UNIVERSITY OF CAMBRIDGE

Cambridge Industrial Innovation Policy

BRIEFING NOTE

The challenges of challenge-led research and innovation agencies

International implementation lessons for the UK's new Advanced Research and Invention Agency

A briefing note prepared by the Centre for Science, Technology & Innovation Policy (CSTI) at the Institute for Manufacturing (IfM) | **MAY 2021**

ABOUT THIS BRIEFING NOTE

This briefing note captures the key points of a roundtable discussion on 24 February 2021, comprising 21 researchers and policymakers representing eight institutions from Japan, the UK, and the US. The aim of the roundtable was to identify challenges and international best practices in designing and implementing challenge-led research and innovation (R&I) agencies, in order to inform the devleopment of the Advanced Research and Invention Agency (ARIA) in the UK and other emerging ARPA-like challenge-led R&I agencies globally.

KEY CONSIDERATIONS FOR ARIA

Framing: Missions should be framed generically and without predefined solutions, while challenge goals should be specific.

People: Aim to hire 'And' people, who combine technical and business knowledge, and who bring ideas to the mission from the private sector or academia.

Coordination: Use the 'island–bridge model', where ARIA operates as a bureaucracy-free island but uses bridges to influential external stakeholders and institutions to coordinate and effect change.

Evaluation: In designing a programme evaluation system, measurement requires patience. Mission outcomes should favour generating subsequent, follow-on investment from industry over initial co-investment.

"Just creating a merry band of genius tech innovators doesn't do it."[1]

Introduction

The UK government announced on 19 February 2021 that it was to launch the Advanced Research and Invention Agency (ARIA), a new independent research body to fund high-risk, high-reward scientific research. This coincides with renewed interest in investing in innovations that solve societal challenges[2].

In response to the increasing need for evidence to support ARIA's operationalisation, CSTI, as part of Cambridge Industrial Innovation Policy (CIIP), held a virtual roundtable on 24 February 2021 that brought together the views of academics and policymakers that are actively shaping challenge-led R&I agencies across the globe.

This roundtable was organised and chaired by Dr Eoin O'Sullivan (CSTI). CSTI's analysis of challenge-led R&I agencies is unique in its focus on operationalisation, made possible by the IfM's strong foundation in technology, innovation, and management. Future events will further explore challenge-led R&I agencies.

In this briefing note, we consider a 'challenge-led' R&I agency as one that identifies valuable, achievable, and specific technical capabilities as targets. The definitions of 'mission' and 'challenge' are not harmonised across the countries represented at the roundtable.

For the purposes of this report, we utilise the US definitions (see Key Terms section) to allow for comparison with existing literature, and to prevent confusion with similar terminology within UK policy spheres. We define a 'mission' as an overarching societal problem to be solved, while 'challenges' compartmentalise a mission into different programmes — R&D funding activities in specific technology areas. Programme managers (PMs) are individuals temporarily employed at challenge-led R&I agencies who propose programmes, recruit, and supervise programme staff. The agency's director oversees a challenge-led R&I agency and reports directly to senior government officials[3].

Four challenges of challenge-led R&I agencies

CHALLENGE #1. Framing the mission – 'Define the problems, not the solutions'

Define the problems, not the solution. The wordings of a mission should focus on identifying new problems that are not addressed by current funding schemes, and open up these problems to all stakeholders that can offer new solutions. Having a problem-focused framing avoids prematurely rejecting plausible solutions.

Define a generic mission (while having focused challenge goals). As programmes might last 10-15 years, generic mission framings will better stand the test of time. Similarly, as individuals are typically employed on contracts lasting three to four years, mission framings have to be generic enough to weather different programme managers. The expert panel pointed out the mission statement's need to demonstrate the UK's unique value proposition in solving local and international challenges.

Don't try to do everything. Ensure that the agency's aim is commensurate with its budget. Focus on doing fewer things very well. For ARIA, it was suggested that two to three challenges would be appropriate to the current proposed budget.

CHALLENGE #2. Getting the right people

Hire "And" people. Individuals that possess both industrial management capacity and understanding of technological principles and implications are critical to success. These 'And' people are able to bring technology to market and are commonly found at startups. While not always available in one person, hiring for business and technology knowledge, with minimum bureaucracy is key. Programme managers should also already have initial programme ideas when joining the agency, to reduce time spent in developing completely new ideas during programme manager's short tenure.

The culture locks in early. Early hires will determine ARIA's long-term organisational culture. Well-known cultural attributes of challenge-led R&I agencies include being non-bureaucratic, non-hierarchical, and respectful, while employees are empowered to ask questions and take ownership in solving problems. In addition, our panellists also identified that programme managers cultivate a sense of urgency, competition, and problem-solving at challenge-led agencies.

Attract candidates from the private sector and academia. Early programme managers at challenge-led R&I agencies are often identified through personal networks, or recommended from industry networks. The exact source of talent depends on the mission. Applications to ARPA-like agencies are to be incentivised through competitive remuneration and by instilling prestige in challenge-led programme positions.

"Have programme managers with a sense of 'religion,' who know their technologies are going to save the world."

CHALLENGE #3. Coordinating across R&I agencies and bureaucracy

In this roundtable, questions were raised about ARIA's working relation with the existing R&I ecosystem, and how ARIA can innovate differently with its budget of £800 million. In particular, the House of Commons expressed concerns about whether ARIA risks duplicating efforts with incumbent R&I agencies such as Innovate UK.

Operate ARIA as an island with bridges. To be protected from bureaucratic pressures, challenge-led R&I agencies operate as independent 'islands' free of direct political influence. This does not mean, however, that R&D is conducted in isolation at challenge-led R&I agencies. Instead, 'bridges' are constructed to connect these independent challenge-led agencies to senior stakeholders within departments, regulators, and other technology development organisations to prototype technological products.

Our panellists highlighted that effective bridges are reflected in new commercial behaviours (to be detailed below) and working relationships that allow mobilisation of non-R&D policy instruments such as technology regulations and standards.

Gather systemic high-level support for ARIA. A common feature of represented challenge-led R&I agencies is their accessibility to political decision-makers. For instance, Japan's challenge-led R&I agency, SIP, is coordinated with four sectoral ministries and agencies and directly managed by the Cabinet Office. Similarly, in the US, the director of ARPA-E has direct bridges to the Secretary of Energy who, in turn, reports to the US President.

Navigate programme managers across bureaucracies via office directors. As programme staff have built-in high turnover, an office director is essential for providing internal support systems that signpost them to the right people and resources. In addition, the office director facilitates knowledge exchange among different programme teams and programme managers.

CHALLENGE #4. Designing a programme selection and evaluation system which is fit for purpose

Our panel identified that traditional innovation and investment evaluation metrics are not compatible with challenge-led R&I agencies that are long term, high risk, and high reward by design. The House of Commons similarly requested 'bespoke Government scrutiny arrangements' to ensure ARIA has sufficient operational independence while ensuring the £800 million allocated budget is well-justified when spent.

Monitor how the private sector is affected by missions after completion. An important indicator for challenge-led R&I agencies is the change in private sector investment behaviours as a result of public sector investments made by the challenge-led agencies. This is preferred to private sector co-investment, which may skew R&D from the revolutionary to the evolutionary. Instead, mission agencies should monitor subsequent private sector investment behaviours. Examples of investment behaviours include private sector spending and business case framings.

Benchmark ARIA using best practices of ARPA clones, not DARPA. Similar to most ARPA clones (challenge-led R&I agencies modelled from the US's DARPA), ARIA is not attached to large procurement agencies in the way DARPA is attached to US defence spending. For example, ARPA-E found that relying solely on venture capital funding to take forward its products was not sustainable. ARPA-E overcame its constraints by requiring well-articulated commercialisation pathways before programme proposals were approved, and by investing heavily in technology-to-market teams. Similarly, the UK's Industrial Strategy Challenge Fund (ISCF) optimises budget allocation by focusing on the technologies where comparative advantages exist for the UK.

Evaluate missions with technology visioning instead of corporate-style phase-gates. Corporate phase-gates, often idiomatically referred to by the trade name "Stage Gate(TM)", are designed for the private sector, which faces cash-flow and shareholder constraints, and may reject challenge-led technology visions prematurely. In comparison, challenge-led R&I agencies' objective is radical innovation. Hence, ARIA's evaluation processses will need to be more flexible and adaptive to technology discovery, and should avoid being stifled or constrained by overly prescriptive or standardised decision-making processes and criteria designed for incremental innovation.

However, members of challenge-led agencies still need to understand the working principles of corporate phase-gates to 'translate' technologies which are eventually commercialised through the private sector.

Lengthen the time horizon of evaluations. Technology implementation is a lengthy process. Patience and policy space are required to let technology vision actualise. For example, the Internet took 30 years to be scaled up from the ARPANET.

Allow programme directors full autonomy in programme spend. In challenge-led R&I agencies, it is the responsibly of the agency director to control spending. To identify which projects go ahead, typically use 2-3 hour programme pitches made by programme managers within their team. When evaluating projects, the agency director should systematically revisit their challenge, the mission statement of the agency and the Heilmeier Catechism (see inset). Once funding is allocated to programme directors, they should have full autonomy in how this is spent.

Terminate unsuccessful missions or programmes by changing the people, not the mission itself. Roundtable panellists underlined a common misconception of pivoting from an unsuccessful mission or programme by reframing. Reinvigorate programmes by bringing in new talent and ideas instead.

Heilmeier Catechism[4] — a recurring framework at the roundtable:

- What are you trying to do? Articulate your objectives using absolutely no jargon.
- How is it done today, and what are the limits of current practice?
- What's new in your approach and why do you think it will be successful?
- Who cares? If you're successful, what difference will it make?
- What are the risks and the payoffs?
- How much will it cost?
- How long will it take?
- What are the midterm and final 'exams' to check for success?

"Your job here is to shape how the private sector subsequently invests its money, not co-invests its money."

Future directions

The following questions posed by the roundtable were identified as objects for further discussion and study:

- What technology innovation challenges are especially 'ARPA-able'? What are defining characteristics of these challenges?
- What can challenge-led programmes achieve that can't be done by other models (e.g. National Labs, Bell Labs 'clones', university-based R&D centres, etc)?
- What programme manager qualities, expertise and experiences are essential? What's the right balance when hiring a programme managers between experience and potential?
- How are technology-to-market transitions managed? How are particular challenge projects (and specific stretch goals) identified and prioritised?
- How should challenge-led R&D agencies engage with industry and the research base while avoiding capture by incumbents?
- How can they drive greater participation in challenges from across the R&D system, including small disruptive players and SMEs?

"You may put this thing on an island but you need to make sure there is a bridge back to the mainland."

To hear more about the CIIP's upcoming events and ongoing work around these themes, contact Dr Eoin O'Sullivan at eo252@cam.ac.uk

Rountable participants

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KEY TERMS

US policy working definitions# (#terminology more conventionally used in many US agencies)	Alternative definitions* (*sometimes used in certain UK and EU policy-related contexts)
Mission: overarching goal of a challenge-led R&I agency[5]	**Grand challenge:** a difficult but important, systemic and society-wide problem with no 'silver bullet' solution[6]
Challenge: specific technical capabilities that are valuable and achievable in relation to the mission; a challenge breaks down a mission into different programmes[3,7]	**Mission:** a concrete target; an achievable step towards a grand challenge that contextualizes projects[6]
Programme: R&D funding activities constructed by identifying specific technology needs or new capabilities; usually made up of a set of projects[8]	**Project:** a single, isolated, clearly defined innovation activity with risky or uncertain outcomes[6]
Project: one of a portfolio of projects within a programme with defined technical goals that are aggressive but can be potentially met within a defined timeframe and budget[5]	

KEY READINGS

Azoulay, P., Fuchs, E., Goldstein, A. P., & Kearney, M. (2019). Funding breakthrough research: promises and challenges of the "ARPA Model". Innovation policy and the economy, 19(1), 69-96.

Bonvillian, W. B. (2020). Lessons from DARPA for Innovating in Defense Legacy Sectors.

House of Commons Science and Technology Committee (2021). A new UK research funding agency: Third Report of Session 2019–21.

ENDNOTES

[1] All quotes within this document are from workshop participants. As the discussion was conducted under Chatham House rule, these will not be attributed.

[2] BEIS (19 February 2021). Press release: UK to launch new research agency to support high risk, high reward science. *GOV.UK*. Available from: https://www.gov.uk/government/news/uk-to-launch-new-research-agency-to-support-high-risk-high-reward-science

[3] Bonvillian, W. B. (2020). *Lessons from DARPA for Innovating in Defense Legacy Sectors*. P. 35-36

[4] George H. Heilmeier was a DARPA director (1975-1977), who crafted this set of questions to help Agency officials think through and evaluate proposed research programs.

[5] This roundtable

[6] Mazzucato, M., & Dibb, G. (2019). Missions: a beginner's guide. *UCL Institute for Innovation and Public Purpose*.

[7] Bonvillian, W. B. (2020). *Lessons from DARPA for Innovating in Defense Legacy Sectors*. p. 13

[8] Bonvillian, W. B. (2020). *Lessons from DARPA for Innovating in Defense Legacy Sectors*. p. 233

About Cambridge Industrial Innovation Policy

Cambridge Industrial Innovation Policy (CIIP) brings together the Centre for Science, Technology & Innovation Policy at the Institute for Manufacturing (IfM), the Policy Links Unit from IfM Engage, and the Babbage Policy Forum. CIIP is based at the IfM, a division of the University of Cambridge's Department of Engineering.

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