imperial to help facilitate sharing among the Science and Engineering South Consortium (SES-5).
3. The Project has also held workshops on setting up and operating Small Research Facilities (SRFs) and developed on-line information and advice on facilities access and budgeting.
4. The University has used EPSRC funds to
    a. co-invest in a major initiative by the e-Infrastructure South Consortium, to establish, with the support of the EPSRC, a new £3.7million regional centre for supercomputing
    b. support 17 initiatives led by PIs and or Heads of Department to increase the use of research equipment and facilities, reduce costs and share scarce resources[9]
    c. take part in a South East England Science & Engineering Consortium (SSESEC) Project, with Cambridge, Southampton, UCL and Imperial College, to facilitate equipment sharing through SEESEC facilities' listings and standard access agreements. (This is now part of the work plan for the Science and Engineering South Consortium (SES-5)).

See http://www.efficiencyexchange.ac.uk/2176/productive-efficiencies-higher-education-case-studies/

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[9] Examples include projects to:

- Enhance capacity and sensitivity (Physics SQUID-based magnetometer)
- Train new users (Materials; JEOL instrument)
- Set up internet booking (Biochem, BMG-PherastarFS platereader)
- Reactivate Differential Scanning Calorimeter (DSC) and thermogravimetric analysis (TGA) systems and incorporate them into the X-ray Crystallography SRF
- Enable material researchers to study high temperature structural phenomena ('Supernova' single-crystal diffractometer SRF)
- Establish new collaborations between Engineering Science, DPAG, Oncology and NDORMS (multiphoton microscope, Eng Sci)
- Make undergraduate lab instruments open to researchers.