THE ROYAL SOCIETY

Friday 31 July 2020

Royal Society submission to the House of Commons Science and Technology Select Committee inquiry into a new UK research funding agency

Summary

- The Royal Society welcomed the Government's March 2020 Budget commitment to increase public investment in R&D to £22bn per annum by 2024-25. The £800m commitment to ARPA demonstrates that this Government is, 'embracing opportunities to try new things.'[1]
- While we welcome the agency in principle, further detail is required in order to make an informed assessment upon how its creation will affect the existing R&D system. The content of the submission is based on information available and the role of DARPA and its variants in the US. It should be understood within those limits.
- A UK ARPA could facilitate investments in technologies with radical potential that may not otherwise receive support through existing mechanisms. It is important that this differentiated focus is clearly articulated and understood.
- Both the new organisation and existing organisations, specifically UKRI and its constituent body Innovate UK, will need to engage in some degree of strategic alignment to mitigate the risk of duplication and engender greater coherence in a research system that has recently undergone significant change.
- The stated focus on 'high-risk, high-reward' research should be retained. A lean structure in which qualified programme managers appointed on a fixed-term basis are given discretion over the programmes that they select should also be retained.
- The indicative level of funding appears appropriate in the context of the commitment to increase the overall level of public investment in R&D. The agency's funds should be put toward supporting a small number of carefully selected programmes. This initial period should be designated an exploratory phase.

Introduction

1. The Royal Society welcomes the opportunity to submit written evidence to the House of Commons Science and Technology Select Committee's inquiry into a new UK research funding agency. This submission follows a letter sent by the Society to the Chair of the Committee on this topic in April 2020. That letter noted, 'it would be beneficial for Government to provide greater detail on its ambitions for the organisation to enable more specific input on its function and design.' This remains the case.

2. The Royal Society is the national academy of science for the UK. It is a self-governing Fellowship of many of the world's most distinguished scientists working across a broad range of disciplines in academia, industry, charities and the public sector. The Society draws on the expertise of the Fellowship to provide independent and authoritative scientific advice to UK, European and international decision makers.

3. The rest of this submission consists of six sections, corresponding to the points identified in call for evidence:
    a. What gaps in the current UK research and development system might be addressed by an ARPA style approach?
    b. What are the implications of the new funding agency for existing funding bodies and their approach?
    c. What should be the focus be of the new research funding agency and how should it be structured?
    d. What funding should ARPA receive, and how should it distribute this funding to maximise effectiveness?
    e. What can be learned from ARPA equivalents in other countries?
    f. What benefits might be gained from basing UK ARPA outside of the 'Golden Triangle' (London, Oxford and Cambridge)?

[1] https://royalsociety.org/news/2020/03/budget-response-2020/

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What gaps in the current UK research and development system might be addressed by an ARPA style approach?

4. In terms of expenditure, the UK research and development (R&D) system is dominated by activity by the private sector, and to a significant though lesser extent, the public sector with private non-profit organisations also having an important role, particularly in the life sciences. UK Research and Innovation (UKRI) and its constituent organisations (including the Councils) is the vehicle for most public investment in R&D[2].

5. UKRI is a relatively new organisation. It was recommended in the 2015 Nurse Review[3], and is formally the product of the 2017 Higher Education and Research Act[4]. The Act also led to the reconstitution of the Higher Education Funding Council for England (HEFCE) as two separate bodies, Research England, and the Office for Students (OfS) – the latter body having augmented regulatory powers. Over the last six years, alongside this reordering of the bureaucratic infrastructure of the R&D system, there have been three general elections and the referendum on the UK's membership of the European Union, the full effects of which remain unclear. The current coronavirus crisis poses a significant challenge to all aspects of the UK R&D system. In brief, the system is in a state of change. Any new research funding agency must be cognizant of this.

6. In the context of this submission, an 'ARPA style approach' is understood as 'high-risk, high-reward', reaching for 'transformational change instead of incremental advances.'[5] The Royal Society welcomed the announcement of funding for a UK ARPA as a demonstration of, 'government embracing opportunities to try new things.'[6]. There is a need now to provide greater clarity on the role of the organisation and its intended place in the research and development system. In terms of the balance between research and development, extant ARPA organisations typically apply this more radical, approach to the development of technologies. Public funding for research and development in the UK has tended to focus on research rather than development[7]. While this binary conceptualisation can be problematic and difficult to measure, in the context of an overall real-terms uplift in research funding, there is value in an organisation with a greater focus on development. Its principal focus should be on technologies. There has been some ambiguity regarding the role of this new research funding agency. It is important that there is clarity on the function of a UK ARPA and that its differentiated role within the UK research and development system is articulated and understood.

What are the implications of the new funding agency for existing funding bodies and their approach?

7. UKRI administers the Government's Industrial Strategy Challenge Fund (ISCF). Its constituent organisations include Innovate UK, the UK's innovation agency. The ISCF launched in 2016. Innovate UK (formerly the Technology Strategy Board) was launched in 2007. It is understood that this new funding agency shall be separate from UKRI. The implications of this new agency for UKRI, its bodies and their approach, is dependent on its model and purpose, both of which are not yet clear, and so hard to identify at this point. At the least, some form of soft strategic alignment will be necessary to mitigate the risk of duplication. To ensure that UK ARPA is strategically aligned, in order to make best use of its differentiated function and avoid duplication, it will need to develop a deep situational awareness of the innovation ecosystem that covers both the public and private sector. This should extend internationally and help enable an optimal flow of talent and ideas in both directions.

8. There is also some scope for this organisation to have a positive indirect benefit upon the norms of the UK research system. For example, if successful, it could help to raise the level of prestige

[2] https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2018
[3] https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations
[4] http://www.legislation.gov.uk/ukpga/2017/29/contents
[5] https://www.darpa.mil/attachments/DARPA-2019-framework.pdf
[6] https://royalsociety.org/news/2020/03/budget-response-2020/
[7] https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/1453/1453.pdf

associated with non-traditional academic outputs and enable greater transition between academia and industry - both longstanding challenges in the UK's research culture[8].

What should be the focus be of the new research funding agency and how should it be structured?

9. The agency will need to define its focus both in terms of technology area/s and types of outputs. Existing ARPA organisations in the United States – DARPA, HSARPA, IARPA and ARPA-E - take their focus from their sponsoring Government Department. For example, DARPA's mission is, 'to make pivotal investments in breakthrough technologies for national security.'[9] The Royal Society has previously argued for ARPA and challenge-based approach or broader challenge-based research in cyber security[10], machine learning[11] and privacy enhancing technologies[12]. Other technological challenges that could benefit from an 'ARPA' type focus include the conversion of electricity to ammonia and the replacement of precious metal catalysts in hydrogen fuel cells. The new agency could align with specific technology areas such as the Industrial Strategy's four 'Grand Challenges'[13] or a specific policy objective such as bringing all greenhouse gas emissions to net zero by 2050[14]. Alternatively, it could retain the flexibility to focus on any area of 'technological white space'[15] that it perceives to be consistent with its 'high-risk, high-reward' approach. Benefits of the approach taken in the US, that would be more easily replicated with a defined 'mission', include the presence of a guiding principle that helps clarify what is, and isn't in scope, both in terms of technology areas and technology challenges ('DARPA-hard problems'[16]), and a customer or customers motivated and able to engage at scale. The departmental customer can provide the organisation a degree of political resilience as well commercial demand to enable technology pull-through. To ensure differentiation within the research system, the new agency, should focus on technologies with transformational potential. The technology area focus for this new agency should follow from its mission. This should be the product of 'serious long-term thinking'[17] that could take place during an exploratory phase. It is important for the long-term viability of the organisation that the overarching mission has popular support as specific programme areas and projects are likely to be esoteric and frequently result in failure.

10. The ARPA model is associated with a lean, flexible organisational structure, in which programme managers have autonomy over the selection of projects. Programme managers are appointed on a fixed-term basis (typically 3 – 5 years) to, 'limit empire building and to bring in fresh talent.'[18] Projects are actively managed using specific technical milestones and time commitments[19]. A similarly lean structure with high levels of autonomy for programme managers appointed on fixed term contracts should be retained for this new research funding agency. Views differ among our Fellowship on the extent to which it will be possible to attract sufficiently qualified programme managers to an untested organisation. These posts may be more appealing to those in industry than academia. In the current system, academics are not incentivised to step away from their own research for prolonged periods. Demand for programme manager positions should be tested and consideration given to how best incentivise participation from across the research landscape.

11. Operationally, the organisation should work across the research and innovation landscape, be industry facing with the ability to sponsor small companies. It should be able to place contracts and hire personnel quickly and efficiently. It is understood that this new research funding

[8] https://royalsociety.org/-/media/policy/projects/changing-expectations/changing-expectations-conference-report.pdf
[9] https://www.darpa.mil/about-us/mission
[10] https://royalsociety.org/topics-policy/projects/cybersecurity-research
[11] https://royalsociety.org/-/media/policy/projects/machine-learning/publications/machine-learning-report.pdf
[12] https://royalsociety.org/-/media/policy/projects/privacy-enhancing-technologies/privacy-enhancing-technologies-report.pdf
[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf
[14] https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law
[15] https://theroyalsociety.sharepoint.com/:w:/r/sites/Researchandinnovationteam/_layouts/15/Doc.aspx?sourcedoc=%7B078BE72B-48FF-4C06-A51F-4A298A734209%7D&file=UK%20ARPA%20-%20Overview%20and%20recommendations.docx&action=default&mobileredirect=true
[16] https://www.darpa.mil/attachments/DARAPA60_publication-no-ads.pdf
[17] 'UK ARPA: An experiment in science policy?' 'Visions of ARPA'
[18] Rumelt, R. P. 2011 Good Strategy / Bad Strategy
[19] https://www.nber.org/papers/w24674.pdf

agency will be independent of UKRI. Independent reporting lines could help to ensure its autonomy and agility.

12. The success of this new research funding agency is likely to be judged in the short term by its perceived health as an organisation and capacity to successfully identify areas of 'technological white space'. The initial funding cycle period of the organisation should be designated an 'exploratory phase' during which the work to define its mission should take place. To ensure that the performance expectations of the organisation during this period are realistic and meaningful, its Director should have a role in creating an initial evaluation framework.

13. The organisation's long-term success will be judged by the extent to which project outcomes have had a direct role in the creation of any breakthrough technologies and new high-technology industrial clusters and supply chains that benefit the UK. To achieve this, the knowledge generated will need to translate to commercial outcomes. This could be delivered by those individuals and organisations that participate in the project. Ideally, where appropriate, others would also be able to take advantage of the knowledge generated to increase any project's real-world commercial impact. Additionally, as this research shall be publicly funded, these commercial outcomes should deliver tangible benefit to the UK economy. Consideration is required as to the best form of collaboration agreement to enable the sharing of intellectual property generated during projects.

What funding should ARPA receive, and how should it distribute this funding to maximise effectiveness?

14. The indicative budget for the organisation is £800m over a period of five years[20]. This formed part of a commitment to, 'increase public R&D investment to £22 billion per year by 2024-25.'[21] The Royal Society welcomed both announcements[22]. The indicative budget for UK ARPA appears broadly appropriate in the first instance given the lean operating structure imagined and the role the organisation is expected to occupy in the UK R&D system. Without further detail on the intended scope and mission of the organisation it is difficult to give an assessment on the appropriate quantum of funding that it should receive.

15. In terms of distribution, given the relatively modest amount of total funding, a small number of programmes within the initial funding period is optimal. This would be consistent with an initial exploratory phase.

What can be learned from ARPA equivalents in other countries?

16. ARPA (latterly DARPA) was created at the outset of the Cold War in response to the launch of Sputnik[5] by the Soviet Union. The willingness of the US Government to create and support the 'high-risk, high-reward' nature of the organisation with relatively small amounts of funding was a product of the country's economic strength, the established interaction between academia, industry and Government and a clear mission: 'to make pivotal investments in breakthrough technologies for national security'[23]. DARPA now has access to broad range of expertise and an annual budget in excess of $3.5bn[24]. It is important to be clear that while it may be possible to replicate the model, the conditions differ, and this may affect outcomes.

17. The appeal of the ARPA model is in its willingness to take on 'high-reward, high-risk' projects. Projects that have contributed to the creation of the internet, the global positioning system (GPS) and stealth aircraft. There are intrinsic and extrinsic challenges in replicating the ARPA model. The former includes the dependence on its capacity to recruit the small group of qualified experts as programme and project managers. The latter includes the model's dependence on the continued availability of sufficient economic resource and political support while pursuing lines of inquiry whose benefits are unlikely to be apparent in the short term.

[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf
[21] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf
[22] https://royalsociety.org/news/2020/03/budget-response-2020/
[23] https://www.darpa.mil/attachments/CreatingBreakthroughechnologiesforNationalSecurity%20Update.pdf
[24] https://www.darpa.mil/about-us/budget

What benefits might be gained from basing UK ARPA outside of the 'Golden Triangle' (London, Oxford and Cambridge)?

18. Over half of R&D investment is concentrated in three regions of the UK: the East of England, London and the South East – the 'Golden Triangle.' This concentration of investment reflects a broader historic disparity in regional economic performance. R&D investment has a role in productivity growth, which is a key determinant in economic performance[25]. The Government's commitment to increase funding in R&D and ensure that the benefits of this investment are more widely felt is welcome[26]. Existing research strength should be protected. Beyond this, there is a role for complementary initiatives that support the development of research strength at a local level. In this context, it is necessary to consider the geographic location of any new research funding agency.

19. UK ARPA is expected to have a lean agile structure with most, if not all, research funded being delivered through existing infrastructure. While a limited physical presence may be useful, it is not obvious that many of the small number of key staff it would employ (programme managers etc.) would need to be physically based there, nor even that this would be desirable (i.e. flexibility may allow for recruitment from a wider pool). Consequently, though there could be some signalling benefit in basing UK ARPA outside the 'Golden Triangle' any direct local benefits may be negligible.

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[25] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf
[26] HM Treasury. 2020 Budget 2020