RSC response to the House of Lords Science and Technology Committee inquiry on Delivering a UK science and technology strategy

With about 50,000 members in 120 countries and a knowledge business that spans the globe, the Royal Society of Chemistry (RSC) is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world. Our members include those working in large multinational companies and small to medium enterprises, researchers and students in universities, teachers and regulators.

Delivery of the UK science and technology strategy is important to the chemical sciences community. We welcome the opportunity to respond to this inquiry.

What would it mean for the UK to be a "science superpower?"

- What would a "science superpower" look like?

For the UK to continue its scientific leadership, its research, development and innovation ecosystem will need to be equipped for future challenges so that it can deliver significant improvements to the world we live in.

While the Covid-19 pandemic has highlighted scientific successes, it also has exposed vulnerabilities in the UK research, development and innovation (RDI) ecosystem. The right elements will need to be in place to ensure that the UK is prepared for future challenges[1]. These include:

- Transparent, long-term funding mechanisms which provide certainty;
- An inclusive and diverse RDI workforce; and
- Infrastructure which harnesses digital technologies from advanced measurement and sensing to AI and robotics, enabling the UK to accelerate science and its translation into applications.

The RSC has explored the needs of scientific RDI in the chemical sciences over the next 10 to 15 years[2,3]. This work has uncovered a range of qualities that chemical scientists expect will characterise leading science in the future:

- multidisciplinary and globally connected, while also delivering benefits locally;
- digitally enhanced and making full use of digital technologies;
- focused on finding paths to sustainable prosperity, including by contributing to achieving the UN Sustainable Development Goals; and
- delivering better and more significant improvements to the world we live in.

- Does the Government have a coherent strategy and sufficient existing policies to make the UK a "science superpower?"

The R&D People and Culture strategy should be developed in a way that ensures coherence across relevant Government departments, and that is coordinated with funders, employers, and sector and professional bodies.

People are the cornerstone of delivering the Government's RDI ambitions. In his 2018 speech at the Royal Society Research Culture conference[4], Sir John Kingman, then Chair of UKRI, said that achieving the Government's 2.4% investment target could require an increase in the scientific workforce of 50%[5]. Policy levers affecting the RDI workforce fall across different Government departments. Supporting people through joined-up policy levers will enable effective diffusion of their knowledge and skills, benefitting individuals and society[1].

- What measures should determine whether the UK has become a “science superpower”?

Measures to determine the performance of UK science should relate to:

- **in how far the right elements are in place to equip science for future challenges,** for example, long-term funding mechanisms; a diverse workforce; and infrastructure, including digital.
- **the qualities expected from an international scientific leading nation,** for example, to what extent does it deliver economic and societal impact; does it result in paths to sustainable prosperity; is it globally connected; and is it digitally enhanced.

While it will be tempting to use delivery against the 2.4% of GDP by 2027 target as a measure of success, we note that the 2.4% target, while important to achieve, is below the 2019 OECD average[6]. A more appropriate measure would be whether UK RDI funding levels are comparable to those in other leading scientific nations.

- What could be done to ensure that the Government’s science and technology strategy is long-term and pursued across administrations? What have been the consequences of a frequently changing science policy?

We welcome the call for a long-term strategy as opposed to the recent frequent changes linked to short-term cycles. As an immediate action, the Government should continue to pursue UK association to Horizon Europe, whilst embedding long-term thinking into any work on alternatives.

The recent multi-year funding settlement set out in the Autumn 2021 Spending Review provided some reassurance, but there is still substantial uncertainty, for example, over the UK’s association to Horizon Europe and what alternatives (“Plan B”) might entail.

Does the introduction of a science and technology strategy challenge the Haldane principle and UKRI’s commitment to fund outstanding research?

- How should the Government balance support for bottom up, curiosity-driven research with support for research focused on its strategic priorities?

Support for curiosity-driven research must be sustained alongside funding explicitly focused on strategic priorities. Quality-related research (QR) funding is important to underpin this and to protect our national RDI capacity and capability. The Government must reverse the decline in QR and ensure that future QR allocations retain their real-terms value.

While it is not always possible to predict the potential applications of curiosity-driven research ideas, it is well-established that curiosity-driven research has paved the way for advances that contribute to addressing societal challenges[7].

In a 2019 RSC survey[8], the chemical sciences community identified funding for curiosity-driven research as one of the most important areas of public RDI funding. Two funding sources that are regarded as important to enabling curiosity-driven research are QR funding and European Research Council (ERC) funding which is part of European Framework Programmes.

QR funding is a vital complement to mission-driven funding streams: it enables institutions to train the next generation of researchers and entrepreneurs, to fund cutting-edge infrastructure and early-stage, risky or disruptive research. Crucially, QR’s flexible nature means universities can use it for both long-term planning and to respond quickly to emerging opportunities and pressures. During the Covid-19 pandemic, universities were able to use QR funding to rapidly pivot their activities even before Government schemes were put in place. Despite its vital role, between 2010/11 and 2020/21 QR funding saw a real-terms decline of 14%[9].

In the 2019 RSC survey, ERC funding was seen to be one of the most difficult elements to replicate as part of potential alternative mechanisms to Horizon Europe association. In a scenario where the UK fails to associate, it will be critical that alternatives include funding for curiosity-driven research at the same scale as ERC.

Is the UK realising the potential of its research investment?

- Do bureaucratic processes hinder R&D in the UK? Are there examples of where these could be removed without compromising oversight?

UK funders should better align their funding application processes and ensure that criteria are clear and unambiguous.

The UK RDI ecosystem currently places a diverse range of requirements on researchers and research organisations which often seek to collect the same information. This significantly impacts chemistry researchers because chemistry has applications in a wide range of fields: within UKRI, chemistry receives some level of funding from every Research Council, with different information requirements for each. Greater alignment between funders in the UK landscape would reduce the complexity of application and reporting processes, freeing up time for researchers. Of course, some data collection is needed to achieve objectives for the RDI ecosystem, for example progress on equality, diversity and inclusion requires good data collection.

In our recent 'What works for innovation' report[10], we have identified the following barriers for deep tech chemistry SMEs applying for public funding, alongside the perceived burdens of the application process:

- Lack of clarity about grant criteria and/or what makes a good application: ensuring that criteria are unambiguous would help address this.
- Mismatch between grant timescales and the unpredictability of chemistry innovation: greater flexibility should be considered.
- Grant panel members may lack understanding of the technologies.

- Could the bureaucracy reducing principles of the Advanced Research and Invention Agency be extended to other public sector research establishments?

It will be important to evaluate how the ARIA principles are working in practice before translating it into the current RDI ecosystem.

The bureaucracy reducing principles of ARIA aim to give the new funding agency financial flexibility and operational freedom. While it is generally agreed that there is currently too much bureaucracy in the UK RDI ecosystem, some caution must be taken before extending ARIA's principles more widely:

- ARIA is intended to be a very different funder and therefore the way it operates may not translate well to other funders;
- Concerns have been raised regarding ARIA's transparency, e.g., it is exempt from the Freedom of Information act[11]. Its budget is relatively small compared to the overall public RDI budget (1%). Any expansion of ARIA's principles would require consideration of whether similar exemption would form a barrier to public accountability, which could lead to a lack of trust and public confidence.

- How can the Government better incentivise and support interdisciplinary research and innovation?

The Government needs to enable collaboration by creating shared spaces, fostering communities around shared challenges, and needs to ensure that interdisciplinary research is recognised.

The RSC reports ‘Science Horizons’ and ‘Digital Futures’ have identified some of the conditions that are important to enabling interdisciplinary research[2,3]:

- The need for highly skilled disciplinary experts while harnessing interdisciplinary approaches to answering questions and delivering solutions;
- The importance of fostering collaboration through networks and events, online fora, and shared facilities, resources and online spaces, including hosted between organisations in different sectors.

It will be important that interdisciplinary work and outputs are recognised through the REF; the Physiological Society provides suggestions on how this can be done in its recent report ‘The future of interdisciplinary research beyond REF2021’[12].

Collaboration is also vital in deep tech chemistry innovation, for example to enable production scale-up. Important enablers of this are leadership and management training / learning to develop open innovation capabilities and support and advice on intellectual property[10].

- Does the Government’s strategic direction and the current allocation of research funding align with the UK’s scientific and economic strengths?

For the UK to maintain its position at the forefront of chemistry, advanced materials and the life sciences, cross-sector integration of frontier techniques into chemistry RDI capability will be essential.

As the world transitions to the digital age, the way in which scientists discover, understand, measure and make materials and molecules is changing and this change is accelerating. While chemistry-using industries - from life sciences & biotech to energy & automotive - are increasingly embedding digital technologies across their operations, academic research settings currently lack the capacity to transform in the same way. They risk losing their competitive advantage as other countries are starting their journey of building advanced chemistry and materials capability enabled by digital technologies from modelling and analytics to AI and robotics.

How should state funding for research and development be allocated between different organisations, who should make that decision and by what criteria?

- How should state funding be used to leverage private sector funding?

More support is needed for deep tech chemistry SMEs to overcome investment challenges.

While SMEs in chemistry-intensive sectors are around twice as likely to be investing in R&D as other SMEs, deep tech chemistry SMEs encounter specific challenges including limited access to capital and lack of available suitable premises and equipment. For businesses to be able to continue to privately invest in R&D, grow and deliver products to market, they need support to overcome these challenges in the form of solutions to address the equity gap as well as gaps in infrastructure needs[10].

What more should be done to encourage private-sector investment in research and development in the UK?

- What more could be done to incentivise collaborations between academics and industry? Are there barriers preventing this collaboration that could be removed?

Improving recognition of outputs and outcomes from collaborations with industry, and changes to academic funding structures, can help remove barriers to university-industry collaboration.

In a 2021 survey of heads of chemistry departments in the UK, the three main barriers identified to engagement with industry were: i) 'IP and contract negotiations are difficult or lengthy and/or university-level processes and procedures are not suitable'; ii) 'available funding streams are insufficient in either scale or flexibility'; and iii) 'tensions arising from different operating timescales and success measures (e.g., academic outputs vs competitive advantage) cannot be resolved'. The three main enablers were: i) 'access to funding streams of appropriate scale and flexibility'; ii) 'institutional culture values and rewards engagement with industry'; and iii) 'staff have the skills, awareness and opportunities to engage effectively with industry'.

Comments from our community, collected in response[13] to the 2016 Stern review of the REF2014 process, indicate that in some cases the REF process is unintentionally driving behaviours whereby institutions do not value patents, generated through industrial research partnerships, as highly as "top" journal papers, and therefore may discourage such collaborations.

The RSC's 'Science Horizons' report[2] captured the views of more than 750 people actively doing research in universities and research institutes around the world. We heard a sentiment that researchers need to be more flexible in working with industry, but that this needs to be supported by similar flexibility in funding structures.

- What stage of the pipeline, from innovation to industry, is presenting the most significant problems for commercialising discoveries in the UK?

The RSC's 'What Works for Innovation' report[10] sets out the challenges faced in commercialising deep tech chemistry innovations.

How well does the UK collaborate on research with international partners and what can it learn from other countries?

- In which areas of science and technology is collaboration, or negotiating access to existing projects, more appropriate than competition or seeking comparative advantage?

Collaboration is a key enabler for advances in the chemical sciences.

Science offers the widest benefits to society when researchers from different backgrounds come together to share knowledge and expertise. This was exemplified when researchers from across the globe have come together to tackle the pandemic[14].

The RSC 'Science Horizons' report[2] evidenced that collaboration, internationally, between disciplines and between industry and universities, is widespread in the chemical sciences and vital to solve increasingly complex challenges. Our 'Digital Futures' report[3] indicated that multidisciplinary collaborations, communities and capabilities will be crucial to enable chemists to benefit from digital technologies and to harness the chemistry-digital interface.

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