

Written Evidence Submitted by the University of Oxford (RFA0079)

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The University of Oxford strives for the highest research excellence and is home to some of the most talented scientists and scholars from around the world. Our work enhances the lives of millions by solving real-world problems through an extensive network of partnerships and collaborations. The breadth of our research and the connections between disciplines drives advancement in knowledge, understanding, innovation and creativity. The University comprises approximately 100 major academic departments, which are overseen by four academic divisions: Medical Sciences; Mathematical, Physical and Life Sciences; Humanities; and Social Sciences. We also have very substantial libraries, collections and other facilities in support of research, teaching and public engagement, overseen by Gardens, Libraries and Museums.

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

- 1.1 The UK research and development system should aim to balance investment in foundational research, discovery science, translation programmes, and advancing innovative ideas to outcomes that can be used or commercialised by private enterprise and governments. However, the UK lacks a mechanism to identify, build and deliver truly ambitious, high-risk/high-reward funding programmes with sufficient funding resource over the extended time-spans required to realise the benefits fully. Most current UK funding programmes tend to focus on incremental advancements, and highly ambitious investments are mostly considered too high risk for public funds. Barriers to entry for new researchers can be significant. Ambition in research is also constrained by overly specified programme definitions too explicitly connected to hoped-for economic outcomes. ARPA offers the opportunity to undertake long-term, larger-scale, risky and ambitious projects with the potential to be 'game-changing' in a broadly defined area, along with increased flexibility, and a tolerance of the necessary high failure rate that goes with this approach.
- 1.2 ARPA offers an opportunity to address the short-termism and lack of follow through in the current UK research funding ecosystem. Many Innovate UK programmes are too short-term, overly specified and have funding formula requirements that drives university participation to the margin of programmes. While this may be appropriate for some industrial R&D, it strongly constrains the contribution the university sector could make to UK innovation.
- 1.3 ARPA presents an opportunity for the UK to address a number of sovereign capability issues (e.g. cybersecurity and defence) that cannot be usefully progressed with small-scale funding.
- 1.4 Whereas UKRI is often seen as politically/governmentally driven, ARPA offers the chance to create an organisation driven by societal and technological need. Unlike UKRI, ARPA should not be overly connected to specific details of the Industrial Strategy and near-term political needs but should focus on lasting, transformational change in a strategic area. In doing so it should create enduring, new and additional research capacity for the UK.

- 1.5 Although making progress, UKRI continues to struggle with cross-disciplinary research. ARPA could help drive further culture change, challenging and providing incentives to challenge norms in discipline-based R&D funding. A distinction in mission and sensible collaboration between ARPA and UKRI will be required.
- 1.6 Social sciences, arts and humanities research capabilities should be embedded within technological research and development as appropriate, to ensure that questions are determined in way that optimises the outcome of the solutions, and enabling translation to occur effectively to society and the economy. Technological change and benefits can be faster realised where policy, behavioural, ethics, law and business practices are an integral part of research.
- 1.7 ARPA should address the difficulty in staffing research projects when the same skills command better salaries and prospects outside academia (e.g. software projects) or where the UK is operating in an internationally competitive employment market for researchers.
- 1.8 Non-UK funding systems with similarities to the ARPA concept involve strong project management of the type that does not exist in the UK system. Project/Programme Directors have a high degree of independence and are most effective when they are outstanding researchers in their own right, fully seconded into the role (to avoid conflicts of interests), remunerated at an appropriate level and with a personal stake in project success.

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

- 2.1 With the introduction of ARPA, it is critical that UKRI and government department funding research avoids excessive overlap. Opportunities for rebalancing should be considered, for example if ARPA programmes tend to provide additional STEM-based funding into the research base, UKRI might be able to rebalance some funding towards non-STEM subjects.
- 2.2 A key danger for the UK R&D ecosystem is the loss of ERC funding, which offers a vital channel for innovative, blue-skies research and a wide-ranging remit beyond the more STEM-based funding from UKRI and the charity sector. ERC funding has been critical in supporting the UK's continuing excellence in non-STEM research, which in turn supports both STEM research and the UK economy. The advent of the new agency needs to be considered alongside the future of EU/ERC and Horizon funding into the UK. For example, in the case that the UK chooses not to have third party status in the Horizon programme, what role will the new agency or agencies (e.g. the Discovery Fund) have and how will the UKRI, ARPA, Discovery Fund, etc remits sit across the UK R&D landscape; which agency will pick up the ERC investigator programmes that are not currently represented in the current R&D funding portfolio?
- 2.3 Doctoral programme funding and funding for early career academics should remain predominantly at UKRI, as this funding needs to be stable over a defined period. ARPA's focus on high-risk programmes means that its funding in some areas may need to cease when it is clear that programme objectives cannot be delivered.
- 2.4 Innovate UK should continue to support a range of business sizes and commercialisation needs, not only those in currently favoured high growth sectors.

2.5 Impactful research is grounded on decades of curiosity driven work and investments into our research infrastructure. It should be the explicit responsibility of UKRI to protect and invest in a broad, strong research capacity of the UK, on which ARPA projects can draw effectively. Only with the highest quality basic research across all domains can ARPA be built on firm foundations.

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

3.1 The new agency should have a wide remit across all technologies and all disciplines, focusing on breakthrough challenges, with careful assessments of where UK capabilities and ability to translate and scale these solutions exists or could be created in a clear manner.

3.2 The new agency should value contentious and risky research goals, framed at the national level, but should not be overly specific. Over-specified research challenges run the risk of suppressing ambition and imagination, and may fail to secure the engagement of the most radical thinkers and most innovative researchers.

3.3 Although focused on challenges and building on existing research capacity to deliver, the agency should have no hesitancy in creating deep, fundamental programmes of basic research if these are not being addressed elsewhere or at sufficient pace or scale.

3.4 Care should be taken to avoid an over-emphasis on a *requirement* for IP generation in agency projects but instead the focus should be to create a research environment in which innovation is incentivized and rewarded, and where IP is spotted early and efficiently protected. IP and technology should be nurtured and developed, and spinning out too early avoided.

3.5 Agency programmes should be able to add strategic direction to high-risk research areas. For example, some promising developments in physics may inspire work in engineering, computer science and mathematics, and the agency should be hands-on in facilitating and funding these types of new interactions where they advance delivery of the agency research programmes.

3.6 Challenge and/or Programme Directors could be established to identify and champion challenge and to oversee agency programmes. Nonetheless, assembly of programme or project teams must involve transparent competition and independent assessment of ideas and ability to deliver. A competitive element is essential to drive up quality, prestige and trust in the new agency.

3.7 The agency should have an analytical unit working alongside projects and programmes to assess progress, commercial opportunities and to support researchers.

3.8 A new agency has the opportunity to nurture and inspire a new generation of researchers, and to establish from the outset an inclusive and equitable research culture for all researchers.

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

- 4.1 It is vital for the UK to invest significant additional resources in research to maintain its international competitiveness and position amongst the world's top research nations. ARPA funding should be additional to current commitments.
- 4.2 Funding at significant scale is required: £1Bn pa initially, ramping up based on success. The potential to involve significant industry co-investment should be explored, but should not dictate strategies or roadmaps; a pragmatic approach to co-funding should be taken.
- 4.3 Funding should be distributed through broadly defined and competed challenges, with flexibility and responsibility for the funding in the hands of a Programme/Project Director. The scale of individual programmes should be flexible, but some will need to be in the £10m-£100m+ bracket if significant breakthroughs and international competitiveness are required.
- 4.4 Care should be taken to avoid re-creating existing physical infrastructure, and physical investments should only be considered after a rigorous gap analysis. ARPA investments could be used to re-invigorate, re-structure and upgrade existing facilities where such facilities can then be efficiently re-aligned to ARPA programme/project goals.
- 4.5 The funding model for research participants should recognize and meet the real costs of research. Such funding arrangements will ensure the engagement of all research institutions and universities across the UK, and consequently could be a valuable mechanism for increasing research capacity across the UK.

5. What can be learned from ARPA equivalents in other countries?

- 5.1 Countries with high-risk/high-reward programmes reap the benefits for their economies when programme outcomes are achieved. Examples include GPS, the modern variant of the Transit satellites developed by DARPA, or gallium arsenide semiconductors. In the UK, the government's sustained investments in the national quantum technologies programme has many exemplary features of a UK ARPA-like programme. These investments over a longer than normal funding cycle are already creating value, for example via a string of spin-out companies and other commercialisation opportunities, even though the overall aim of the national programme remains some years away.
- 5.2 Learning and improving on the US implementation of ARPA/DARPA:
 - 5.2.1 Identifying the right challenges to pursue, framed in all their technological and societal complexity.
 - 5.2.2 ARPA markedly increased its effectiveness when it became DARPA and overly abstracted challenges became a clear mission: to provide the US military with the best defence technology in the world. ARPA/DARPA works best with (i) a broad challenge, (ii) mid-level abstraction of the underlying problems, (iii) an engaged user community, (iv) large scale funding deployed at pace, but reconfigurable in the light of progress.
 - 5.2.3 DARPA is clearly aligned with a primary customer (US military/Department of Defense) which provides both the technology 'pull' and the means, resources and scale to deploy and utilise innovations and technology emerging from DARPA programmes. Identifying primary customers for programmes (e.g. the NHS) will be critical for the success of a UK

ARPA. Government departments and public sector investment will have an essential role to play since relying on private sector pull is unlikely to be sufficient on its own.

- 5.2.4 Highly skilled and respected Programme/Challenge Director/Managers who have the experience, track-record, vision and ability to convene top researchers and who are able to encourage the best responses amongst multidisciplinary teams of academics and non-academic partners.
- 5.2.5 DARPA is widely viewed, including in our own direct experience, as requiring substantially more bureaucracy than other UK and international funders. UK ARPA should strive for low levels of bureaucracy and increased levels of devolved decision-making to research teams, while ensuring clear lines of responsibility.
- 5.2.6 The DARPA model had a tendency to underfund projects and essential capital investments are difficult. Meeting the real costs of research is the most effective way to ensure participation of all researchers, and the delivery of the best research outcomes.

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

- 6.1 ARPA should be a national funding body, and its geographical location should not affect the way or to whom funding is awarded, which should have research excellence and ambition at its core. Consequently, the location of the organisation should simply reflect the optimum and most cost-effective organisational and administrative arrangements.
- 6.2 Locating ARPA close to UKRI in Swindon would enable it to draw on the infrastructure and expertise of the staff in UKRI, notwithstanding earlier points about the need and opportunity the new agency may provide to challenge current funding norms, especially in reducing bureaucracy at the application and post-award stages.
- 6.3 A hub and spoke arrangement for ARPA would work well, with Programme Directors recruited and located around the country, and ensure ARPA has visibility in all parts of the UK.

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