Written Evidence Submitted by The Alan Turing Institute

(RFA0087)

Introduction

The Alan Turing Institute ("the Turing") is the UK's national centre for data science and artificial intelligence (AI). The Turing works alongside major regional, national and international organisations in order to deliver societal benefit from data related technologies, in line with its charitable objectives. The Turing comprises of over 350 academics from the UK's leading universities: Birmingham, Bristol, Cambridge, Edinburgh, Exeter, Leeds, Manchester, Newcastle, Oxford, Queen Mary, Southampton, University College London, and Warwick; with major international research, development and innovation (RD&I) collaborations, and a convening power that is internationally unique.

The Turing's position provides insights into the research landscape of data science and AI across academia and industry in the UK. This document provides the Turing's response to the House of Commons Science and Technology Committee call-for-evidence on "A new UK research funding agency" ("the call-for-evidence"). The Turing's response combines the perspectives of various researchers affiliated with the Turing, and a list of individuals who contributed to this response can be found in the appendix.

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

The UK's basic and applied researcher community is considered by many to be world-leading and an asset to the UK's status as a 'science superpower'. However, our digital infrastructure has suffered from a lack of long-term planning and investment, and its competitiveness has been too dependent on one-off "fiscal events". In addition, various constraints have limited the ability of the UK to provide long-term funding to support high-risk, high-payoff scientific, technological, engineering, and medical ideas.

ARPA and DARPA were successful due to a combination of unique design elements specifically in the US that includes: long-term political support; considerable and sustained funding; high-risk tolerance; a strong network of mission-driven national laboratories; funding broad, ambitious visions over discrete goals, and talented teams over projects; flat organisational structure; and having a mix of connected partners.

We think that an ARPA-like agency in the UK could potentially address two gaps, namely: the limited incentives and mechanisms for performing high-risk research; and the lack of sustained and combined "science push" and "industry pull" that helps great scientific ideas escape from the universities into applications across society. To be fully effective, the agency needs to be supported by a healthy network of national mission-driven institutes and laboratories that are structured and funded, i.e. which providing full-time multidisciplinary teams of researchers, technical support staff and large-scale facilities as appropriate, to provide scale-up and industry readiness.

Funding

In the UK, few, if any, funding mechanisms are currently in place that are able to tolerate risks in service of supporting researchers at the scale and ambition needed. The European Research Council (ERC) has played a significant role in funding outstanding individuals and encouraging 'frontier research', which is, to a degree, in line with the aspirations of this agency.

The most significant, immediate gap in funding for research across the UK the Turing currently sees is in the potential loss of access to ERC-like funding schemes, if the UK Government chooses not to associate with the EU's Horizon Europe Framework after the end of the Transition Period, following the UK's exit from the EU. An ARPA-like agency in the UK could help to fill this gap, however, this would not be a like-for-like replace for loss of this type of funding and the Government should also consider an ERC-inspired funding paradigm.

Science Push

Moreover, an ARPA-like agency in the UK needs to be examined as part of the UK's wider RD&I ecosystem. Currently, there is a gap in "science push", i.e. ensuring that great research outputs can find the real-world applications.

If an ARPA-like agency in the UK is to be successful, the Government will need to take responsibility not only for research, but also for nurturing and scaling up technological breakthroughs toward final products, just as ARPA and DARPA did. This requires

technology diffusion mechanisms; strengthening multidisciplinary national institutes and laboratories as conveners between academia and the market; the Government stepping in as a first buyer where there is no market; and a reform of public sector procurement.

The so-called "valley of death" is a significant challenge to overcome, for example in the field of AI, which we also identified in the Turing's industry-wide study on the barriers to AI adoption. Even sophisticated AI adopters find it challenging to move from cutting-edge research on AI that is developed in academic research labs to applications of these innovations, due to regulatory uncertainty, skills shortage and data limitations. It is significantly more challenging for SMEs who cannot access large-scale real data, or the computing power to develop and test their products.

An ARPA-like agency in the UK would need to engage with the commercial sector more actively, including small and medium-sized companies, as well as larger, RD&I heavy organisations to inform the design of enabling environments for disruptive technologies. It would need to work with national institutes and laboratories to ensure these environments are deployed and adequately supported.

Finally, the many academic institutions and old behemoths in industries like telecommunications, stifle innovation as they are considered to have aggressive, overly protective Intellectual Property policies. A carefully designed ARPA-like agency in the UK has the potential to close the "science push gap" if it systemically addresses the idiosyncrasies of the UK RD&I landscape.

Other gaps

Programme Managers

Programme Managers were critical to the success of ARPA and DARPA. These are technical experts who are recruited on three- to five-year contracts and have the freedom to fund projects that rely on contractors in universities and in industry to carry out activity as needed.

Programme Managers bring a vision, domain and technical expertise, knowledge of the community and continuity. They are empowered to allocate funding in an agile manner that, while accountable, is not tied to a lengthy review process that does not take into account the overall vision, nor the need to take risks.

A Programme Manager in a APRA-like agency in the UK would not have the aim of advancing their own research agenda; instead, they would be chosen on their ability to build, inspire and empower a community of researchers to do excellent work that delivers a clear and consistent vision. The risk in this approach would need to be managed by clear accountability and performance management to deliver real outcomes and constant scrutiny of the opportunity cost of backing a powerful individual against a spread bet of research grants. Despite this risk, the Turing thinks it is worth taking given the potential benefits, and the fact that the new agency would complement more traditional models.

Currently, those who have the ability and experience to think imaginatively about transformative RD&I in esoteric, but emerging strategic application areas are usually not rewarded for acting like innovators for prolonged periods outside of ARPA-like structures.

Programmes

The agency should be prepared to support risky programmes, but should also be willing to close programmes that are not working. It is important that this is done in such a way as to not penalise researchers who undertook ambitious work that simply proved to be too difficult.

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

An ARPA-like agency in the UK should not be a substitute for other sources of RD&I funding and associated infrastructure, but instead, serve as a complementary piece of a diverse RD&I system. If an ARPA-like agency in the UK is to be effective, it must operate catalytically and stimulate investment to 'pull through' advances in the areas in which it invests and fund projects that are significantly different.

There is room for high-risk funding for proposals that are: either complementary to the UK's Industrial Strategy four Grand Challenges (e.g. clean growth, AI, healthy ageing and the future of mobility), or for those areas that do not fit neatly into these Grand Challenges.

An ARPA-like agency should both articulate with and leverage UKRI's programmes to diversify the funding landscape and support longer-term initiatives through a focused and efficient funding mechanisms. Turing affiliated researchers noted that even well-thought-out research drivers, such as REF, can introduce perverse incentives. Thus, a new agency that is different just for the sake of it could be damaging if it is not driven by a very clear and accepted purpose.

The key lesson learned from ARPA is that the agency needs to be properly funded to make it a success and deliver its ambition here in the UK.

The Government should also aspire to strengthen the capabilities of existing institutions that have ARPA-like potential and culture to deliver high-risk technological outputs. The Turing, for example, is already using the model of the Programme Director to fund and deliver research outputs; has the extended networks and the skills internally to translate science to technology with its Research Engineering Group; and could deliver riskier AI breakthroughs if it was funded appropriately in the long run.

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

The agency should have an enduring clarity of purpose and take a long-term view of the strategic threats and opportunities facing the world. An ARPA-like agency in the UK should develop advanced technologies on a 10 to 15-year time horizon, rather than undertake basic research or incremental near-to-market innovation, for which successful structures already exist. However, given the socio-economic uncertainties and challenges facing the UK, as exposed by the COVID-19 pandemic, there is a strong need for an ARPA-like agency in the UK to be sufficiently agile enough in order to respond to emerging and unpredicted scientific challenges.

There is a clear opportunity for an ARPA-like agency in the UK to facilitate large-scale projects that address a single "grand-challenge" problem. These have been used with some success by the charitable funders, notably Cancer Research UK's Grand Challenge programmes and the British Heart Foundation Big Beat Challenge. Such large-scale (>£10m) projects are rare in the UKRI framework. Long-term visions of resilience and sustainability came up consistently in the views of Turing affiliated researchers, for example clean and sustainable energy and food technologies.

Furthermore, an agency that sits across the disciplines would open opportunities that would be very difficult to support via current mechanisms. Funding opportunities that span the medical and physical sciences are reasonably well established (if not at the scale that is necessary to drive true innovation), but the humanities and social sciences are much less well served, and a mechanism by which those communities could engage with "grand challenge" projects in the data science and AI would be transformative and also ensure the responsible use and widespread adoption of these technologies.

The key take-away from the success of APRA in terms of scope is that it needs to have clarity of purpose. The Turing was encouraged to read in the UK Government's recently published R&D Roadmap that it would "work with [the Prime Minister's Council for Science and Technology] to convene a group of experts and stakeholders to review what moonshots we could pursue, looking at where government-backed missions and challenges are already working well and can be built upon, what we might stop doing, and where else we should prioritise our efforts." Beyond this outlined process, the Turing would encourage the Government to continue to consult on the key priorities it aspires to have for an ARPA-like agency in the UK. There are a number of potential missions in public health, climate change mitigation, etc. where a government department could take on an equivalent role of the US Department of Defense with regards to DARPA. The Turing would be delighted to utilise its central position in the data science and AI community to mobilise our network of interdisciplinary researchers and help characterise research challenges together with an ARPA-like agency in the UK.

Finally, an ARPA-like agency in the UK should be managed by a clearly identified and empowered governance body. Splitting of responsibility potentially allows for divergent approaches to RD&I support to emerge, but this comes at the cost of duplication of bureaucracy and less effective communication.

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

Based on the budget proposed for an ARPA-like agency in the UK in the Conservative and Unionist Party's manifesto, the agency will be allocated approximately £800m. The timescale for spending this funding should be more precise.

Researchers affiliated with the Turing are concerned that taking funding out of the existing funding bodies would be damaging to a lot of the high-quality UK science, technology, engineering and medicine RD&I ecosystem; therefore, the Turing would like to reinforce the Government's message not to break what currently works, but to supplement existing structures.

An ARPA-like agency in the UK could enable a dynamic, streamlined, and responsive approach to funding research similar to some third sector funders such as the Bill and Melinda Gates and Chan-Zuckerberg foundations, and the Wellcome Trust. It must be able to respond to the best ideas regardless of which field, or where they come from. To ensure an ARPA-like agency in the UK retains a proactive and strategic direction, its principle remit should permit it to commission research. However, to complement this approach and to encourage agility and risk taking, parts of the funding could also be allocated through 'fast cut' mechanisms where researchers submit only two pages and are quickly given a response.

It is preferable to distribute funding in large chunks to reduce administrative overhead. Where a critical mass of capability already exists, a possible alternative model is to distribute funds to national institutions and laboratories / consortia of institutions for large programmes of work. Funding can then be distributed locally to specific projects within the programme under the oversight of an independent scientific advisory board for each programme.

We also recommend that funding is allocated towards the creation of a series of robust, open demonstrators. Demonstrators can maximise the impact of an ambitious research programme, while inspiring and encouraging those not directly funded to engage through evaluating, exploiting and enhancing the demonstrators. These would also act to bridge the engineering gap between typical blue skies research outputs (papers, theoretical results and fragile prototypes) and the more robust systems needed if they are to be exploited in the wider research community, and ultimately by industry in the form of new products and services. In the area of computer software, specialist Research Software Engineering teams, including those of the Turing, have demonstrated their worth in fulfilling this role through engineering robust solutions, thus encouraging reuse and reproducibility.

5. <u>What benefits might be gained from basing UK ARPA outside of the 'Golden Triangle' (London, Oxford and Cambridge)</u>

The idea of locating ARPA outside the Golden Triangle is a welcome one. However, it is important that it is not just the administration that is based outside of the Golden Triangle, but that its Programme Managers are drawn from and operate in all regions of the UK. Also, for the new agency to assist in the "levelling up" agenda, the consultation processes need to be transparent and open-minded to ensure that the best ideas are captured from everywhere.

Whilst a focus on bringing together the best, relevant researchers around a vision is vital for the success of any ARPA-like programme in the UK, we would argue that harnessing talent around the regions – across the portfolio of programmes, though not necessarily within each individual one - is important for several reasons:

- it builds regional capacity in key emerging technology areas by funding existing researchers, attracting those from overseas, and creating a talent pipeline of PhD and master's students
- it fits with the Government's "levelling-up" agenda
- it encourages the involvement of regional industry, particularly SMEs, government and third sector organisations, who:
    - may have expertise that can help drive the research,
    - may offer testbeds and case-studies to evaluate it
    - will then be in a better position to exploit the results,

  As cited in the Government's recent Research and Development Roadmap, existing examples of leveraging regional strengths include precision medicine in Glasgow and marine innovation in the Western Gateway.

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

INRIA and similar institutes in France, Max Planck in Germany and CIFAR in Canada are all examples of effective ARPA-like agencies which have demonstrated significant impact already. In France, President Macron recently invested €1.5bn in four full-time real, i.e. not virtual, institutes. Also, INRIA is not only in Paris, and Max Planck is not Berlin, and yet they are still able to flourish outside of their respective countries' political centres.

General comments

An ARPA-like agency in the UK needs to implement dramatically different ways of working and adopt a different attitude to risk with public money. This is a key difference between ARPA and DARPA in comparison to most agencies; they aren't afraid to fail, and sometimes they are just too far ahead of the curve, for example, with autonomous driving.

DARPA, as a mission-led agency, pursed technologies, though delivery of large-scale RD&I programmes, to solve real-world problems directly relevant to national defence. A key success factor for DARPA was the ability of the technologies it developed to be tested and deployed by the US Department of Defense, in effect a vehicle for large-scale government procurement of prototypes. Being world-leading in research does not necessarily result in being world-leading in deployment. For an ARPA-like agency in the UK to replicate the success exemplified by DARPA, UK Government procurement should also be considered as a key contributor to its future success, as it enables pull-through of innovation from research, often via SMEs, to wide-scale deployment.

To complement the role an ARPA-like agency in the UK would have with government departments, is how it would be interface with UK companies. ARPA and DARPA are considered to have subsidised companies' RD&I, which has, for example, kept viable computer companies in the US. This model may not be appropriate for the UK, however, for an ARPA-like agency in the UK to be a success, it needs to be part of the RD&I pipeline for some UK companies, particular in sectors where levels of RD&I investment is relatively lower than other sectors, with the aspiration to create new markets, and not necessarily subsidise existing ones.

Finally, it is this risk-tolerant culture that the UK needs to clone in other domains rather than cloning the institution itself. This means that researchers would need to move away from the current model of regular, incremental paper publication that has been encouraged by the REF and citations-driven promotions criteria. Instead they should be freed to focus on more risky challenges that have the potential to make greater leaps forward. This includes requiring a more flexible and redefined understanding of research impact for research undertaken through the ARPA-like agency in the UK. This is likely to include periods in which researchers are enabled to move out of their comfort zone by exploring alternative solutions and building new collaborative research relationships with those within and outside of their field – we expect that a holistic approach that brings together a range of perspectives (including the humanities) is going to be needed to achieve ambitious, risky research goals.

Appendix

We are grateful to the following individuals associated with the Institute for contributing to this response:

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