

Written Evidence Submitted by the UCL Institute for Innovation and Public Purpose (RFA0085)

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1. Summary of recommendations

Regarding a new UK research funding agency based upon the USA Advanced Research Projects Agency (referred to herein as ARPA-UK), research at UCL IIPP would indicate that:

- ARPA-UK should not be focussed on new scientific discoveries but rather on transformational application, development, scaling and deployment of existing technologies.
- ARPA-UK should carefully consider its governance structures to act as a market shaper: steering innovation, getting fair prices, ensuring that patents and competition work as intended, setting conditions for reinvestment, and safeguarding supply of strategically important innovations.
- ARPA-UK should be oriented around societal challenges with broad buy-in that define the 21st century and can just as effectively stimulate cross-disciplinary innovation, for example climate change.
- ARPA-UK should aim to leverage procurement and demand-side policies to “pull” technologies and innovation. The UK does not have a vast defence sector to perform this role as in the US, so must look to where past policies such as Contracts for Difference in offshore wind, for example, have shaped demand.
- ARPA-UK should embed a new attitude to risk and uncertainty to enable the public sector to take “big bets” in the development, scaling and deployment of transformational technologies.
- ARPA-UK should learn from the organisational structure of its American counterpart having independence of decision-making and program management, whilst being a prestigious place to work attracting the highest calibre of employee.

2. Introduction

The UK is facing three simultaneous crises: the immediate health and economic crisis of the Covid-19 pandemic; a longer-term crisis of low growth and productivity originating in the 2008/9 financial crash; and the global climate crisis putting our environment at risk and driving significant economic transitions. The inter-linked characteristics of these crises will define the 21st century and the UK government urgently needs the capacity and tools to confront them head on.

In this difficult context, challenge oriented policy is key. At the [UCL Institute for Innovation and Public Purpose](http://www.ucl.ac.uk/bartlett/public-purpose) we have been advocating a challenge-led approach to innovation and industrial

policy. Innovation policy and industrial strategy offer opportunities for UK to structure strategic investments and interventions to support innovation-led economic growth in the recovery from the economic crisis triggered by the Covid-19 pandemic. As part of this recovery the UK needs to focus on both the rate *and* direction of innovation to ensure that our economic recovery is in a sustainable and equitable direction.

Innovation is a key driver of long-term economic growth and it is an outcome of collective value creation by businesses, governments, and non-profit institutions. Of course, investment in R&D is a key input to innovation and UK government commitments to a significant uplift in innovation funding are important, but the structure of that investment is just as important as the quantity.

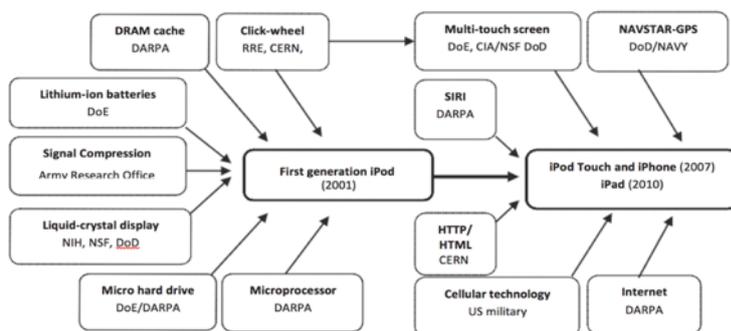
To support an economic recovery fuelled by innovation, it is crucial to ask what types of organisations and institutions are needed. Furthermore, while most countries invest in R&D in higher education institutions, it is also crucial to ask how the entire innovation system can be made more interconnected and be supported, including for example the existence of public laboratories.

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

3.1. Applied vs. Basic Research

In the March 2020 budget, the UK government announced significant uplifts in government funding for R&D. The UK's national system of innovation is particularly strong in universities but weak compared to international competitors in translational or applied research, typically conducted in applied research centres and national laboratories. New funding should be directed to remedying this imbalance by supporting the development of a balanced national system of innovation that includes multiple types of organisations.

This includes a range of intermediary organisations and public laboratories in between, exemplified by Catapult centres or Fraunhofer research centres. In the UK, the network of research capabilities, including those nurtured in public labs, has been thinned out over the decades.¹ This infrastructure needs to be sustained and grown, and government should be patient supporters of these institutes and recognise that the application of research is valuable alongside new scientific discoveries. For example, the collaboration between universities, the High-Value Manufacturing Catapult and Advanced Manufacturing Research Centre in Sheffield has led to the development of a high-tech supply chain cluster and attracted significant foreign direct investment from frontier firms such as Boeing. Attempts to replicate this success across other technologies or challenges should be pursued. Organisations and funding streams that provide connections and interactions between the more basic and applied ends of the research spectrum are a key part of sectoral and technological



systems.

Figure 1 - What could an iPhone do ‘smartly’ without the internet, GPS, touchscreen display, and a SIRI voice activated system? —all financed heavily in the early stages through public funds, from a host of different types of public organizations (Mazzucato 2013; p. 116)²

In the USA, the Advanced Research Projects Agency (ARPA) invested in key areas across the entire innovation chain, not simply in curiosity-driven or blue-skies scientific research, but in close-to-market innovation. In an innovation ecosystem spanning research, early-stage development, commercialisation, and production, ARPA invested at both early stages of scientific research but also at more applied stages of prototyping and demonstration. As shown in Figure 1, a lot of the applied technology development that went into the final product of an iPhone were researched at ARPA.

In the UK, fundamental scientific research is already well served by UKRI and the system of research councils. Therefore, plans to establish an ARPA-type body in the UK (ARPA-UK) are welcome, but it needs to learn from what made ARPA successful in the US whilst being tailored to the specific cases of the UK. There is a misguided belief in the UK that to emulate ARPA means only investing in the discovery of new technologies, when in fact ARPA-UK should invest across the whole innovation chain but be uniquely focused on close-to-market interventions and supporting radical technology development that could have transformational effects upon different sectors.

¹ Dobb, G. (2018) How can the UK’s public research laboratories support a mission-oriented industrial strategy?, IIPP Blog available here: <https://medium.com/iipp-blog/how-can-the-uks-public-research-laboratories-support-a-mission-oriented-industrial-strategy-60ede8261e6d>

² Mazzucato, M. (2013) ‘The Entrepreneurial State: Debunking the Public vs Private Myths in Risk and Innovation’. Anthem Press.

ARPA-UK should not be focussed on new scientific discoveries but rather on transformational application, development, scaling and deployment of existing technologies.

3.2. Demand-side “Pull” and Market Creation

To achieve transformational technological change usually requires both a research and innovation “push” but also a market “pull” from a ready customer for effective scale and deployment. One of the key reasons for ARPA’s success in research translation is that its innovation projects were inserted into its large customer base (both government and corporate) for operationalisation and commercialisation. ARPA leveraged the vast defence procurement of the American military to provide a ready customer and demand “pull” for technologies nearing application.

To emulate the successes of the ARPA-model, a UK ARPA will have to effectively leverage demand-side pull, however clearly there is no direct analogue of the US military that can so easily be utilised. ARPA exemplified the close relationship between defence R&D, the military, and large defence contractors that characterises the intimate public-private collaboration in this sector in the US. It is hard to identify anything that comes close to that in the UK R&D landscape.

Without such a ready customer, a UK ARPA should seek to utilise market-shaping and market-creation policies in conjunction with “supply-side” innovation support. Such policies seek to support the demand for technologies through measures including direct support (e.g. subsidies), the state as an active purchaser (e.g. feed-in tariffs to support installation of solar panels where the government purchased excess electricity at a guaranteed price), the state mitigating risk in a sector (e.g. the use of contracts for difference to guarantee a sale price for offshore wind, stimulating installation) or the use of progressive product standards to drive producer behaviour (e.g. the Japanese ‘Top Runner’ program).

Governments can leverage conditions and guarantees to further support market-creation. ARPA-UK could use policies such as a volume guarantee where the government guarantees that it will procure a certain number of a successful innovation, giving security to any company of the size of future markets and ensuring economies of scale. Alternative models also include price guarantees, where government guarantees not the number of products it will purchase but the sale price, which also serves to give certainty to a future market for an innovation. Contracts for difference in the offshore wind sector serve effectively as a minimum price guarantee and have contributed to making the UK a world leader in offshore wind, with more installed capacity than any other country.

Alternatively, public procurement of goods and services can be leveraged to support innovation and innovative companies. In the UK public procurement is the government’s largest expense making up approximately 14% of GDP. To divert even a small proportion of this finance towards supporting innovation therefore represents a significant policy tool. The Social Value Act in the UK offers a template for how procurement can be re-oriented away from a simple consideration of lowest cost to best value evaluated in broad societal terms. The NHS and other major public procurers offer strategic opportunities for supporting a demand-side pull for technologies if used in this way.

ARPA-UK should aim to leverage procurement and demand-side policies to “pull” technologies and innovation. The UK does not have a vast defence sector to perform this role as in the US, so must look to where past policies such as Contracts for Difference in offshore wind, for example, have shaped demand.

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

4.1. Solving Problems

IIPP advocate a challenge-led approach to innovation policy and industrial strategy – picking the problem, not specifying the technology or solution. For ARPA, military capability was the primary target: guns and bombs and military tech were purposefully developed for defence, but they also had secondary, spill-over benefits in commercial application exemplified by touchscreens and Siri. It is worth noting that “defence” is in itself a purpose-driven, multi-sectoral industrial area. Clearly, the military focus is ill-equipped for the UK context so one fundamental question to address is: What should be the driving force of ARPA-UK in place of defence?

Innovation policies and industrial strategies have historically involved both ‘horizontal’ policies that try to improve conditions across the national economy (for example skills and infrastructure) and ‘vertical’ policies that target interventions in specific areas, notably industrial sectors (such as aerospace, automotive, or manufacturing). However, there is a compelling case for building a modern strategy that addresses grand societal challenges by stimulating investment across, rather than through, sectors. The UK Industrial Strategy published in 2017 confronted this issue and was structured around 4 grand challenges; clean growth, an AI and data economy, the future of mobility, and an ageing society. In 2018, the Institute for Innovation and Public Purpose launched a Commission for Mission Oriented Innovation and Industrial Strategy (MOIIS) to help the government’s challenge led agenda be mission oriented, with concrete goals that require multiple sectors to collaborate, invest and innovate.³ Chaired by Prof Mariana Mazzucato and Lord David Willetts MOIIS explored how policymakers could implement and deliver such a bold strategy and reported in May with 8 top-level recommendations and 25 implementation steps.

ARPA-UK should be structured to solve problems, this is after all what made ARPA in the US so successful, but *which* problems? As set out above the government already identified 4 grand challenges in the 2017 Industrial Strategy which still seem relevant three years later. The BEIS R&D roadmap published in July 2020 has similar aspirations around technology “moonshots”. A new ARPA-UK body should consider how it aligns to these two separate existing policies.

What we can say is that to emulate the success of ARPA in the US, ARPA-UKs challenges should:

- Be societal in nature
- Have broad buy-in with policymakers, business, and public

³ MOIIS - UCL Commission on Mission-Oriented Innovation and Industrial Strategy (MOIIS) co-chaired by Mazzucato, M. and Willetts, D. (2019). A Mission-Oriented UK Industrial Strategy. UCL Institute for Innovation and Public Purpose, Policy Report, (IIPP WP 2019-04). <https://www.ucl.ac.uk/bartlett/public-purpose/wp2019-04>

- Not be vertical, technological (e.g. quantum computing) or sectoral (aerospace) in nature
- Effectively stimulate cross-disciplinary innovation

Furthermore, there are pressing questions about *how* an organisation should structure itself to maintain such a core focus on its main challenge. ARPA had just one challenge. If ARPA-UK is to have many, it is not clear how the organisation, and those who staff it, can maintain a similar clarity of purpose.

ARPA-UK should be oriented around societal challenges with broad buy-in that define the 21st century and can just as effectively stimulate cross-disciplinary innovation, for example climate change.

4.2. Organisational Structure

ARPA in the US was a purpose-driven funding body that could decide its direction and flexibility in pursuing capability, where decisions were made purely within the agency. This was achieved through a reduction of oversight and ensuing the linkage of responsibility and authority. ARPA program managers were recruited on fixed term contracts to ensure fresh flow of ideas and prevent personal interests from influencing the interests of the agency.

According to Azoulay et. al.⁴, the defining characteristics of the ARPA model were

1. Organisational flexibility
 - a. Independence from branches of government
 - b. Flat internal structure
 - c. Hiring outside standard government recruitment processes
 - d. Fixed term employment of directors and project managers
 - e. Flexible contracting mechanisms
2. Bottom-up program design
3. Discretion in project choice
4. Active project management

These characteristics should be replicated in any new ARPA-model organisation in the UK.

Here follows another challenge in governance: while ARPA sat within, and was overseen exclusively by the defence department, how should the proposed ARPA-UK sit within the British government? Should there be one unified ARPA-UK, or several sub-organisations running different thematic strands? Should it be situated within UKRI or outside? If anything, the Industrial Strategy Challenge Funds of the last government have provided cautionary tales: misalignment between organisational governance and its goals, and confusion about what constitutes a challenge, could see ARPA-UK become “just another pot of money”.

Another key aspect of the success of ARPA and similar organisations is how they have been able to attract talent and expertise by making it an honour for scientists to work towards solving grand

⁴ Azoulay, P., Fuchs, E., Goldstein, A.P., and M. Kearney (2019) ‘Funding Breakthrough Research: Promises and Challenges of the “ARPA Model”’, *Innovation Policy and the Economy* 19: 69–96.

challenges – this requires the role of civil servant to carry prestige. This must be a consideration for ARPA-UK.

ARPA-UK should learn from the organisational structure of its American counterpart having independence of decision-making and program management, whilst being a prestigious place to work attracting the highest calibre of employee.

4.3. Attitude to Risk

ARPA was successful because it was given the space within the American bureaucracy to take risks and to make big bets on technologies. Such a portfolio approach to innovation exemplified by the “ARPA model” requires the public sector to welcome the inherent uncertainty of innovation. ARPA largely functions within the existing innovation system – it did not blow things up or create something new from scratch. What is unique about it is that it creates a portfolio of public investments that has a very high-risk appetite, which is tolerated and justified through the defence/national security needs.

Building public organizations in ways that allow them to welcome rather than to fear the trial and error explorative process behind innovation is challenging and a key part of the success of organizations like ARPA.⁵

Unlike scientific or research grants that chiefly support curiosity-driven discovery for its own sake (e.g. EPSRC), the ARPA portfolio concerns high-risk projects pertinent to translation, which traditionally require a more conservative approach.

ARPA-UK must operate on the principle of “fail easy, fail fast” to experiment with a range of projects and exercise its autonomy to terminate projects at will should they fail to deliver. Knowing when to turn the funding taps off is as important as knowing when to turn them off.

ARPA-UK should embed a new attitude to risk and uncertainty to enable the public sector to take “big bets” in the development, scaling and deployment of transformational technologies.

4.4. Risk and Reward: Governance of Innovation

Whilst ARPA has a strong track-record of being a key player in the earliest stages of transformational technology development, they have been weak on ensuring that the public receives a return on the public investment in these technologies. ARPA had no active forms of recouping public investment other than the tax return from successful companies. Similarly, ARPA-UK cannot rely on the profitability of future firms as the only way of recouping investments, especially not in areas where the technologies are not “sticky” – i.e. they are likely to merge with or be acquired by multi-nationals with no guarantee of UK tax revenues. IIPP research on state investment in pharmaceutical innovation⁶ is relevant here; if governments have no legal ownership of future intellectual property

⁵ Mazzucato, M. and Penna, C., 2015. Mission-oriented finance for innovation: New ideas for investment-led growth. Policy Network and Rowman & Littlefield International.

(IP) then they have no right of recourse should any future medical treatments or drugs be unfairly priced. Ongoing conversations about the state's role in supporting Covid-19 vaccine development and how it should be priced internationally are extremely relevant here.

An ARPA-UK body should therefore carefully consider its governance structures for the technologies and innovations it will play a part in developing. The government should govern the innovation process more like a market shaper: steering innovation, getting fair prices, ensuring that patents and competition work as intended, setting conditions for reinvestment, and safeguarding supply of strategically important innovations like drugs. Focusing on what the public sector can proactively do and achieve is key to the governance of an innovation system that is not working for members of the public, who have invested in some of the riskiest stages of innovation. In this context, the publicly funded ARPA-UK instrument must explicitly consider its implications for public return throughout the innovation chain, from R&D through to manufacturing.

ARPA-UK should carefully consider its governance structures to act as a market shaper: steering innovation, getting fair prices, ensuring that patents and competition work as intended, setting conditions for reinvestment, and safeguarding supply of strategically important innovations.

5. About us

The UCL Institute for Innovation and Public Purpose (IIPP) is a department within University College London (UCL) — founded in 1826 to solve grand challenges — and part of The Bartlett faculty, known internationally for its radical thinking about space, design and sustainability. We apply our critical thinking to research and thought leadership; teaching and training; influencing public policy; and engaging the broader public.

(July 2020)

⁶ UCL Institute for Innovation and Public Purpose (2018). The People's Prescription: Reimagining health innovation to deliver public value. IIPP Policy Report, 2018-10. London: IIPP, StopAids, Just Treatment, Global Justice Now. Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/wp2018-10>