

Written Evidence Submitted by the Norwich Research Park (NRP) (RFA0099)

This submission is from the following four research institutes, all based on the Norwich Research Park (NRP) in the east of England:

The [Earlham Institute](#) (EI) brings together multidisciplinary expertise in biosciences, bioinformatics high performance computing and statistics to understand complex biological systems in relation to pathogens, plants and animals and their interaction with the environment. EI's research is enabled uniquely by core national capabilities in advanced genomics, single cell analysis and computational platforms.

The [Quadram Institute](#) (QI) is an interdisciplinary organisation creating new interfaces between food science, gut biology, human health and disease. Scientists and clinicians work to ensure the translation of QIB's fundamental science to benefit patients, consumers and the wider society. From plants to food to digestion to health, QIB investigates how food and microbes interact to promote health and prevent disease.

The [Sainsbury Laboratory](#) (TSL) is a world-leading research institute working on the science of plant-microbe interactions. TSL has developed an enviable reputation for the quality of its fundamental scientific research but is also committed to delivering science solutions that reduce crop losses to important diseases.

The [John Innes Centre](#) (JIC) is an independent, international centre of excellence in plant science and microbiology. JIC's research generates knowledge of plants and microbes, pioneering fundamental research with a focus on genetics. The knowledge, resources and the researchers trained at JIC help global societies address important challenges including providing sufficient and affordable food, making new products for human health and industrial applications, and developing sustainable bio-based manufacturing.

Executive Summary

The government has committed in its manifesto to establish a new agency for high-risk, high-payoff research, at arm's length from government, modelled on the US Advanced Research Projects Agency (ARPA), with a budget over the years of the Parliament of £800m. Such an agency has the potential to make a significant contribution to the UK's leadership in scientific and technological innovation.

Our report summarises the history of the UK's science and innovation system and analyses the key features of the US system to consider how the lessons of ARPA/DARPA might be transferred to the UK. Seven experts in science and innovation, including former science ministers, vice chancellors and leading academics then discuss aspects of how an ARPA could be established in the UK.

- William B. Bonvillian summarises the key features of the ‘DARPA model’, analysing the factors that contributed to its phenomenal success.
- Julia King discusses how a dramatically different way of working could enable ARPA to help great scientific ideas escape from the laboratory by acting as an interpreter and matchmaker.
- Richard Jones sets out the centrality of empowered programme managers in driving research in support of the long term goals of the nation.
- Jo Johnson discusses the appropriate relationship between ARPA and UK Research and Innovation (UKRI).
- Nancy Rothwell and Luke Georghiou explore the concept of ‘high innovation risk’ and how ARPA must successfully navigate this to reap the rewards of its investment.
- David Willetts champions the role of ARPA in promoting the development and application of key technologies.
- Tim Bradshaw analyses the challenges of commercial pull through and the need for reform of public procurement if ARPA’s innovations are to progress from the laboratory to the market.

Drawing upon these essays, we conclude that ARPA needs to focus on developing advanced technologies on a 10-15 year time horizon, rather than on theoretical basic research or near-to-market incremental product innovation. It must embrace risk – while we are hesitant to define the exact success ratio, we can say that if more than half of ARPA’s projects succeed fully it will be being too cautious. The agency should be prepared to fail fast and fail often, with its success judged by the impact of its successes, which should be transformative.

A number of our essays discuss whether ARPA should be created within UKRI or as a separate body, a subject upon which our contributors have different positions. Our own view is that if two distinguished former science ministers, amongst others, have reached different conclusions on this matter, there are clearly strong and credible arguments on both sides. Wherever it is situated the government must tear up the rule book of research funding bureaucracy, allowing empowered and highly expert project managers to drive forward projects and allocate funding to the best people and projects wherever it can be found. And to secure commercial pull-through, government must take active steps to fill the gap created by the lack of a single intelligent customer (a role filled by the US Department of Defense¹ for DARPA) to ensure the technologies catalysed by ARPA are deployed for the lasting economic benefit of the UK.

ARPA has the potential to have a transformative impact on the UK’s science and innovation landscape. The government should move boldly to create it with the mandate, freedom and risk appetite that will allow it to truly fulfil its potential.

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

The current UK research funding system has an important and major role driving underpinning and basic science in the UK. The model is the reason that the UK is able to punch well above its weight internationally in Science. It is held up as a successful funding mechanism worldwide.

However, there are gaps:

- 1) The UK research and development system is dominated by private sector activity. However, public sector activity and private, non-profit organisations play a vital role, particularly in the life sciences. The NRP is a strong example of this with both public sector (UKRI Institutes – EI, JIC, QIB), private non-profit organisations (TSL, the Norfolk and Norwich University Hospital) and the University of East Anglia (UEA) working closely together. Discovery science and its strategic development are still funded very largely by public funding, which is critical for new, disruptive technologies. The new funding agency must fit into this landscape and it is important to recognise that this will happen only shortly after establishment of UKRI (in 2017), which has yet to launch its own long-term strategic plan. They must be complementary in approach.
- 2) There is a widely perceived failure of coupling research and invention to deployable technologies with a user base or industry ready to exploit technologies. Strategy is often developed with little to no industrial input.
- 3) Current UK research funding, particularly through UKRI is somewhat risk averse. A research agency that is willing to accept a high level of failure would be very valuable for science but also industry, de-risking areas of development.
- 4) Funding “big science”. This is particularly evident in the life sciences with perhaps the only example of big science funding in this area being Genomics England. This is despite the life sciences being a major UK growth area.

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

This should be seen as separate money, the fact that technologies exist is due to the effective science base in the UK. UKRI plays a major role driving the underpinning, basic science.

A successful UK ARPA should have a very different mission to UKRI, filling gaps rather than replacing them. This needs careful thought. UKRI administers the government’s Industrial Strategy Challenge fund (ISCF) and its constituent research councils include Innovate UK (formed from the previous Technology Strategy Board) in 2007. The ISCF was launched in 2016 and its effectiveness has yet to

be evaluated. It is therefore important that the remit of the new funding body is well articulated and clear in the context of the wider role of UKRI which operates in some of the same space.

For example, how will this relationship be governed?

Where will the remit of Innovate UK and its relationship with the new funding body be governed?

If an ARPA style organisation is to be successful it needs to have a highly complementary relationship that does not preclude discovery UKRI funding from operating alongside longer-term, development-oriented funds. There should be additionality and scale possible through both funding streams.

While the two agencies should be separate it will be important that they are coordinated and the line of accountability for the new head of ARPA must also be made clear.

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

Dominic Cummings wrote of the ambitions to *“make Britain the best place in the world to be for those who can invent the future.”* The UK punches well above its weight in the sciences and is inventive. Where the UK has an issue is in applying technologies for economic gain.

William Schneider, in his introduction to the ARPA vision documents writes, *“DARPA relies on its Program Managers to create military capabilities from advanced technologies rather than responding to a ‘top-down’ concentration on specific military missions to be served by the application of technology. DARPA’s six offices are technology rather than mission centric.”* It would appear that in order to create a successful equivalent in the UK, an ARPA style agency would need to have a “lead customers” and a clear set of technologies. This lead customer must be an expert in understanding what it needs to shape technology developments to this goal. This could be a government department or government agency which can clearly communicate the current needs or challenges.

Alternatively, the customers could be a group of industries. Having industrial groups shaping a technology would mean as it reaches maturity, industry is already capable of exploiting it. For example, artificial intelligence may have seemed abstract 5 years ago. However, if a set of industries were involved in developing, shaping and adopting early AI technology it would give them a huge competitive advantage, moreover as experts, through their involvement in fledgling AI technologies they shape the direction of future developments rather than just responding. This behavior can clearly be seen for companies like Amazon and Google. In effect you are building industries around developing technologies.

For technologies to focus on Lord Willetts' Eight Great Technologies, worked brilliantly for aligning academic research and industry. Looking again at these technologies would be a good starting point. However, spending time at the start thinking of what will be the next eight great technologies would be extremely valuable. Also, it is important that these are not fixed in stone and are regularly reviewed and changed if appropriate.

ARPA in the USA has very specific remits – DARPA, HSARPA, IARPA and ARPA-E all take their lead from specific government departments. If UK ARPA is to be all-encompassing as described, then it will need to have a mechanism by which it is able to focus specifically on given technologies. This is not straightforward and requires careful planning. The mechanism will need to be formalised and transparent. There would logically need to be some direct line back to government priorities and the views of specific government departments if this is to work well and be sustainable. It is critical the ARPA is seen in parallel and separate to the Research Councils and Innovate UK funding R&D.

Given that we have a successful system of Research Councils and Innovate UK funding R&D at different Technology Readiness Levels, I think that both have its merit, and ARPA should not replace either, but become an additional mechanism for creating exceptional capabilities, step-changes, that could be deployed to address immediate societal challenges owned by the “lead customer”. The model of National Laboratories, such as Central Science Laboratory (CSL), which was in place around the 1990s... would work as a lead customer with exception that we would not need ARPA to have its own laboratories. CSL was supporting Defra's delivery of Strategic Objectives, such as management of disease outbreaks, Biomass Strategy, or Stewardship Scheme.

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

£800 M for the first five years seems modest and should not be reduced. DARPA in the USA has an annual budget of \$3.4 B .

There needs to be a long-term commitment beyond the first 5 years to 10-15 years. The spending profile must be thought through carefully, there should be no pressing need to rapidly spend in the first few years as the agency establishes itself. Funding should not place a burden on recipient organisation and should cover the full economic cost. The budget should be deployed flexibly by the project managers, allow under and over-spend where required and to switch budget headings flexibility i.e. between capital cost and staffing costs change rapidly. The process of failing fast is an important concept but it is important that the implication of rapid removal of funding is considered, for small institutes or SME the risk of rapid funding loss could deter them from getting involved in the first place.

For this to succeed at the start, the spend should be slow and the funding needs to be at least the 800 million suggested in outline reports.

What can be learned from ARPA equivalents in other countries?

ARPA's success has been based on having very specific remits and the ethos of 'high-risk, high-reward' projects. ARPA contributed to technologies such as stealth aircraft, global positioning system (GPS) and the internet, for example. A new UK agency should be similarly bold. Consider that the impact of an evolving technology might not yet be known; simply trust that the really exciting, 'shiny' concepts always attract the canniest magpies who will use those concepts to best advantage.

The government has to be ready to stand by its assertion that if UK ARPA is too successful, it has not been taking enough risks. If UK ARPA is to be high risk, then it and the government must be prepared to make that clear. If nothing is successful for a long time, they must be ready to defend charges of ARPA being a waste of money. The opposition and the press will be tough judges at budget time if ARPA, in the years to come, seeks an increased budget, but has nothing to show for the first £800 million.

In the same way as DARPA directed funding to projects that benefited the military, funding by a new UK agency could be used to drive funding to projects aimed at key sectors. For example, such funding could take emerging technologies and research ideas and target them straight into the NHS. Providing targeted solutions to the "If only there was a way of..." questions fielded by NHS chief executives would reduce the time taken from research to clinic and potentially have major economic benefits as a result. Similarly, agriculture, food security, optimising food for human health, green technologies, carbon capture, the automotive industry; all provide focal points for pursuing high risk projects.

Using emerging technologies to generate targeted solutions does require consideration as to how successful outputs are funded. Does creation of a UK ARPA indicate that the government is also willing to invest in the scale-up, manufacture and roll out of innovative technologies? Consideration also needs to be made as to how industry or, indeed, private citizens will be persuaded to adopt technologies, especially when doing so might be at significant cost (for example, the introduction of emission-free vehicles or other home-improvements in mitigation of climate change).

As important to DARPA as the innovators have been, it seems, the programme managers are the ones, as noted by Professor Richard Jones (University of Manchester), who have *"...come with a vision of the future of some field of science or engineering, they develop and elaborate that vision – in collaboration with others - into a research programme, and then they create and support a research community to realise the vision."* This is key, so these individuals must be chosen wisely

and then be given the freedom and space to pursue their visions; albeit they must also have the conviction to end a project if it is not going to offer real benefit within a realistic timeframe.

The success of ARPA may have depended on its ability to recruit qualified experts who have the authority and decision-making ability to rapidly commission projects. UK ARPA's success will depend very much on recruiting such individuals and, critically, allowing them the freedom to make such decisions even when the potential economic gains will be long-term and perhaps not visible at all to political leaders. This will require a new way of thinking because sustained economic and political support for ARPA projects will be necessary over a long time frame, as with the projects in the USA that led to disruptive technologies, such as GPS.

The innovators, researchers and programme managers should be recruited for their ideas, ambition and clarity of thought. They should be recruited from all levels of career stage and it might well be that a risky project is made riskier by virtue of the fact that it comes from the mind of an early career researcher, or someone who is working from the outskirts of a discipline; but why not? In some measure those who have not travelled a route yet, might more easily conceive of the way to overcome a roadblock, than someone who has been sitting staring at it for a long time

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

It is critical that ARPA funds the best, no matter the location of the researchers, there is an obvious overlap with the governments so-called "levelling up" agenda, to boost deprived parts of the country however this should not be seen as route to achieve this. It would be better to fund "the Northern powerhouse" through separate mechanism to make it align with ARPA strategy.

Positioning ARPA outside of traditional science centres would have benefits in terms of these agendas, but the agency does need to be connected politically to government, and scientifically to the areas where the greatest advances are being made. ARPA could be a very agile and lean organisation with most of its programme managers situated around the country and not in a dedicated centre. This would allow it to be very well networked. Under these circumstances the location of its centre is not critical to its success, but if it was situated outside the Golden Triangle, it would send a clear signal politically of the government's commitment to levelling up opportunity and influence across the regions of the UK.

The Norwich Research Park, which has strong collaborative links between four research institutes, a large NHS teaching hospital trust and the University of East Anglia is a superb example of a location for innovation in the interlinked areas of food, health and climate change all underpinned by significant expertise in genomics technology. ARPA projects conceived in these subject areas would benefit from being sited in Norwich and provide, in parallel, significant development of the region.

There could be significant benefits in funding projects at locations that are more *in situ* when placed outside of the Golden Triangle. Projects and technologies aimed at off-shore roles might be better funded at research centres based around the UK coast. Those benefiting the agricultural sector may be best served by funding research centres in the East of England, for example.

The funding for the new agency should be sufficiently ambitious that there is opportunity for those inside *and* those outside the Golden Triangle to benefit. There are excellent clusters of talented scientists outside the Golden Triangle and tapping into fresh thinking and societal problem-solving will be best achieved by looking at the new and upcoming as well as the established scientific centres.

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