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WHEN MISSIONS FAIL: LESSONS IN 'HIGH TECHNOLOGY' FROM POST-WAR BRITAIN

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Executive summary

The idea that national security and economic prosperity stem from being at the technological frontier ('techno-nationalism') is once again a dominant feature of global politics. The post-war United States has emerged as the key model in these discussions, with the 'moonshot' seen as an outstanding example of how to direct state resources towards technological breakthroughs, while the capacity of the American government is praised more generally for its ability to sponsor ground-breaking technology. This paper, however, suggests that the United States was the exception, not the rule, and that the failures of post-war Britain highlight the limitations of 'techno-nationalism' with vivid clarity.

During the 1950s and 1960s, the British state took long-term bets on securing a leading role in the world's technological future, specifically in the areas of supersonic flight via Concorde and nuclear power generation. The result, however, was not export glory but industrial calamity. These long-running programmes were eventually cut back in the 1970s, when it became accepted in Whitehall that Britain should no longer try to be *the* Science and Tech Superpower, attempting to leapfrog the United States to technological glory.

Understanding this trajectory in Britain dislodges the sense that focusing on emerging technology and the long term is a silver bullet in policymaking. We must appreciate that the realities of technological power matter, and grasp that the post-war US was an unrepresentative case: no country today will have the relative level of industrial and technological might that it enjoyed at that time.

While my arguments will resonate in other national contexts, my focus is on ensuring that any strategy for 'high technology' in the UK today continues to learn the lessons from the errors of the post-war period. It must be wary of expert capture within the state. It must also think about industrial strategy in an integrated way, across national security, economics, and foreign policy, with a policymaking machinery set up to deal with this level of complexity. Moreover, despite the attention afforded to national state funding, the UK should continue to see forging alliances as essential alongside working with international business and be clear-eyed about where it does and does not need to sustain national capabilities.

Introduction

In 1977, the economist David Henderson made the striking claim that the post-war British state had been responsible for 'two of the three worst civil investment decisions in the history of mankind', referring to the Anglo-French supersonic airliner, Concorde, and the Advanced Gas-Cooled Reactor (AGR), a type of nuclear reactor for power generation, both long-running programmes with their origins in the late 1950s.[1] In a stinging cost-benefit analysis, published in the *Oxford Economic Papers*, he estimated that the AGR and Concorde programmes lost around £33 billion in inflation-adjusted terms (2023 prices).[2] Henderson, who had worked as an economic advisor in the Treasury and then Chief Economist in the Ministry of Aviation in the mid-to-late 1960s, argued that the issue was partly one of industrial capture – that the state engineers in favour of these programmes monopolised ministerial advice – but he also

[1] David Henderson, 'Two costly British errors', *The Listener*, 27 October 1977, 530.
[2] P. D. Henderson, 'Two British Errors: their probable size and some possible lessons', *Oxford Economic Papers*, 29 (1977), 185. He estimated that they lost £4.4 billion in 1975 prices, which was between 12 and 13 times the total research and development spend of all British universities at that time.

argued that a distinctively British belief in administrative decorum exacerbated the problem. That is, an adherence to organisational niceties restricted the flow of information across departmental lines and promoted anonymity within the system, undermining a sense of personal responsibility for any particular piece of advice given.

This paper takes another look at the AGR and Concorde – the two most ambitious and long-lived efforts at state-led 'high technology' in post-war Britain – and draws new lessons. Using the records in the National Archives, this paper suggests that Henderson was right that interested parties had much influence over ministerial advice and that the departmental siloing of knowledge hampered dissent. This paper contests a core point made by Henderson, however. In Henderson's account, even by the late 1970s, there were no recriminations and no lessons learnt. This paper shows that Whitehall did learn from these projects, and radically cut them back in the 1970s. By then, Whitehall had come to understand that Britain should no longer try to be *the* Science and Tech Superpower. Part of the reason for this was a shift in the nature of policymaking, with a new focus on cross-departmental strategic advice that undercut the internal advocates of these 'high technology' schemes.

Rewriting this story matters for our wider understanding of what makes for effective industrial strategy in the 21st century. It is striking that the post-war United States has emerged as the key model in this literature and in policy terms too, serving as a paradigmatic entrepreneurial state and mission economy: the 'moon shot' has been suggested as a model for policymakers. A core idea in this literature is that the state should be used to pioneer next-generation technological leaps that shape markets, not just follow them.[3] Yet, within this analysis, there is little sense of the particularity of the American case: that it was the industrial and technological superpower of the post-war age, and remains disproportionately powerful today. Britain stands as an example of what can go wrong when techno-nationalist dreams are fatally rooted in an inflated sense of a country's place in the world; an overestimation of its own ability to lead globally. It was for the better that Whitehall ran down the very mission economy that it had created, at least in the fields of aviation and nuclear power. Then and now, for medium-sized powers the focus in 'high technology' must be on working with allies and international businesses as much as on maintaining national capacities.

There is in fact much more understanding of this reality within the UK policymaking system than is immediately apparent, and there is no serious attempt to go back to the radical techno-nationalism of the 1950s and 1960s. Nevertheless, the lessons of the post-war era still bear underlining. There is a growing policy dialogue that posits a dichotomy between resilience and national security on the one hand and openness and free markets on the other. Yet, it remains the case that a liberal economy like the UK will get much of its security and resilience through its openness and its alliances. Even a partial return to the techno-nationalist age would leave us both weaker and poorer.

This paper reviews the literature on 'high technology' in post-war Britain, then reassesses Henderson's analysis of Concorde and the AGR, and, finally, draws out their policy lessons. This wider historiographical review is needed because in order to create a viable industrial strategy for 21st-century

[3] The core works in this literature are Mariana Mazzucato, *The Entrepreneurial State: debunking public vs. private sector myths* (London, 2015); Mariana Mazzucato, *Mission Economy: a moonshot guide to changing capitalism* (London, 2022). Also see Shaun Kantor and Alexander T. Whalley, 'Moonshot: public R&D and growth', *NBER Working Paper Series*, DOI: http://www.nber.org/papers/w31471.

Britain, it is paramount to understand its current economic characteristics, especially the openness of the UK economy and its relative lack of a national capitalism – factors that history helps to highlight. It is also worth explaining that when I refer to 'high technology', I mean state-backed programmes, both civil and military, that are ambitious, technically complex and expensive: the sort of projects that are regarded as next-generation technological leaps. The key technologies involved are often dual-use and the companies and industries usually work across the civil and defence sectors.

From autarky to openness: techno-nationalism and the national economy in post-war Britain

Understanding the scale and impact of Britain's industrial intervention in the post-war decades transforms our understanding of British history. The 'declinist' narrative was once widespread: the idea that the nation suffered an avoidable economic decline in the 20th century because its anti-scientific, anti-industrial elite did not invest in science and technology, with Harold Wilson's 'white heat' entering as a brief and failed attempt to inject technological modernity into the British state.[4] It was made clear long ago that this whole set of arguments is highly misleading – about the nature of the British state, about the politics of technology, and even about the narrow issue of Harold Wilson's plans for modernisation.[5] Britain was not lacking in science and technology in the immediate post-war period, but was, on the contrary, the scientific and technological leader of Western Europe; the running of the British state was not an entirely amateur affair, but was filled with many experts and engineers; and the British ruling elite was not hostile to modernity, but if anything had indulged in technological excess during the immediate post-war period.[6]

Contrary to the declinist narrative, the Conservative governments of the mid-to-late 1950s pursued an agenda of radical, state-led techno-nationalism, supporting hugely ambitious weapons programmes and civil spin-offs, which aimed to leapfrog the United States to export success. Both the AGR and the Concorde had their origins in this period. For many years, the Ministry of Supply, a wartime creation only abolished in 1959, had control of these projects. It was a vast super-ministry with enormous power over British industry; the sort of department that the declinists therefore sought to erase from history. The Atomic Energy Authority (AEA), the state-run body that designed Britain's nuclear reactors was somewhere between a nationalised industry and a state laboratory. In the early 1960s, it had over 41,000 employees and a budget that dwarfed all the Research Councils put together. As **Table 1** shows, it accounted for just under a third of all state-funded civil research and development.[7] Similarly, the Anglo-French supersonic jet Concorde was by far the dominant civil aviation project throughout the 1960s and 1970s, with over 24,000 people working on it in the early 1970s in Britain alone.

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[4] This key declinist argument was voiced from the early 1960s into the early 1990s, from those on the left and on the right. For a standard version of the argument, see Eric Hobsbawm, *Industry and Empire: from 1750 to the present day* (London, 1969).

[5] For these general arguments, see David Edgerton, *England and the Aeroplane: an essay on a militant and technological nation* (London, 1991). On the 'white heat' specifically, see David Edgerton, 'The 'White Heat' Revisited: The British Government and Technology in the 1960s', *Twentieth Century British History*, 7 (1996), 53-82; David Edgerton, *Warfare State: Britain 1920-1970* (Cambridge, 2005), 230-269. Also see Jim Tomlinson, The Politics of Decline: understanding post-war Britain (London, 2014).

[6] Historians have strengthened these claims in important ways since this 'post-declinist' framework was first established. One of the most significant has been to demonstrate the centrality of scientific research to colonial policymaking. See especially Sabine Clarke, 'A Technocratic Imperial State? The Colonial Office and scientific research, 1940-1960', *Twentieth Century British History*, 18 (2007), 453-480.

[7] Phillip Gummett, *Scientists in Whitehall* (Manchester, 1986), 39.

It was usually not the generalist administrators who were in charge of these programmes, but state technocrats, hugely influential scientists and engineers from the technical branches of the civil service. Indeed, it makes sense that Henderson's 1977 'Two British Errors' paper, a rare analysis that understood the power of the technocratic branches of the British state, was an important influence on the emergence of this post-declinist framework.[8] There needs to be more work looking into these officials, their influence, their politics, and their decline, but it is already clear that before 1970 they had both remarkable power and freedom, seeing themselves as a crucial component of the nation's technological strength.[9] There were around 18,000 scientific civil servants working in government departments in the late 1960s, which had declined to 7,300 by 1997.[10]

[8] Note the reference to David Henderson's work in David Edgerton, 'Liberal Militarism and the British State', *New Left Review*, 185 (Jan-Feb, 1991), 155. Also see David Edgerton, *The Rise and Fall of the British Nation: a twentieth-century history* (London, 2018), 377-378.

[9] For a rare study of government scientists and their influence as policymakers, see Alexandros-Panagiotis Oikonomou, The Hidden Persuaders: government scientists and defence in post-war Britain (Unpublished PhD dissertation, Imperial College London, 2011).

[10] Emmeline Ledgerwood, ''We lost a type of job for a type of person in this country': changing expectations of working in the UK scientific civil service', *Science Museum Group Journal*, Spring 2023: https://dx.doi.org/10.15180/231903.

Table 1: Civil research and development spending in 1962

Source: Maurice Dean, 'The Machinery for Economic Planning: IV. The Ministry of Technology', *Public Administration*, 44 (1966), 46.

	1962 prices, £m.	2023 prices, £m.
Universities and learned societies	24.0	424.50
Department of Scientific and Industrial Research	21.4	378.5
Medical Research Council	6.0	106.1
Agricultural Research Council	6.5	114.9
Nature Conservancy	0.6	10.6
Development Fund	0.8	14.1
Ministry of Aviation	24.7	436.8
Agriculture Departments	4.6	81.3
Other Civil Departments	2.8	49.5
Admiralty – Observatories and Oceanography	1.0	17.7
Air Ministry – Meteorology and Aviation Medicine	1.0	17.7
Atomic Energy Authority (Civil Research and Development)	50.0	884.38
National Institute for Research in Nuclear Science	7.0	12.3
Space Research	1.2	21.2
Total	151.6	2681.4

With the depth of this Tory techno-nationalism understood, we can now appreciate that Wilson's 'white heat' was not the beginning of enthusiasm for national technology, but an ending.[11] The Wilson government rejected the technological priorities of the right. They sought to shift state-funded research and development away from defence and unprofitable schemes in aviation and nuclear power towards smaller, more commercial endeavors that could be more directly applied in industry. They also accelerated a turn away from national projects towards industrial collaboration in Europe as well as more procurement of American-designed weapons.[12] The cancellation of the British TSR-2, the most

[11] It has also been established that Labour's strategy of the 'white heat' had Treasury support. See Jim Tomlinson, *The Labour Governments 1965-1970, Volume 3: economic policy* (Manchester, 2004).

[12] It was telling that the European Technological Community, an important part of Britain's second attempt at European integration in 1967, was partly about encouraging industrially focused projects in Europe. See John W. Young, 'Technological Cooperation in Wilson's Strategy', in Oliver Daddow (eds.), *Harold Wilson and the European Integration: Britain's second application to join the EEC* (London, 2003), 95-114. While collaborating with Europe became standard, the question of whether Britain should partner with Europe or the United States in major industrial endeavours remained an open one for much of the 1960s and into the 1970s. Takeshi Sakade, *The British Aircraft*

advanced military aircraft in the world, for the American F-111 caused much public outcry. In the computing industry too, the 'white heat' weakened the UK challenge to American technological power.[13] More generally, while the Ministry of Technology (Mintech), established by Labour in 1964, was in effect a recreation of the Ministry of Supply at the peak of its powers, though tasked with the redeployment and the reduction of the warfare state. Concorde was thus a complex programme for the Wilson government, both in tune and out of step with the 'white heat'. It was an Anglo-French partnership, a key step towards European collaboration that was regarded as essential for the aviation industry, but it was also a hugely risky scheme with dubious commercial prospects. In addition, Mintech would later be home to an even more radical reassessment of Britain's technological efforts, recognising that a key techno-declinist argument that had led to its creation – that is, the argument that the nation was deficient in research and development spending – was completely false.[14] The Labour government would subsequently run down the state research corps, and it left office in 1970 with a remarkable plan to amalgamate the state laboratories and run them largely on a commercial basis. While these reforms never came to be, they demonstrated that faith in state technocrats and state-led research and development programmes was over. It became accepted that industry, not bureaucrats and politicians, needed to direct state-funded industrial research. Mintech decisively brought an end to the age that gave birth to Concorde and the AGR, and was the final major attempt to use the warfare state for civil purposes.[15]

These arguments have important implications for the policy shifts of 1970s and how they are understood. In this new view, it becomes important that Edward Heath, the Conservative leader, well known for his criticisms of industrial policy and 'picking winners', would abolish Mintech in 1970, soon after taking over from Harold Wilson as Prime Minister. He separated out military and civil procurement and research, and consolidated a different relationship between supplier and customer, with the customer coming first. In this new context, the Labour governments of the mid-to-late 1970s have been seen as a partial return to an older techno-nationalism – a '1940s redux', a moment that brought an emphasis on national production and national inventions, which saw also defence spending and defence R&D increase.[16] For instance, this was the period in which the National Enterprise Board launched INMOS, a nationalised semiconductor company, and was the broader context for the highly nationalist Alternative Economic Strategy.[17] Yet, these policies proved to be short-lived, and while under

Industry and American-led Globalisation (Abingdon, 2022) demonstrated that the aviation industry was caught between the US and Europe, and how by the end of the 1970s, Britain successfully rode both horses. In essence, Rolls Royce came to supply aero-engines to American projects, while British Aerospace joined Airbus, demonstrating that the politics of engines and airframes were strikingly dissimilar.

[13] James Sumner, 'Defiance to Compliance: Visions of the Computer in Postwar Britain,' *History and Technology*, 30 (2015), 309–33. Also see James Sumner, 'The United Kingdom: going it alone?', in Dick van Lente (eds.), *Prophets of Computing: visions of society transformed by computing* (New York, 2022), 119-168.

[14] This insight would be lost again during the late 1970s and 1980s when the 'misallocation thesis' came to dominate studies on industrial strategy in post-war Britain. It was an attempt to explain away the seeming paradox of Britain's high levels of research and development spending alongside its low growth. The claim was that industrial intervention on the civil side was confined to 'prestige projects', like Concorde and the AGR, and that high defence spending also worked to turn British industry away from profitable endeavours. The key works were Christopher Freeman, *Technology Policy and Economic Performance: lessons from Japan* (London, 1987); Keith Pavitt (eds.), *Technical innovation and British Economic Performance* (London, 1980).

[15] Edgerton, *Warfare State*, 265.

[16] For this specific point, see David Edgerton, *The Rise and Fall of the British Nation*, 406-407. On the politics of the military-industrial complex under the Labour governments of the mid-to-late 1970s, more generally, see Keith McLoughlin, *The British left and the defence economy: rockets, guns and kidney machines, 1970-83* (Manchester, 2022).

[17] Ibid., 411-412.

the Thatcher governments there was initially support for techno-nationalist policies in some key areas, most notably in advanced computing, the techno-nationalist era was firmly over at least on the civil side. While there was still much support for highly advanced military projects, despite Treasury opposition, there were 'no more Concordes'.[18] And even more significantly, the whole system of nationalised industries who could be effectively forced to buy national inventions came to an end, producing a political-economic framing of innovation and manufacturing that was radically different from that even of the 1970s, let alone the 1950s. The 'white heat', despite appearances, was a step in the drawn-out journey away from radical techno-nationalism, despite in many quarters continuing to be understood as a rare example of just that.

This historiographical rethinking of Britain's industrial strategy was part of a broader critique that challenged the idea of continuity in Britain's political economy. David Edgerton argued that a developmental state – the sort denied within the older declinist framework – not only existed in post-war Britain but was central to its politics.[19] From the 1940s into the 1970s, the long-term planning of the British state created a national economy, built through protectionism, the promotion of 'Buying British' and modernising national industries. With this understanding, we can see the Thatcher governments as a radical rejection of the economic nationalism so central to the post-war decades. As time went on, state support for national champions was withdrawn, civil research and development cut, and very crucially, with the nationalised industries in private hands, there was little impetus to 'Buy British'. The British economy was opened up, and foreign capitalism remade it. The 1990s would bring a 'post-national' politics, in which there was little disquiet about the economic liberalism that had transformed Britain. It would be a time when few were disturbed about the use of foreign-designed trains or that imports of coal were dramatically growing.[20] Britain would be left with a lack of national capitalism quite unlike any comparable Western European nation.

It Is also important to understand that the familiar narratives – a transition from Keynesian economics to monetarism, a shift from 'social democracy' to 'neo-liberalism' – obscure the dynamism and importance of the political right in shaping the politics of the post-war period, not least in building Britain's highly militarised developmental state.[21] Indeed, it is a mistake to assume, as standard framings used to, that technological enthusiasm in post-war Britain went hand-in-hand with progressive politics. Thinking about the politics of gender draws the point out clearly. While discrimination existed in both countries, Mar Hicks established how it was more structural in the British case of post-war computing than in the United States. In Britain making computing work masculine was part of a top-down government initiative. During the Second World War, computing operation and programming was viewed as women's work but by the 1960s, after it had gained prominence, men displaced women. In the 1960s the Treasury and HMSO devised plans to create a new high-level of technocrats in charge of government computers. They were not recruited from existing computer workers, many of whom were

[18] For a detailed account of Thatcher's role in rejecting an industrial strategy, see Jon Agar, *Science Policy Under Thatcher* (London, 2019).
[19] This was suggested in earlier works, but it is most developed in Edgerton, *The Rise and Fall of the British Nation*.
[20] Edgerton, *The Rise and Fall of the British Nation*, 491-492.
[21] David Edgerton, 'What came between new liberalism and neoliberalism? Rethinking Keynesianism, the welfare state and social democracy', in Aled Davies, Ben Jackson and Florence Sutcliffe-Braithwaite, eds, *The Neoliberal Age? Britain since the 1970s*, eds., (London, 2021), 30-51.

women, but from management-level workers with no technical experience. This was in effect lowering standards to produce a male elite.[22]

'Two British Errors' reconsidered: the politics of Concorde and the Advanced Gas-cooled Reactor

With the scale and importance of the techno-nationalist age outlined, this section looks again at Henderson's analysis of why the British policymaking machinery indulged the AGR and Concorde. His analysis is worth revisiting partly because it is a rich and interesting variant of a more general, 'neo-liberal' critique.[23] When Henderson was writing in the 1970s, public choice theory was being popularised, which depicts bureaucracies as hostile to change and unable to produce internal dissent.[24] While it is true that the internal critics of these programmes struggled in the 1950s and 1960s, they cut through in the 1970s. Contrary to the ideological vision of the state gaining ground when Henderson was writing, Whitehall had the capacity to kill off its own technocratic darlings, and in doing so it transformed the political economy of the British state. Never again would Britain rely on its state engineers to deliver next-generation technological leaps. When it came to ending 'high technology' investment, it was Whitehall who radically curtailed the ambitions and nature of the state itself, bringing it more in line with the realities of Britain's place in the world.[25]

The following section demonstrates how state engineers did have much influence over ministerial advice and how the siloing of information limited dissent in the 1950s and 1960s but then demonstrates how these long-running programmes were drastically cut back in the 1970s.

Internal advice

It was certainly the case, as Henderson argued, that state engineers were crucial lobbyists for the Advanced Gas-Cooled Reactor (AGR) and Concorde in the 1950s and 1960s, although they never had a monopoly on ministerial advice. There were also internal doubters, especially in the case of Concorde, but ministers sided with the advocates of these schemes, largely due to a belief in the industrial necessity of these programmes.

Up until the mid-1960s, the Atomic Energy Authority (AEA) still had a commanding presence in Whitehall. While many of its functions would eventually be hived off, it had wide-ranging responsibilities at this time, including designing and testing Britain's nuclear weapons, handling waste management and creating nuclear reactors for electricity generation. The organisation also had many successes to its name. For instance, in 1956, it completed the construction of Calder Hall, the world's first full-scale

[22] Mar Hicks, *Programmed Inequality: how Britain discarded women technologists and lost its edge in computing* (Cambridge, Massachusetts, 2018).
[23] For instance, in *The Road to Serfdom*, Frederick Hayek prefigured Henderson's claims, arguing that experts could not be trusted to plan because they would know more than politicians and thus covertly guide decisions in their own interests: F. A. Hayek, *The Road to Serfdom* (Abingdon, 2006), 68.
[24] The key works are James M. Buchanan and Gordon Tullock, *The Calculus of Consent: logical foundations of constitutional democracy* (Ann Arbor; Michigan, 1962); Gordon Tullock, *The Politics of Bureaucracy* (Washington, 1965).
[25] For a more detailed account of this argument, and its wider historiographical implications for British history, the history of technology, and histories of 'neo-liberalism', see Tom Kelsey, 'The retreat from 'high technology' in post-war Britain', *English Historical Review*, forthcoming. This journal article also details how my histories of the cases themselves differs from the historiography on them too.

nuclear reactor, both on time and within budget. Those on the left saw the AEA as a form of 'high socialism', a bold demonstration of what the state could achieve. In 1965, the Labour government announced a second nuclear power programme of 8,000MW, a 3,000MW increase on the Conservative plans they inherited. Such faith was largely based on an assessment of the tenders for Dungeness B, which the AEA conducted alongside the nationalised Central Electricity Generating Board (CEGB), then Britain's largest electricity supplier. It validated the AGR as the cheapest reactor available, beating American-designed alternatives, specifically the Boiling Water Reactor (BWR), which elements of the nuclear construction industry wanted to build under licence. However, the AGR programme would be a commercial and industrial disaster, with huge construction delays and cost increases. Dungeness B was supposed to be finished in 1970 but was only completed in 1983 and its building costs had more than doubled in inflation-adjusted terms.[26] No AGR was ever exported.

There were figures in Whitehall in the mid-1960s who suspected the AGR was not quite the British triumph that the AEA claimed. Sir Alec Cairncross had especially deep concerns about the Dungeness B assessment. He had a remarkable career both as an academic economist and a Whitehall official. He was then the head of the Government Economic Service, which gave cross-departmental advice, but was a division within the Treasury. He suspected that the AEA-CEGB assessment was a biased endorsement of the AGR and one unlikely to be challenged because of the power the AEA wielded.[27] While Treasury officials did question why the Boiling Water Reactor (BWR) was so costly to build in Britain, and how the AGR had become so economically competitive so quickly, they also believed that they lacked the technical expertise to challenge the claims of the Central Electricity Generating Board (CEGB) and AEA in a direct manner.[28]

Labour ministers ignored these internal warnings. This was partly for ideological reasons. The AEA stood for what Harold Wilson sought to achieve: the 'white heat' was initially an attempt to use the methods of that had sustained the warfare state, such as state-funded R&D contracts, for civil purposes.[29] Moreover, in the context of persistent balance-of-payments crises, Labour ministers wanted to back an export success. This meant that they not only had to support the AGR, but champion it wholeheartedly in order help the sales effort, convincing other countries that it really was better than buying American. It was precisely for these reasons that James Callaghan, when Chancellor of the Exchequer, ignored the advice of his officials in the Treasury. He told them bluntly: 'I think it unwise to disrupt the second nuclear power programme at this early stage, with a risk of damage to export prospects.'[30]

Concorde was a more complex case, with much more internal opposition, but again the state engineers were in influential positions. Take the two top officials in charge of it from the mid-to-late 1960s into the early 1970s: James Hamilton, the director-general of the Concorde division, and R. R. Duddy, a director in that division. Hamilton was an aeronautical engineer, a specialist in wing-design, who had worked at the Royal Aircraft Establishment (RAE) from 1952 to 1965, eventually becoming head of the

[26] Walter C. Patterson, *Going Critical: an unofficial history of British nuclear power* (London, 1985), 60.
[27] National Archives, Kew, T 319/686, Alec Cairncross to Mr. Hunt, 14 October 1965.
[28] National Archives, Kew, POWE, 14/1831, L. Airey to H. J. Gummer, 24 May 1965; National Archives, Kew, T 319/686, Alec Cairncross to Mr. Hunt, 3 December 1965.
[29] Edgerton, 'The 'White Heat' Revisited', 53-82.
[30] National Archives, Kew, T 319/1506, James Callaghan to Richard Marsh, 27 October 1966.

Projects Division. The position of director-general was created for him in 1966 to strengthen the management team on the project. Duddy, another aeronautical engineer, worked at the RAE for nearly two and a half decades from 1939, with a brief interruption at the Defence Research Staff in Washington from 1959 to 1961. These engineers continued to support Concorde even after other top officials in the Ministry of Technology (Mintech) wanted it cancelled on industrial grounds, suggesting that the opportunity costs were too great. Duddy, for instance, argued that a cancellation would destroy Filton, where Concorde was being designed and built, leaving the site a mere sub-contractor to the United States.[31]

There was little belief among either officials or ministers that Concorde would be a great commercial success, and this scepticism was there from the beginning. The Treasury thought that cost escalation was certain and its market prospects dubious: they did not believe that it could operate profitably against subsonic jets.[32] By the mid-1960s, it seemed that Sir Richard Way, the Permanent Secretary at the Ministry of Aviation between 1963 and 1966, reluctantly came to agree. In 1964, he told the Treasury that it should have been stopped before so much money and industrial resources had been committed.[33] The substantive debate in the 1960s was less about whether Concorde made commercial sense, and more about whether the British aviation industry could survive its cancellation. In the mid-1960s, the Labour government wanted to cancel the TSR-2, a military jet, and Roy Jenkins, when Minister of Aviation, warned the Cabinet that the British Aircraft Corporation (BAC) could not survive the 'dual blow'.[34] The wider calculations about Britain's place in the European aviation industry were important too. In March 1969, the Cabinet wanted to withdraw from the European Airbus A300B, partly to support the British-designed alternative, the BAC 3-11, another wide-body subsonic jet – the sort of aeroplane that would dominate civil aviation, rather than supersonics. Ministers were concerned that if they were to do this *and* scrap Concorde, their commitment to industrial collaboration in Europe, which was then accepted to be pivotal to the future of the industry, would be called into question.[35] The Treasury criticised these industrial arguments too, chiefly arguing that Britain's over-sized aviation industry needed reducing, but its advocates narrowly won the argument.

Flow of information

As Henderson suggested, the fact that policymaking in the British system operates via Cabinet discussion, in which each department gives one view, limited dissent, because minority critical voices within departments were not heard. If there was a greater flow of information between sceptical officials across departments then the AGR and Concorde may have been scrapped.

There was more concern within the Ministry of Power about the AGR than was obvious from their Cabinet papers. In 1965, the scientific advisors could not provide an independent view on the claim that British-designed reactors were cheaper than American alternatives because the CEGB refused to

[31] National Archives, Kew, FV 2/538, R. R. Duddy, BAC-311/Concorde, 18 June 1970.
[32] National Archives, Kew, T 319/130, R. W. L. Wilding, Supersonic Airliner, 12 February 1962.
[33] National Archives, Kew, T 325/129, R. W. B. Clarke to Mr. Bancroft, 21 October 1964.
[34] National Archives, Kew, CAB 130/212, Minister of Aviation, Future of the Concord Project, 4 January 1965.
[35] National Archives, Kew, CAB 128/44/14, Cabinet Conclusions, 25 March 1969.

give them the relevant information in the lead-up to the government's decision to commit to the AGR.[36] Moreover, within the electricity division of the Ministry, there was a particular worry about the design of the pressure vessel: a fear it was essentially unfinished and that redesigns could dramatically increase capital costs.[37] If the Treasury had known about such concerns, which confirmed their fears that the CEGB-AEA assessment was likely to be biased in the favour of the AGR, if not something of a stitch-up, they would surely have been more vocal in their opposition.

The power of ministers to select what information gets presented to the Cabinet was potentially crucial in saving Concorde, especially after the Tories came to office in 1970. Mintech was now clearly presenting its scepticism to its minister. A paper outlined two plausible options: immediate cancellation or continuing until after the Mach 2 test flights in 1971. Much evidence was put forward in favour of the first option. The issue was put bluntly: 'Concorde is not an economic project.' It was suggested that scrapping it would save around £150 million (around £2 billion in 2023 prices), and it was even acknowledged that the employment consequences of doing so may improve the balance of payments, as resources would move out of the aviation industry into more export-orientated work. Doubt was also cast on Concorde's benefit to British prestige: it was suggested that it would be a blow to national morale if no aeroplanes were sold to foreign buyers. Finally, it was argued that to continue until after the Mach 2 tests would effectively mean irreversibly committing to the project, given that so many resources would then be poured into it.[38] The Board of Trade, who were responsible for the nationalised airlines, told their minister outright to argue for cancellation. The airlines would only be able to operate it with subsidies, and in any case, the subsonic BAC 3-11 would be better for the aviation industry. Again, the point was made that misuse of resources ultimately hinders economic growth and that previous experience, such as with the TSR-2, had demonstrated that skilled labour is often quickly reabsorbed.[39] Foreign Office officials were also at this moment suggesting that withdrawing from Concorde would have little impact on the Common Market negotiations.[40] A crucial reason for keeping the project had been a reluctance to annoy the French while trying to enter the European Economic Community (EEC).

Ministers ensured, however, that much of this essential information did not reach the Cabinet. After Heath came to power, Geoffrey Rippon briefly served as the Minister of Technology before Edward Heath abolished Mintech. Rippon, a free marketeer and a Europhile, was a parliamentary secretary at the Ministry of Aviation when Concorde began. Almost a decade later, Rippon remained a keen advocate. Rippon's memorandum accepted that its economic prospects were not encouraging, but insisted that it was 'too early' to make a conclusive judgement, and, despite what his officials had said, he still stressed the foreign exchange earnings.[41] The need to keep the French onside while negotiating into the EEC was also highlighted, despite its importance being doubted by many officials, and Rippon also made the wider industrial case about Britain's place in the future of European aviation without mentioning that many in Whitehall now believed that this rested with subsonic projects, not with

[36] National Archives, Kew, POWE 14/1831, R. G. S. Skipper to Charles Cawley, 21 March 1965;; National Archives, Kew, POWE 14/1831, Charles Cawley to Philip Chantler, 14 April 1965.
[37] National Archives, Kew, POWE 14/1832, L. J. Goss to A. N. Norris, 15 July 1965.
[38] National Archives, Kew, FV 2/539, Ronald Melville to Geoffrey Rippon, 25 June 1970.
[39] National Archives, Kew, AVIA 112/241, D. F. Hubback to Michael Noble, 21 July 1970.
[40] National Archives, Kew, FV 2/539, J. A. Hamilton to Ronald Melville, 6 July 1970.
[41] National Archives, Kew, CAB 129/150/15, Minister of Technology, Concorde, 17 July 1970.

Concorde.[42] Moreover, for this same Cabinet meeting, Michael Noble, the President of the Board of Trade, ignored the calls from his officials to argue for cancellation and produced a memorandum that avoided discussing whether it should continue.[43] By this time at least, it was clear that officials were not duping ministers into supporting Concorde. If anything, ministers hoodwinked the Cabinet, and it worked.

When discussing the Cabinet papers from Rippon and Noble, Edward Heath, the Prime Minister, was not impressed with their work. He remarked that the problem was not only that these newly installed ministers were unable to grasp the complexities of these issues that impacted the whole of the aviation industry, but also that there was no cross-departmental function that could adequately analyse these policy questions.[44] In the Cabinet discussion, it was suggested that poor decisions had been made in military and civil aviation throughout the post-war decades due to the nature of UK decision-making, 'whereby the technological and political advantages of proceeding with advanced projects were merely set in opposition to the economic necessities of reducing Government expenditure.'[45] In other words, the set-up of boosterish departments against a penny-pinching Treasury failed to produce analysis that was able to think about issues in the round and at an adequate level. Concorde was in fact the sort of issue that Edward Heath had in mind when he established the Central Policy Review Staff (CPRS) in 1971, which had a mission to provide long-term, cross-departmental advice to the Cabinet on complex, crucial problems.[46] Heath wanted the merits of Concorde versus the BAC 3-11 to be weighed up in the round and after further study.[47]

The lack of this function – a cross-departmental capability that could analyse complex issues and produce quality work at pace – may well have worked to save Concorde. By the time the CPRS reported on the project in November 1971, the window in which it could be feasibly cancelled had closed. The chief issues were political: the Heath government saved Rolls-Royce from bankruptcy in a major U-turn in February 1971, cancelling Concorde would cast doubt on their commitment to making a success of the company, and by this time the negotiations to enter the EEC had opened again.[48] Before the CPRS was established, Heath turned to the Cabinet Secretary, Burke Trend, to lead a cross-Whitehall review on Concorde, but he did not produce the wide-ranging review the Prime Minister asked for, thinking about the project in relation to the aviation industry as a whole, and instead, it focused on the project individually.[49] Later in 1970, the Conservative Cabinet cancelled the BAC 3-11, while accepting it would be beneficial for the British aviation industry, in part because they could not afford it alongside Concorde.[50] Heath had come to power wanting to end state support for failing industries – for a freshly elected government, the cancellation of Concorde, with full disclosure of its costs, could have been sold as a victory for the rational, technocratic government he wanted. While we cannot say

[42] National Archives, Kew, CAB 129/150/15, Minister of Technology, Concorde, 17 July 1970.
[43] National Archives, Kew, CAB 129/150/23, President of the Board of Trade, Concorde, 21 July 1970.
[44] National Archives, Kew, CAB 128/47/11, Conclusion, 30 July 1970.
[45] National Archives, Kew, CAB 128/47/11, Conclusion, 30 July 1970.
[46] Peter Hennessy, *Whitehall* (London, 1989), 225.
[47] National Archives, Kew, CAB 128/47/9, Conclusion, 28 July 1970; National Archives, Kew, CAB 128/47/11, Conclusion, 30 July 1970.
[48] National Archives, Kew, CAB 128/49/15, Cabinet Conclusions, 18 March 1971; National Archives, Kew, CAB 128/49/61, Cabinet Conclusions, 2 December 1971.
[49] National Archives, Kew, CAB 129/151/15, Burke Trend, Concorde, 10 September 1970.
[50] National Archives, Kew, CAB 128/47/42, Cabinet Conclusions, 1 December 1970.

with certainty that Heath would have scrapped Concorde if he had a fuller account of its realities soon after coming into power, it is fair to say that this possibility was denied to him partly because he never had the right information at the right time.

The masked cancellations

The element of Henderson's argument that needs to be challenged most is the idea that Whitehall did not learn lessons from the AGR and Concorde. Not only did the experience of these projects warn policymakers off 'high technology' for a generation, they were themselves effectively cancelled compared to the ambitions that were originally invested in them.

For all the lingering belief in the luxury of Concorde, only a budget version of the programme ever went ahead. While the CPRS argued Concorde should continue for political reasons, they were clear about its economics. Lord Rothschild, formerly director of research at Shell and had wartime experience in intelligence, was the first head of the CPRS. His 1971 paper on the supersonic jet opened bluntly: 'Concorde is a commercial disaster. It should never have been started.'[51] By the end of 1973, even the manufacturers accepted that the current design would only gain around forty sales.[52] It was in this context that they recommended spending another £150 million on developing a new Concorde, primarily to reduce noise at take-off and landing and to enhance range. They argued that these improvements would ensure at least 130 sales and proposed a production run of 100 by 1982. A joint report from the DTI, the Treasury, the Foreign Office, the Ministry of Defence, and the CRPS discredited these proposals. They did not believe even an enhanced Concorde would sell and called on the government to limit production to fourteen for commercial purposes and to invest the bare minimum needed to bring it into service.[53] This was a radical reduction from the mid-1960s when it was assumed 150 would go into production. The factories in Bristol and Toulouse were geared to produce three Concordes a month. There was now a shared belief among officials that the opportunity costs of Concorde were too great and that it was damaging the aviation industry. Moreover, even the bare minimum programme only went ahead because Tony Benn, as Secretary of State for Industry, fought doggedly for it against much opposition within the Cabinet.[54]

There was likewise deep internal despair about the AEA and its reactor designs in the 1970s. The CPRS took an even more leading role in producing consensus across Whitehall that British-designed reactors needed to be abandoned. In an influential 1977 report, Sir Kenneth Berrill, who replaced Lord Rothschild as the head of the CPRS in 1974, argued that any long-term commitment to nuclear power had to be with American-designed reactors, and estimated that this would produce a saving of between £15 and £20 billion (the equivalent of £88 and £110 billion in 2023 prices) over a twenty-year period.[55] The immediate problem was that there was no existing design of these American Pressurised Water Reactors (PWRs) that had then met British safety standards. While two further AGRs were needed to keep the nuclear construction industry afloat, Berrill, an economist who came to the CPRS from the Treasury, implored the government to give clarity to the nuclear industry by making it clear publicly that

[51] National Archives, Kew, CAB 129/160/5, Lord Rothschild, Concorde, 29 November 1971.
[52] National Archives, Kew, CAB 134/3608, Department of Trade and Industry, Concorde, 12 December 1973.
[53] National Archives, Kew, CAB 134/3608, Department of Trade and Industry, Concorde, 12 December 1973.
[54] Kelsey, 'The retreat from 'high technology' in post-war Britain', *English Historical Review*, forthcoming.
[55] National Archives, Kew, CAB 134/4137, Central Policy Review Staff, Thermal Reactor Policy, 13 December 1977.

afterwards there would be a switch to American designs. The Labour government ignored this advice, building two AGRs but refusing to commit to the PWR. Tony Benn, now Secretary of State for Energy, fought trenchantly against the PWR in a close parallel to the Concorde case.[56] Yet, these were ultimately debates within a new consensus of deep disillusionment about national technological strength. It was a remarkable political shift to go from having the largest nuclear power programme in the world in the 1950s to arguing for a small commitment to British-designed reactors alongside a greater reliance on coal.

Conclusion

There was much to Henderson's analysis: the state engineers did have too much power and the siloing of information did limit dissent in the 1950s and 1960s. Yet, by the 1970s, both the politics and the policymaking had changed. The CPRS worked alongside the practical experience of spectacular failure to usher in a more realistic assessment of British technological strength. It was a significant shift to go from having state engineers in the nuclear and aviation industries feeding into ministerial advice to relying on a more independent function, with a remit to root out any awkward information. My revised histories show that Whitehall could cut back its own *grands projets* and defeat vested interests elsewhere in the state, undermining a 'neo-liberal' vision of bureaucrats always seeking to increase state spending and as unable to act in the national interest.

A cautionary tale: why 'Two British Errors' matter for 21st-century policymaking

Concorde and the AGR matter when thinking about industrial strategy in the 21st century because they act as an important rejoinder to many of the core assumptions in the academic literature. The experience of post-war Britain dislodges the idea that a focus on emerging technology and the long term is a silver bullet in industrial policymaking. The faith in aviation and nuclear power as the key technologies of tomorrow during the 1950s and 1960s resembles the optimism around artificial intelligence and quantum computing today. The British state poured vast resources on a long-term basis into these areas. Yet, these programmes rank as some of the worst public policy decisions ever taken. Concorde was only sold to nationalised airlines from the countries who built it, and then under much pressure and at less than the cost of production. No foreign country ever bought an AGR.

This is not America

The work of Mariana Mazzucato is currently central to debates about industrial strategy both in Britain and globally. It is useful to discuss it in part because of its predominance but also because it makes assumptions that are widely shared in the literature. In works such as *The Entrepreneurial State* and *Mission Economy*, she argues for a rejuvenated state capacity, believing that the state can solve key societal challenges, such as the climate crisis, through investing in large-scale research and development programmes akin to the American moon landing. This faith in emerging tech and belief in focusing on long-term goals have become central to how some scholars and many policymakers think about modern industrial strategy; indeed, they are key ways in which it is differentiated from older policy approaches. There is no doubt that the hollowed-out nature of the state will have to be reversed

[56] Kelsey, 'The retreat from 'high technology' in post-war Britain', *English Historical Review*, forthcoming.

if we are to tackle the complex policymaking challenges of the 21st century, and Mazzucato has done policymakers an important service by advocating for what the state can achieve and through shifting the conversation towards what sort of industrial strategy we should have, rather than whether we should have one. Nevertheless, the arguments at times can obscure a crucial point: that the realities of technological power matter.

One of Mazzaucato's key objectives is to write into American history its enthusiasm for state-led technological endeavour, against the standard image of it as the free-market nation. This is an important corrective, but the US was the technological superpower of the twentieth century. In 1960, the US accounted for 69% of global R&D, both public and private.[57] Thus, it is misleading to generalize from its case. As we see with the post-war United States, the nature of technological power is multifaceted and often self-reinforcing: it is partly about R&D spending, but it is also dependent on the size of the internal markets and maintaining large companies with global reach. The psychology of it is important too. It was politically easier for a country as powerful as the US, one that had actually achieved the 'moonshot', to scrap economically nonsensical schemes. It withdrew funding from its own supersonic transport programme in 1971. In contrast, Britain kept the Concorde programme going partly due to a sense that it was one of the few areas where the UK had a lead over the Americans. In 1974, Tony Benn told the Cabinet: 'Concorde is the only product Britain makes that is supremely better than anything else on offer in the world.'[58]

We need to continue to shift the conversation about R&D policy away from whether the state is effective towards understanding the circumstances of both success and failure in greater detail.[59] Although it is not well-known, the case of post-war Britain in fact illustrates the limits of techno-nationalist ambition with vivid clarity. Britain had an entrepreneurial state in the post-war decades, and indeed a mission economy, but – at least in the 'high technology' sphere – its entrepreneurialism failed and its missions were rightly abandoned. By the 1970s, Whitehall came to learn a difficult lesson: that Britain should no longer try to be *the* Science and Tech Superpower, creating the technological future for the rest of the world to buy. The more general point we take from this history is that it is hard for medium-sized countries to take on the global industrial leader in a key area of technological competition and win. Taking bets on controlling the technological future if you are an industrial superpower might be a reasonable strategy, but the far harder issue is what to do when powers are matched, and what medium-sized countries should do in a world of multiple technological superpowers.

It is striking that many of the organisational features that Mazzucato praises in NASA could be seen in the AEA in its heyday in the 1950s and 1960s. They were both lavishly funded, broadly independent from political oversight and had much room to experiment. Both had inspirational visions: one the 'moonshot', the other cheap, near-limitless electricity generation. Both shaped markets and worked alongside the private sector, doing fundamental design work in-house but relying on private contractors for construction. The core difference that dictated success in one case and failure in the other was not organisational but geopolitical: the US was racing against the Soviet Union, while Britain was seeking to challenge the US. To put it differently, a key determinant in whether any given country

[57] Paul Scharre, *Four Battlegrounds: power in the age of artificial intelligence* (New York, 2023), 38.
[58] National Archives, Kew, CAB 129/177/1, Tony Benn, 'Concorde', 22 May 1974.
[59] There has been movement towards this within the literature, which is noted within this recent literature review: Juhász R, Lane R, Rodrik D. 2023. The New Economics of Industrial Policy. Annu. Rev. Econ. 16: Submitted. DOI: https://doi.org/10.1146/annurev-economics-081023-024638.

wins a technological race is who you pick as your opponent. The AGR may well have been an export success if the Americans had not been in the race.

Moreover, spin-off benefits, a key argument that Mazzucato and others make for state R&D spending, are more difficult to identify outside the American case. If you are a medium-sized power with limited industrial resources, the opportunity costs of major programmes are more apparent. There was in fact a detailed British study from 1971 into the spin-off effects of both Concorde and the Advanced Passenger Train on the companies that built them and the wider supply chains, which conducted surveys with the businesses involved. It concluded that with Concorde, for the majority of companies involved, the work was of a straightforward type, not involving huge technical novelty. In general, it concluded that there is not enough robust evidence documenting the benefits of spin-off for it to be used as a justification for large projects.[60] The broader point is that with Concorde and the AGR, a generation of scientists and engineers worked on technological dead ends, a reality that the Treasury had long foreseen.

Understanding the great techno-nationalist schemes of post-war Britain also undermines a core cliché about the benefits of long-termism within policymaking: it these crucial cases long-term ambitions hampered, rather than supported, the nation's economy and industry. The investments in civil aviation and atomic energy were based on assumptions about what the world would look like decades into future, visions that never came to pass of supersonic transport replacing sub-sonics jets and fast breeders replacing thermal nuclear reactors and fossil fuels. The standard story is that the frequent changes of government made long-termism impossible. Yet, it was actually the very shifts between governments that kept these plans going. A re-elected Labour government in 1970 would have probably cancelled Concorde. Barbara Castle, when Secretary of State for Health and Social Service, wrote in her diary: 'Most of us agreed that it was politically not on to cancel before the Election, though the aim should be to cancel immediately after.'[61] The Conservatives may have switched to the PWR if they had won the 1974 general election. There were certainly key advocates for switching to American reactors within the Cabinet.[62] The key point is that the world of 'high technology' can change quickly, and it often requires a nimble response from government rather than a fixed long-term vision. For all the current pleas for more expertise within Whitehall, a state filled with technocrats who are keen advocates of national schemes can easily become lobbyists for yesterday's future. It took decades to reset the British state to adjust to its feasible technological place in the world.

Mazzucato appreciates that the 'moonshot' cannot be applied in all contexts at all times. Moreover, the idea of the 'mission' as a concept for policymakers is not just about technological endeavours, but any bold imitative that unites the public and private sectors in a common purpose. It is a framework that has been used in a wide range of issues, many quite removed from the very particular politics of technological races, from health inequalities to addressing the digital divide. Nevertheless, for Mazzucato, state-led innovation plays a central role in rewiring the state to achieve ambitious outcomes at a general level. What is striking about post-war Britain is how effective the state was in its more mundane work, rather than in the 'high technology' adventures. My claim is not a general argument

[60] Centre for the Study of Industrial Innovation, *Aspects of Spin Off: Study of the Impact of Concorde and the Advanced Passenger Train on their supplier-firms* (London, 1971).
[61] Barbara Castle, *The Castle Diaries 1964–70* (London, 1984), 738–9.
[62] Peter Walker, *Staying Power: An Autobiography* (London, 1991), 116–18.

against planning and investment for the long term by the state. The UK economy in the post-war period was transformed in positive ways through such work, in agriculture, roads, electricity supply, and very much else. It is a warning about betting on technological superiority, in particular, with its claims to transform the UK's export prospects as well as its geo-political position. It reinforces the calls for a politics of incremental improvement, not technological breakthroughs, when thinking about questions of industrial strategy and it is a reminder that political change does not need new technology, and that calling for new tech is often a way of keeping things the same.[63]

A final problem with the focus on national capacities, which gets so much of the policy attention within industrial strategy debates in the UK, is that it is distracting from the actual power dynamics that will unfold in the coming decades.[64] When it comes to technologies like artificial intelligence, we need to think about not only how governments interact with each other, but also about how governments interact with business, and specifically how they deal with American corporate power. The research and development importance of the big five American tech giants is staggering. In 2022, they poured $223bn into research and development.[65] Specifically in terms of AI, in 2022 the US attracted $47.4 billion of private investment, roughly 3.5 times that of China, and nearly half the global total.[66] The UK is a solid third place in the world for spending on AI research, but is dramatically behind the US. In 2022, it attracted a total of $4.37 billion in private investment, less than 10 per cent of the US total.[67] Moreover, the National AI Strategy claims the government invested a total of £2.3 billion in AI from 2014 to 2021, far less than the yearly total the private sector invested in 2022.[68] Thinking about these realities of political economy, it is clear that policies that promote competition within the 'tech giants' such as digital markets reform as well as technological collaboration with the United States are as important as any attempts to build national champions.

Lessons for policymaking

All of this raises the question, to what extent is Britain returning to the radical techno-nationalism of the 1950s and 1960s? The rhetoric of 'world beating' capabilities and the narrative of being a 'Science and Tech Superpower' mask what is a more nuanced and strategic approach. There is no attempt to bring back a role for the state as dominant as we saw in the immediate post-war period or to leapfrog the United States to technological glory. The Integrated Review suggests that the ambition of policy is to build on the UK's national strengths, especially in emerging technology, with a fuller awareness of the need to rigorously assess where Britain should pioneer its own breakthroughs, work with partners, and

[63] David Edgerton, *Shock of the Old: technology and global history since 1900* (Oxford, 2007), 210.
[64] There is of course a lot of work on industrial strategy that thinks beyond the national frame, including that of Mariana Mazzucato, who has done much to promote the need to regulate 'Big Tech', as well as helped shape policies across the European Union.
[65] 'Big tech and the pursuit of AI dominance', *The Economist*, https://www.economist.com/business/2023/03/26/big-tech-and-the-pursuit-of-ai-dominance, last accessed 13 September 2023.
[66] Nestor Maslej, Loredana Fattorini, Erik Brynjolfsson, John Etchemendy, Katrina Ligett, Terah Lyons, James Manyika, Helen Ngo, Juan Carlos Niebles, Vanessa Parli, Yoav Shoham, Russell Wald, Jack Clark, and Raymond Perrault, "The AI Index 2023 Annual Report," AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, April 2023, 189: https://aiindex.stanford.edu/wp-content/uploads/2023/04/HAI_AI-Index-Report_2023.pdf.
[67] Ibid.
[68] HM Government, National AI Strategy, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1020403/National_AI_Strategy_-_mobile_version_.pdf, 29 November 2023.

buy from abroad.[69] The recent Semiconductor Strategy is a good manifestation of this approach: it partly supports national strengths in chip design, while also strengthening key relationships with foreign suppliers, notably Japan.[70] While many of the lessons highlighted below are already appreciated in Whitehall, they still bear underlining, not least because the calls for more economic nationalism are becoming louder.

Culture

An important part of the political culture of the 1950s and 1960s Britain was a 'bi-partisan technological chauvinism': a deeply embedded sense of national inventive genius and faith in the capacity of the state to pioneer next-generation technological breakthroughs. The aim was to leapfrog the United States to great commercial success. Broadly speaking, these efforts led not to export glory but to industrial calamity. Even if the systems for policymaking were better, it is possible that these policy errors – rooted in economic nationalism and an overestimation of relative technical genius arising from pioneering in both fields – would have still occurred. Until the 1970s, both the internal and public critics of such efforts were ignored. An ideological faith in techno-nationalism blinded both ministers and public commentators to these well-founded warnings. It must be remembered that an overestimation of national strength can leave the nation weaker and that buying key technologies from allies can often be the best strategy for both economic prosperity and national security.

Business

The British case underlines that predominately state-led endeavour in 'high technology' can easily harbour technocratic dreams divorced from commercial realities and industrial benefits. It is striking that the origins of both Concorde and the AGR lay in state laboratories. The aviation industry, then not nationalised, was in fact at first resistant to commercial supersonic airliners, doubting their profitability. The nuclear power plant industry, which was also in private hands, was increasingly hostile to British-designed nuclear reactors, understanding that building American designs under licence was the only way to sustain the industry. The broader point is that governments need to work with markets and private industry to create a successful industrial strategy.

Coalitions

From the late 1950s into the 1970s, there was a slow, complex but important transformation in Britain's industrial strategy. It became accepted that the nation could only maintain its technological advantages through partnering with other countries. There was a shift towards procuring more American-designed weapons. It is imperative, especially now that Britain is relatively weaker in technological terms, that the British state continues to recognise the limits of economic nationalism, particularly in 'high technology' investment. There is a longstanding and well-made critique of Britain's collaborations in Europe, suggesting that they are more likely to favour producers over consumers, with

[69] Cabinet Office, *Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy*, https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy, last accessed 8 August 2023.
[70] Department for Science, Innovation and Technology, National Semiconductor Strategy, https://www.gov.uk/government/publications/national-semiconductor-strategy, last accessed 26 September 2023.

work allocated by ministers, officials, and lobby groups.[71] Concorde stands as a testament to such criticism. The United States and Japan have long been natural partners for Britain's aviation industry. More generally, the UK needs to continue to work with allies to secure and maintain its competitive advantages. While AUKUS is best known as a nuclear submarine deal with the US, UK, and Australia, it is also a broader technology-sharing pact in which AI is a crucial component. It is precisely the sort of alliance Britain needs to establish and deepen.

Information and people

Generalists are widely criticised today, with the claim made that Whitehall needs more technically trained experts. This may well be true, but expert capture needs to be avoided as much as amateurism. Concorde and the AGR occurred partly because the internal proponents of these programmes, usually state engineers, had much influence over ministerial advice. They serve as a warning of the dangers of putting the experts in charge of the policy areas in which they are technically expert. The state engineers had a disproportionate belief in the transformative impact of these programmes and a clear interest in selling their political and economic importance. Another core issue was that the critics of these programmes within the departments were often ignored and their scepticism rarely found its way into Cabinet memorandum. Indeed, my argument is not against experts at a general level: it was often specialists of various kinds, especially economists and scientists, who were the important critics of the great techno-nationalist programmes. All of this highlights the need to break down departmental siloes and ensure that a diversity of expertise is used in the production of policy advice.

Systems

With this in mind, it is vital to have systems in place that can avoid vested interests dominating the policymaking process and can help to make hard-headed strategic decisions. The Central Policy Review Staff (CPRS), established by the Heath government in 1971 and closed down under Thatcher in 1983, is a case in point. It provided cross-departmental advice to the Cabinet, thinking about policy issues in the round. It was particularly successful in producing effective advice in matters of industrial strategy, not least because it did not have the same close connections to vested interests that defined the departmental relationships. When devising industrial strategy, in particular, it is imperative to think across economics, national security, and foreign policy. As I will detail alongside Rosa Hodgkin in an upcoming paper, the government should consider the case for establishing a central analysis and assessment function to consider cross-cutting policy issues. Given the nature of the challenges that the UK faces in the coming decades, questions of economic security and industrial strategy would naturally be a central aspect of its work.[72]

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[71] Douglas Dosser, David Gowland, and Keith Hartley, *The Collaboration of Nations: a study of European economic policy* (Oxford, 1982). Also see Keith Hartley, *The Economics of Defence Policy: a new perspective* (London, 1995).

[72] Rosa Hodgkin and Tom Kelsey, forthcoming.

Conclusion

When it comes to decisions in 'high technology', the stakes are higher now than they were during the Cold War. Technological dominance has been central to the practice of Western power in the twentieth and twenty-first centuries. Yet, the United States now faces a rival in China that could plausibly outclass it in technological terms in the coming decades. Working out how we can avoid an unproductive techno-nationalist race among allies, while also maintaining the benefits of competition central to capitalism, is crucial to ensuring that our technological future will be built by democracies for democratic purposes. In order to do this, we need to maintain our critical faculties when thinking about technology policy, ensuring we are aware of the drawbacks of economic nationalism and techno-optimism. While no doubt we do need to rebuild state capacity in the UK and other liberal democracies too, we cannot forget the centrality of international business and the need to work with our allies in creating the technological future. It is important to remember that techno-nationalism, with its powerful lure of national control and industrial strength, can make a nation weaker and less secure.

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