The shifting sands of UK Government technology prioritisation

Richard Jones
University of Manchester

12 February 2024

Introduction

The problem of policy churn has been identified in a number of policy areas as a barrier to productivity growth in the UK, and science and innovation policy is no exception to this. The UK can't do everything – it represents less than 3% of the world's R&D resources, so it needs to specialise. But recent governments have not found it easy to decide where the UK should put its focus, and then stick to those decisions.

In 2012 this the then Science Minister, David Willetts, launched an initiative which identified 8 priority technologies – the *"Eight Great Technologies"*. Willetts reflected on the fate of this initiative in a very interesting paper published last year[1]. In short, while there has been consensus on the need for the UK to focus (with the exception of one short period), the areas of focus have been subject to frequent change.

Substantial changes in direction for technology policy have occurred despite the fact that we've had a single political party in power since 2010, with particular instability since 2015, in the period of Conservative majority government. Since 2012, the average life-span of an innovation policy has been about 2.5 years. Underneath the headline changes, it is true that there have been some continuities. But given the long time-scales needed to establish research programmes and to carry them through to their outcomes, this instability makes it different to implement any kind of coherent strategy.

Shifting Priorities: from "Eight Great Technologies", through "Seven Technology Families", to "Five Critical Technologies"

Table 1 summarises the various priority technologies identified in government policy since 2012, grouped in a way which best brings out the continuities.

The *"Eight Great Technologies"* were introduced in 2012 a speech to the Royal Society by the then Chancellor of the Exchequer, George Osborne[2]; a pamphlet by David Willets expanded on the rationale for the choices[3]. The 2014 Science and Innovation Policy[4] endorsed the *"Eight Great Technologies",* with the addition of quantum technology, which, following an extensive lobbying exercise, had been added to the list in the 2013 Autumn Statement[5].

2015 brought a majority Conservative government, but continuity in the offices of Prime Minister and Chancellor of the Exchequer didn't translate into continuity in innovation policy. The new Secretary of State in the Department of Business, Innovation and Skills was Sajid Javid, who brought to the post a Thatcherite distrust of anything that smacked

of industrial strategy. The main victim of this world-view was the innovation agency Innovate UK, which was subjected to significant cut-backs, causing lasting damage.

This interlude didn't last very long – after the Brexit referendum, David Cameron's resignation and the premiership of Theresa May, there was an increased appetite for intervention in the economy, coupled with a growing consciousness and acknowledgement of the UK's productivity problem. Greg Clark (a former Science Minister) took over at a renamed and expanded Department of Business, Energy and Industrial Strategy.

A White Paper[6] outlining a *"modern industrial strategy"* was published in 2017. Although it nodded to the *"Eight Great Technologies",* the focus shifted to four "*missions*". Money had already been set aside in the 2016 Autumn Statement for an *"Industrial Strategy Challenge Fund"* which would support R&D in support of the priorities that emerged from the Industrial Strategy.

2019 saw another change of Prime Minister – and another election, which brought another Conservative government, with a much greater majority, and a rather interventionist manifesto that promised substantial increases in science funding, including a new agency modelled on the USA's ARPA, and a promise to *"focus our efforts on areas where the UK can generate a commanding lead in the industries of the future – life sciences, clean energy, space, design, computing, robotics and artificial intelligence."*

But the "modern industrial strategy" didn't survive long into the new administration. The new Secretary of State was Kwasi Kwarteng, from the wing of the party with an ideological aversion to industrial strategy. In 2021, the industrial strategy was superseded by a Treasury document, the *Plan for Growth*[7], which, while placing strong emphasis on the importance of innovation, took a much more sector and technology agnostic approach to its support. The Plan for Growth was supported by a new Innovation Strategy[8], published later in 2021. This did identify a new set of priority technologies – *"Seven Technology Families"*.

2022 was the year of three Prime Ministers. Liz Truss's hard-line free market position was certainly unfriendly to the concept of industrial strategy, but in her 44 day tenure as Prime Minister there was not enough time to make any significant changes in direction to innovation policy.

Rishi Sunak's Premiership brought another significant development, in the form of a machinery of government change reflecting the new Prime Minister's enthusiasm for technology. A new department – the Department for Innovation, Science and Technology – meant that there was now a cabinet level Secretary of State focused on science. Another significant evolution in the profile of science and technology in government was the increasing prominence of national security as a driver of science policy.

This had begun in the 2021 Integrated Review[9], which was an attempt to set a single vision for the UK's place in the world, covering security, defence, development and foreign policy. This elevated "*Sustaining strategic advantage through science and technology*" as one of four overarching principles. The disruptions to international supply chains during the covid pandemic, and the 2022 invasion of Ukraine by Russia and the subsequent large scale European land war, raised the issue of national security even higher up the political agenda.

A new department, and a modified set of priorities, produced a new 2023 strategy – the *Science & Technology Framework - taking a systems approach to UK science & technology*[10]. This included a new set of technology priorities – the "*Five critical technologies".*

Thus in a single decade, we've had four significantly different sets of technology priorities, and a short, but disruptive, period, where such prioritisation was opposed on principle.

Continuities and discontinuities

There are some continuities in substance in these technology priorities. Quantum technology appeared around 2013 as an addendum to the "*Eight Great Technologies*", and survives into the current "*Five Critical Technologies*". Issues of national security are a big driver here, as they are for much larger scale programmes in the USA and China.

In a couple of other areas, name changes conceal substantial continuity. What was called *synthetic biology* in 2012 is now encompassed in the field of *engineering biology*. Artificial Intelligence has come to high public prominence today, but it is a natural evolution of what used to be called *big data,* driven by technical advances in machine learning, more computer power, and bigger data sets.

Priorities in 2017 were defined as *Grand Challenges*, not *Technologies*. The language of challenges is taken up in the 2021 Innovation Strategy, which proposes a suite of *Innovation Missions*, distinct from the priority technology families, to address major societal challenges, in areas such as climate change, public health, and intractable diseases. The 2023 Science and Technology Framework, however, describes investments in three of the *Five Critical Technologies*, engineering biology, artificial intelligence, and quantum technologies, as "*technology missions",* which seems to use the term in a somewhat different sense. There is room for more clarity about what is meant by a *grand challenge*, a *mission*, or a *technology*, which I will return to below.

Another distinction that is not always clear is between *technologies* and *industry sectors*. Both the Coalition and the May governments had industrial strategies that explicitly singled out particular sectors for support, including through support for innovation. These are listed in table 2. But it is arguable that at least two of the Eight Great Technologies – agritech, and space & satellites - would be better thought of as industry sectors rather than technologies.

The sector approach did underpin major applied public/private R&D programmes (such as the Aerospace Technology Institute, and the Advanced Propulsion Centre), and new R&D institutions, such as the Offshore Renewable Catapult Centre, designed to support specific industry sectors. Meanwhile, under the banner of Life Sciences, there is continued explicit support from the pharmaceutical and biotech industry, though here there is a lack of clarity about whether the primary goal is to promote the health of citizens through innovation support to the health and social care system, or to support pharma and biotech as high value, exporting, industrial sectors[11].

But two of the 2023 "*five critical technologies*" – *semiconductors* and *future telecoms* - are substantially new. Again, these look more like industrial sectors than technologies, and while no one can doubt their strategic importance in the global economy it isn't obvious that the UK has a particularly strong comparative advantage in them, either in the size of the existing business base or the scale of the UK market (see my earlier discussion of the background to a UK Semiconductor Strategy[12]).

The story of the last ten years, then, is a lack of consistency, not just in the priorities themselves, but in the conceptual basis for making the prioritisation – whether challenges or missions, industry sectors, or technologies.

From strategy to implementation

How does one turn from strategy to implementation: given a set of priority sectors, what needs to happen to turn these into research programmes, and then translate that research into commercial outcomes? An obvious point that nonetheless needs stressing, is that this process has long lead times, and this isn't compatible with innovation strategies that have an average lifetime of 2.5 years.

To quote the recent Willetts review[13] of the business case process for scientific programmes: "*One senior official estimated the time from an original idea, arising in Research Councils, to execution of a programme at over two and a half years with 13 specific approvals required*." It would obviously be desirable to cut some of the bureaucracy that causes such delays, but it is striking that the time taken to design and initiate a research programme is of the same order as the average lifetime of an innovation strategy.

One data point here is the fate of the Industrial Strategy Challenge Fund. This was announced in the 2016 Autumn Statement, anticipating the 2017 Industrial Strategy White Paper, and exists to support translational research programmes in support of that Industrial Strategy. As we have seen, this strategy was de-emphasised in 2019, and formally scrapped in 2021. Yet the research programmes set up to support it are still going, with money still in the budget to be spent in FY 24/25.

Of course, much worthwhile research will be being done in these programmes, so the money isn't wasted; the problem is that such orphan programmes may not have any follow-up, as new programmes on different topics are designed to support the latest strategy to emerge from central government.

Sometimes the timescales are such that there isn't even a chance to operationalise one strategy before another one arrives. The major public funder of R&D, UKRI, produced a strategy in March 2022[14], which was underpinned by the *seven technology families*. To operationalise this strategy, UKRI's constituent research councils produced a set of delivery plans[15]. These were published in September 2022, giving them a run of six months before the arrival of the 2023 Science and Innovation Framework, with its new set of critical technologies.

A natural response of funding agencies to this instability would be to decide themselves what best to do, and then do their best to retro-fit their ongoing programmes to new government strategies as they emerge. But this would defeat the point of making a strategy in the first place.

The next ten years

How can we do better over the next decade? We need to focus on *consistency* and *clarity*.

Consistency means having one strategy that we stick to. If we have this, investors can have confidence in the UK, research institutions can make informed decisions about their own investments, and individual researchers can plan their careers with more confidence.

Of course, the strategy should evolve, as unexpected developments in science and technology appear, and as the external environment changes. And it should build on what has gone before – for example, there is much of value in the systems approach of the 2023 Science and Innovation Framework.

There should be clarity on the basis for prioritisation. I think it is important to be much clearer about what we mean by *Grand Challenges*, *Missions*, *Industry Sectors,* and *Technologies*, and how they differ from each other. With sharper definitions, we might find it easier to establish clear criteria for prioritisation.

For me, *Grand Challenges* establish the conditions we are operating under. Some grand challenges might include:

- How to move our energy economy to a zero-carbon basis by 2050;
- How to create an affordable and humane health and social care system for an ageing population;
- How to restore productivity growth to the UK economy and reduce the UK's regional disparities in economic performance;
- How to keep the UK safe and secure in an increasingly unstable and hostile world.

One would hope that there was a wide consensus about the scale of these problems, though not everyone will agree, nor will it always be obvious, what the best way of tackling them is.

Some might refer to these overarching issues as *missions*, using the term popularised by Mariana Mazzacuto[16], but I would prefer to refer to a mission as something more specific, with a sense of timescale and a definite target. The 1960's Moonshot programme is often taken as an exemplar, though I think the more significant mission from that period was to create the ability for the USA to land a half tonne payload anywhere on the earth's surface, with an accuracy of a few hundred meters or better.

The crucial feature of a mission, then, is that it is a targeted program to achieve a strategic goal of the state, that requires both the integration and refinement of existing technologies and the development of new ones. Defining and prioritising missions requires working across the whole of government, to identify the problems that the state needs to be solved, and that are tractable enough given reasonable technology foresight to be worth trying, and prioritising them.

The key questions for a judging missions, then, are, how much does the government want this to happen, how feasible is it given foreseeable technology, how well equipped is the UK to deliver it given its industrial and research capabilities, and how affordable is it?

For supporting an *industry sector*, though, the questions are different. Sector support is part of an active industrial strategy, and given the tendency of industry sectors to cluster in space, this has a strong regional dimension. The goals of industrial strategy are largely economic – to raise the economic productivity of a region or the nation – so the criteria for selecting sectors should be based on their importance to the economy in terms of the fraction of GVA that they supply, and their potential to improve productivity.

In the past industrial strategy has often been driven by the need to create jobs, but our current problem is productivity, rather than unemployment, so the key criteria for selecting sectors should be their potential to create more value through the application of innovation and the development of skills in their workforces. The capacity of the sector to export matters too, given the UK's persistent current account deficit. In addition, the discipline of competing in export markets is a significant driver of productivity.

In addition to the economic dimension, there may also be a security aspect to the choice, if there is a reason to suppose that maintaining capability in a particular sector is vital to national security. The 2021 nationalisation[17] of the steel forging company, Sheffield Forgemasters, to secure the capability to manufacture of critical components of the Royal Navy's submarine fleet, would have been unthinkable a decade ago.

Industrial strategy may involve support for innovation, for example through collaborative programmes of pre-competitive research. But it needs to be broader than just research and development; it may involve developing institutions and programmes for innovation diffusion, the harnessing of public procurement, the development of specialist skills provision, and at a regional level, the provision of infrastructure.

Finally, on what basis should we choose a *technology* to focus on? By a technology priority, we refer to an emerging capability arising from new science, that could be adopted by existing industry sectors, or could create new, disruptive sectors. Here an understanding of the international research landscape, and the UK's part of that, is a crucial starting point. Even the newest technology, to be implemented, depends on existing industrial capability, so the shape of the existing UK industrial base does need to be taken account. Finally, one shouldn't underplay the importance of the vision of talented and driven individuals.

This isn't to say that priorities for the whole of the science and innovation landscape need to be defined in terms of challenges, missions, and industry sectors.
A general framework for skills, finance, regulation, international collaboration, and infrastructure – as set out by the recent Science & Innovation Framework - needs to underlie more specific prioritisation. Maintaining the health of the basic disciplines is important to provide resilience in the face of the unanticipated, and it is important to be open to new developments and maintain agility in responding to them.

The starting point for a science and innovation strategy should be to realise that, very often, science and innovation shouldn't be the starting point. Science policy is not the same as industrial strategy, even though it's often used as a (much cheaper) substitute for it. For challenges and missions, defining the goals must come first; only then can one decide what advances in science and technology are needed to bring those in reach. Likewise, in a successful industrial strategy, close engagement with the existing capabilities of industry and the demands of the market are needed to define the areas of science and innovation that will support the development of a particular industry sector.

As I stressed in my earlier, comprehensive, survey of the UK Research and Development landscape[18], underlying any lasting strategy needs to be a settled, long-term view of what kind of country the UK aspires to be, what kind of economy it should have, and how it sees its place in the world.

Table 1. A history of UK technology priorities since 2010

Eight Great Technologies	**"Nifty Nine" -** *Quantum technology added to the 8 Great Technologies*	**Our plan for growth: science and innovation** *Endorses 8 Great + quantum*	**The Javid interlude - opposition in principle to industrial strategy, cut-backs at Innovate UK**	**Modern Industrial Strategy: four missions**	**UK Innovation Strategy - Leading the future by creating it: seven technology families**	**Science & Technology Framework - taking a systems approach to UK science & technology: five critical technologies**
2012	2013	2014	2015-2016	2017	2021	2023
Big Data & Energy-efficient computing	Big Data & Energy-efficient computing	Big Data & Energy-efficient computing		Artificial intelligence and data	AI, Digital, Advanced Computing	Artificial intelligence (AI)
						Future telecommunications
	Quantum Technology	Quantum Technology			Electronics, Photonics, Quantum	Quantum technologies
						Semiconductors
Advanced Materials and Nano-technology	Advanced Materials and Nano-technology	Advanced Materials and Nano-technology			Advanced Materials and Manufacturing	
Robotics and Autonomous Systems	Robotics and Autonomous Systems	Robotics and Autonomous Systems			Robotics and Smart Machines	
Life sciences, genomics and synthetic biology	Life sciences, genomics and synthetic biology	Life sciences, genomics and synthetic biology		Innovation for an ageing society	Engineering Biology	Engineering biology
Regenerative medicine	Regenerative medicine	Regenerative medicine			Bioinformatics and Genomics	
Agri-science	Agri-science	Agri-science				
Energy and its storage	Energy and its storage	Energy and its storage		Clean Growth	Energy & Environment Tech	
				The future of mobility		
Satellites & Space	Satellites & Space	Satellites & Space				

Table 2. Priority sectors in the Coalition and May governments

Coalition industrial strategy sectors, 2014[19]	Industrial strategy sector deals, 2019[20]
Aerospace	Aerospace
Agricultural technology	Artificial intelligence
Automotive	Automotive
Construction	Construction
Information economy	Creative industries
International education	Life sciences
Life sciences	Nuclear
Nuclear	Offshore wind
Offshore wind	Tourism
Oil and gas	Rail
Professional and business services	

[1] https://policyexchange.org.uk/publication/the-eight-great-technologies-10-years-on/
[2] https://royalsociety.org/news/2012/osborne-at-royal-society/
[3] https://policyexchange.org.uk/wp-content/uploads/2016/09/eight-great-technologies.pdf
[4] https://www.gov.uk/government/publications/our-plan-for-growth-science-and-innovation

[5] https://uknqt.ukri.org/wp-content/uploads/2021/10/National-Quantum-Technologies-Strategy.pdf
[6] https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future
[7] https://assets.publishing.service.gov.uk/media/6048fd05d3bf7f1d16e263fd/PfG_Final_Web_Accessible_Version.pdf
[8] UK Innovation Strategy - Leading the future by creating it. https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it
[9] https://www.gov.uk/government/collections/the-integrated-review-2021
[10] https://assets.publishing.service.gov.uk/media/6405955ed3bf7f25f5948f99/uk-science-technology-framework.pdf
[11] https://www.nesta.org.uk/report/biomedical-bubble/
[12] http://www.softmachines.org/wordpress/?p=2896
[13] https://assets.publishing.service.gov.uk/media/65c5ef3ccc433b0011a90ae9/independent_review_of_the_dsit_business_case_and_approvals_process.pdf
[14] https://www.ukri.org/who-we-are/our-vision-and-strategy/our-strategy-2022-to-2027/
[15] https://www.ukri.org/who-we-are/our-vision-and-strategy/delivery-plans/
[16] https://marianamazzucato.com/books/mission-economy/
[17] https://www.gov.uk/government/news/uk-government-to-acquire-sheffield-forgemasters-international-limited

[18] https://www.productivity.ac.uk/research/science-and-innovation-policy-for-hard-times-an-overview-of-the-uks-research-and-development-landscape/
[19] https://assets.publishing.service.gov.uk/media/5a74f22b40f0b6360e4721fa/bis-14-707-industrial-strategy-progress-report.pdf
[20] https://www.gov.uk/government/publications/industrial-strategy-sector-deals/introduction-to-sector-deals