University of Reading

United Kingdom Defence Industrial Strategy: 1998-2023

Doctor of Philosophy

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Declaration:

I confirm that this is my own work and the use of all material from other sources have been properly and fully acknowledged.

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Abstract

This thesis sets out to investigate the role and effectiveness of defence industrial strategy (DIS) in addressing the performance shortfall in defence aerospace procurement projects and in securing the sustainability of the defence industrial base. In so doing, it assesses whether DIS successfully provided an equilibrium in the strategic triad of ends, ways and means. To this end, it offers an account of the main characteristics of the three versions of DIS (2005, 2022 and 2021) and their reception. It explores the topic further through three deliberately varied case studies on procurement - the Wildcat helicopter, the Crowsnest airborne radar and the Protector drone - and through twenty semi-structured elite interviews with both industrialists and civil servants.

In conclusion, the research identified shortcomings in the formulation of DIS in the treatment of sovereign capability and operational independence, future technology requirements and the optimisation of the routes to contract. It also assessed that significant barriers to implementation arose because DIS objectives were not harmonised with the funding available in the equipment plan, rendering the strategies implausible through a lack of equilibrium between ends, ways and means. In addition, the delivery organisation's structure militated against the adoption of strategic change and, despite the move towards partnerships, the long tradition of competitive procurement undermined harmonious relationships between MOD and industry. DIS has therefore had minimal impact on aerospace project performance. Industrial sustainability also received inadequate attention until the creation of sector strategies, and the reorientation to a more interventionist approach in DSIS 2021. The thesis recommends that a future DIS should be wider in scope and be subject to full cross-government endorsement if it is to deliver change and enhance the credibility aspect of the UK's deterrence posture.

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Chapter 1 – Introduction

> *Viewed through the lens of deterrence, seeming weakness could have the same consequences as an actual deficiency. (Henry Kissinger, 2021).*

The problem

In mid-2023, the House of Commons Defence Committee published an excoriating report on the UK's Defence procurement system, entitled, *It is broke – and it's time to fix it* (Parliament, House of Commons, 2023a). It is rare that a Parliamentary select committee should adopt such a populist tone. Weeks later, the Defence Committee released a further report with an equally acerbic title, *Aviation Procurement: Winging it?* (Parliament, House of Commons, 2023b). Yet more strident criticism was heaped upon allegedly perverse Ministry of Defence (MOD) decision-making on reducing combat air fleet sizes, particularly over seeking to save money by generating gaps in key capabilities and extending procurement timescales. The nature of both reports was consistent with the findings of a 2021 Public Accounts Committee inquiry into defence contracting which concluded:

> The Ministry of Defence (the Department) has been managing suppliers and delivering military equipment programmes critical to our national security for decades. There have been numerous reviews of defence procurement over the past 35 years, which have provided the Department with opportunities to take stock and learn from experience. We are therefore extremely disappointed and frustrated by the continued poor track record of the Department and its suppliers - including significant net delays of 21 years across the programmes most recently examined by the National Audit Office - and by wastage of taxpayers' money running into the billions. (Parliament, House of Commons, 2021a, p.3).

This situation is a matter of public policy concern for two reasons. First, a threat from a potential adversary consists of a combination of capability and intentions. Deterring that threat requires a combination of capability and credibility, accompanied by the means to communicate the associated posture so that a potential adversary understands the risk associated with malign action (MOD, 2019a). Inadequate management of defence resources, particularly in equipping the armed forces undermines that sense of credibility. Such equipment is termed 'tournament goods' by economists because it must have a winning edge in combat (a feature that drives higher development and production costs because of the need to stay abreast of the technological prowess of potential adversaries). Instances of inadequate project management and poor financial

stewardship also undermine military capability by delivering equipment late or in reduced quantities as an economy measure to stay within budget. Secondly, such performance adversely affects the reputation of the MOD as a reliable steward of public money. The 10-year rolling equipment budget in the period 2022-32 was set at £242 billion, split about equally between the cost of procuring new equipment and the support of in-service capability. This represents 46% of the entire defence budget and covers some 1800 projects (MOD, 2022a). A decade earlier, the 2012 equipment budget was set at £160 billion (MOD, 2012a). Inadequate management at these high levels of expenditure make it harder to broker future resources with the Treasury. In parallel, failure in the wider machinery of government to achieve value for money weakens public trust causing the general competence of government to be questioned. In addition, the defence industry sees financial uncertainty as undermining the MOD's competence as a customer which generates doubts over the department's reliability in maintaining its requirements throughout the life of a contract. This reputational aspect is reflected in industry's negotiations on terms and conditions as a 'risk to completion' when dealing with MOD.

Defence equipment procurement is a challenging task. It is not amenable to the application of a simple market-driven supply and demand model given the bespoke nature of the product, limited customer base and concerns over security of supply. Defence projects frequently take a decade to reach the production stage with the equipment concerned likely to have a service life of up to 30 years. Successive government investigations into defence procurement dating back to the 1961 Gibb-Zuckerman Report have resulted in a range of mostly bottom-up change programmes but few have yielded consistent improvement (Brooke-Holland, 2019). Within MOD, systemic limitations to procurement reform arise because these bottom-up approaches are applied tactically to customer-side processes. Thus, wholesale change is slow to take root, and initiatives are rarely agile enough to account for rapid variations in the operational, technological and industrial contexts in which defence procurement operates. Reflecting on this track-record, McInnes (1998) suggested that "efficient defence procurement is the philosopher's stone of defence policy" (McInnes, 1998, p.843). Despite the imperfect nature of the market as a monopsony with few suppliers and high barriers to entry, governments should have considerable power over the market through their contracting behaviour and should therefore be able to influence the characteristics and ownership of the indigenous industrial base (Hartley,1998). In so doing, governments will need to recognise the role of the defence industrial base in underpinning both the capability and credibility elements of deterrence. Governments therefore attempt to incentivise firms to participate in their domestic defence market through the publication of their defence industrial policy (DIP) and supporting defence industrial strategy (DIS) which together represent top-down guidance on the preferred market characteristics.

The object of the thesis

In seeking to understand the problem and propose solutions, this thesis investigates the role and effectiveness of DIS in addressing the performance shortfalls in defence equipment projects and its impact on the sustainability of the defence industrial base. To be effective, a strategy needs to generate an equilibrium between 'ends' (the objectives to be achieved) with the 'ways' (how they will be achieved) and the 'means' (the resources required to achieve them). This research recognises the 1998 Strategic Defence Review (MOD, 1998a) as a partial precursor to the subsequent introduction of DIS. It had significance as the first post-Cold War analysis of the future requirements for industrial capacity. Its two supporting essays on industry and technology contained important policy aspects. On the former, it placed strong emphasis on the previously announced Smart Procurement Initiative as the tool by which to meet the aspiration for a 'faster-cheaper-better' approach to procurement processes (MOD, 1998a, Essay 10, para. 151-161). On the latter, it stressed the probability that future coalition operations would be US-led with the need for the UK to retain a "decisive technological edge over any potential opponent … based on high but proven technology" (MOD, 1998a, Essay 3, paras.2 and 8-10). SDR 1998 is thus a baseline from which to analyse the formulation of the three successive editions of DIS in 2005, 2012 and 2021, and assess whether they achieved an equilibrium between 'ends', 'ways' and 'means.' In seeking examples, it places particular emphasis on defence aerospace projects which, given their complexity, tend to expose any shortcomings in project management. In terms of procurement outcomes, the research focuses on cost and time. The classified performance aspect of adherence to equipment specification is not available in the public domain. Prior to 2016, the MOD published performance against about ten high-level Key User Requirements (KUR) associated with each project. Reported performance varied between 98% and 100% which, given that KURs are very broad-brush in nature, reveals little about project performance. Subsequently, KUR's have been reported only by exception in MOD's annual reports to the Infrastructure Projects Authority (IPA). Equally, judgements on through-life costs are problematic given the lack of publicly available data and the large swings in support costs occasioned by changes in platform off-take numbers, mid-life capability updates and contractorization of support. These factors combine to render initial estimates of through-life costs at project initiation of limited value when seeking to construct a common baseline by which to compare project management performance across the procurement portfolio.

Each issue of DIS approached the subject in different ways but maintained the common characteristics of addressing sovereign capability, future technologies and routes to contract. Nevertheless, DIS 2012 was deemed by critical commentators (Including the Defence Select Committee) not to represent a DIS for two reasons: the text studiously avoided the term 'Defence Industrial Strategy' and also narrowed the options for routes to contract solely to "open competition on the domestic and global markets" (MOD, 2012b, p.6). In responding to the Defence Select Committee, the Government refuted these assertions with the statement:

> The Government rejects the Committee's conclusion that the UK lacks a defence industrial strategy. The National Security through Technology White Paper, published in February 2012, replaced the Defence Industrial Strategy (DIS) 2005 and Defence Technology Strategy 2006, and sets out our approach to purchasing equipment, support and technology for the UK Armed Forces (Parliament, House of Commons, 2013c. p.4).

In terms of aerospace projects, there were twelve 'classic' aircraft procurements across the period of this research which are listed at Appendix A to this chapter. That number excludes follow-on buys of the same aircraft (Chinook), major capability sustainment upgrades (Apache) and those procured through the UOR process (Predator). These classic programmes covered three fast-jets, two transport aircraft, one tanker, one helicopter and five ISTAR[1] platforms. Six requirements were met through the US government-to-government Foreign Military Sales (FMS) scheme with five as single-source procurements and one subject to competition. Two were European collaborations involving single-source procurement and one was acquired through a Private Finance Initiative. Three were procured through UK-based primes, two as single-source contracts with the other, which was subsequently cancelled, resulting from a competition. In terms of performance, four exceeded their approved cost by greater than five per cent and seven were more than 6 months late on delivery. Among these delayed projects, three were the result of broader equipment plan affordability issues. Six projects resulted in mid-project reductions in numbers. Four projects stand out for the extent of their combined cost growth, delivery delay and reduction in numbers: Typhoon; Nimrod MRA4; and A-400M.

As for broader procurement performance, an NAO study in 2021 examined 12 major projects that had completed the assessment phase which is the process between the Initial Gate investment to the Main Gate approval for full project investment. The cohort included Protector where cost grew by 74% between the two gates, and the P-8A Poseidon maritime patrol aircraft. As an off-the-shelf

[1] intelligence, surveillance, target acquisition, and reconnaissance.

purchase through the US government-to-government FMS system, Poseidon saw an 11% reduction in cost having reduced the quantity of aircraft from twelve to nine (NAO, 2021a, p.25, fig.4). Across the twelve projects considered by the NAO, nine saw forecast cost growth during the Assessment Phase before main gate with three exhibiting cost growth between 59% and 74% (NAO, 2021a, p.24). As a result, the MOD could be committed to projects within the equipment plan "before the true costs become clear" (NAO, 2021a, p.24). "This is not solely a UK problem. The NAO's US counterpart, the General Accountability Office (GAO), drew similar conclusions about the Pentagon's procurement performance in its 2010 report to Congressional Committees (GAO, 2010). The report made specific recommendations on lack of adherence to the 'knowledge-based acquisition approach' pointing-out that "Achieving the right knowledge at the right time enables leadership to make informed decisions about when and how best to move into various acquisition phases. In essence, knowledge supplants risk over time" (GAO, 2010, p.10)."

From the perspective of DIS, two procurement process issues emerge. First, unforeseen technical integration or manufacturing issues might arise in these complex programmes, and in others collaboration could slow progress. Secondly, it is also clear that inaccurate initial forecasts of cost and time have distorted the performance picture. This aspect greatly adds to the challenge of financial management of the equipment plan leading to delay at best and a reduction in project platform numbers at worst. It also undermines the accuracy of assessments on value for money made at the Main Gate approval. The research therefore seeks to analyse the extent to which the three successive versions of DIS (2005, 2012, 2021) have been formulated and then successfully deployed to address these performance shortcomings. The analysis also draws on procurement policy developments in the years before the 1998 Strategic Defence Review such as the those related to the 1985 Levene review when competitive tendering became embedded in procurement practice. Likewise, the impact of DSIS 2021 is analysed in subsequent government documents published before mid-2025. This leads to the research question:

> ***Why have the MOD's three defence industrial strategies produced in the period 1998-2023 not yielded greater improvement in the delivery of UK defence aerospace projects to time, and cost, and what has been their impact on the sustainability of the defence industrial base? What changes need to be made to the formulation and deployment of defence industrial strategies to generate improved outcomes?***

Beneath this question, there are four suggested explanations for the imperfections in deployment of a DIS. First, the structure of the delivery organisation, Defence Equipment and Support (DE&S), could be significant in creating barriers to the implementation of strategy. Secondly, its

organisational culture could generate human behaviours related to perceptions on uncertainty and risk that might limit acceptance of change. Thirdly, the strategy itself might fail to provide a compelling route-map of 'ways' by which to achieve the selected 'ends' or objectives. It would thus lack credibility, undermine effective deployment and fail to get traction across the defence equipment enterprise where the time-consuming minutiae of contract negotiations take precedence. Fourthly, the 'means' in terms of the size, profile and stability of the equipment budget might render the strategy unaffordable and thus fail to incentivise industry to respond positively to the strategy's objectives. There are two potential causes for such instability: it could arise externally from adverse changes in the macro-economic environment requiring reductions in public expenditure and, internally, from inadequate MOD financial control. This latter aspect arises mainly where poor project management leads to expensive cost overruns, or worse, to project failure. Such events would call for significant budgetary reprioritisation. It is also possible that elements of all these aspects might be at play simultaneously such that the strategy's goals become unattainable. To set the framework for the research, the literature review (Chapter 2) explores the UK's track record on applying broader industrial strategy before seeking to identify the existing schools of thought around each of these themes in the narrower application of DIS. Of note, little has been published on DIS from the perspective of industry.

In Chapter 3, the thesis proposes a conceptual framework with which to understand the potential lack of traction of UK DIS across the defence equipment enterprise. Mintzberg's work on organisational structures provides a useful framework by which to understand how barriers could arise that suppress the deployment of strategy within DE&S as the delivery organisation. Mintzberg's typology would consider DE&S as a machine organisation given its characteristics as an "Integrated, regulated and highly bureaucratic" closed system with an intense control mentality in a bid to eliminate uncertainty and generate stability (Mintzberg, 1989, p. 133). This is a common structure in government activity where there is public accountability for the probity of their actions or a particular need for safety as a characteristic of the output. This approach also calls for a sizeable 'technostructure' by which to implement standardisation of process. The notion of technostructure first arises in Galbraith's study (1967) on the growth of large corporations in the post-war industrial era published in his book, *The New Industrial State*. He identifies that "the entrepreneur no longer exists as a single person" but is replaced by a cohort of managers who bring specialized knowledge, talent or experience to group decision-making. (Galbraith, 1967, p.79-80). This also aligns with Schumpeter's earlier view that early 20th century industrial mechanisation meant that innovation and "technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways" (Schumpeter, 1942, p. 117-118). To Galbraith, the concept of technostructure emerges from three aspects of developed

organisations: personnel specialisation; the planning required for capital investment in advanced technology; and coordination through the fusion of information (Galbraith, 1967, pp. 70-72). The complexity of the technological requirements inherent in delivering an organisation's output therefore requires the collective, deep expertise of a cohort of specialist individuals. In a manufacturing business, this group would cover disciplines such as engineering, production control, supply chain logistics, finance and marketing. In a public sector procurement agency, the same skills are applied to assessing emerging technology, setting contract requirements, assessing bids and managing projects but defence acquisition involves very high levels of complexity. Combat equipment invariably requires the integration of a system of systems with individual elements at varying levels of technological and engineering maturity. Such activity is also overlaid with public sector governance and the need to adhere to the strictures of financial control and risk management. Trade-offs are inevitable and the process relies on near constant decision-making at a variety of levels on a plethora of topics from the mundane to the strategic. In common with other machine organisations, this means that much of the effective power of decision-making is held deep in these organisations rather than exclusively by managers. As such, the technostructure operates with a high degree of autonomy given that "the complexity of modern technological and planning decisions also protects the technostructure from outside interference" (Galbraith, 1967, p. 89). The sustainability of a firm's technostructure depends on the continuing need to transform novel technology into products or services that meet market demand thus contributing to corporate growth. Stability in demand is thus a vital criterion for an effectively functioning technostructure. In a defence aerospace firm, the technostructure is critical in meeting the armed force's capability requirements. In so doing, it generates valuable intellectual property which contributes to defence capability goals. According to Galbraith:

> This leads the technostructure to identify itself closely with the goals of the armed services and, not, infrequently, with the specific goals of the particular service, Army, Navy or Air Force which it most intimately serves. … Its members develop the same commitment to these goals as do officers of the services (Galbraith, 1967, p. 314).

Some of Galbraith's work might appear dated and *The New Industrial State* has since had its detractors among academics who regarded his populist views to be at variance with economic theory. Krugman (1994) opines that the book "could safely be ignored" (Krugman, 1994, p.13). Sollow (1995) took a similar line over Galbraith's assertion on the invulnerability of large corporations and their ability to control their markets. In support, he cites the subsequent insolvency of major firms ranging from Pan American to the Chrysler Corporation (Sollow, 1995, p. 66). Nevertheless, Galbraith's concern over the market power of large industrial corporations

continues to have resonance with the defence industrial complex of today. Mintzberg paid particular attention to the way in which highly standardised machine organisations adapt to and absorb new strategies, concluding that there are inherent systemic barriers. Determining the effectiveness of industrial intervention by government in these circumstances leads to consideration of Gansler's theory of 'second best.' This theory acknowledges that the varying characteristics of the sectors of the economy means that each "must be treated as a special case" (Gansler, 1987, p. 48). Despite the imperfect nature of the defence market, the 1985 Levene reforms meant that competitive procurement decisions were left to market forces in the pursuit of a 'first best solution'. The alternative of a partnership approach with industry (a second best solution) started to emerge in SDR 1998 but only in limited circumstances with competitive procurement remaining as the bedrock. While DIS 2012 strongly promoted competition, it was progressively misaligned with the texture of the changed procurement approaches. A higher proportion of contracts were being let on a single-source basis with the use of industrial partnering to provide through-life support. These changes in market characteristics were recognised in DSIS 2021 which stated that "we are replacing 'global competition by default' with a more flexible and nuanced approach" (HMG, 2021a, p.6).

On human behaviours, the work on cognitive biases by Kahneman, Tversky and Arrow provide the basis for Flyvbjerg's subsequent work on behavioural biases in project management. Applying Flyvbjerg's approach to defence equipment procurement reveals that true optimism bias is just one of the components leading to poor project forecasting. Strategic misrepresentation, planning fallacy and overconfidence bias are also factors that influence the procurement process (Flyvbjerg, 2021, p.532). Their impact can be reduced by the application of Reference Class Forecasting which looks outwards for statistical analysis of risks for similar projects beyond the UK defence enterprise. Although recognised in the UK defence procurement process, the technique has not been fully embraced. Rather, it relies on the application of broad-brush comparators using data collected in 2002 which is no longer representative of modern integrated systems (Mott MacDonald, 2002, pp.46-48).

Chapters 4 and 5 then analyses successive editions of DIS to determine the rationale and realism of their component elements in achieving the stated objectives. In so doing, the strategies are judged on whether they contain appropriate incentives to industry to participate in the UK defence market. They are also assessed for coherence with the prevailing financial conditions at the time of publication, particularly against the resources available in the current ten-year equipment plan. The analysis also considers the implications for the sustainability of the UK defence industrial base and their overall impact of DIS on the credibility element of the deterrence equation. The initial findings

are then triangulated against three aerospace case studies in Chapter 6 and twenty elite interviews in Chapter 7. The case studies were selected for their complexity, variations in procurement strategy, and representation across the period of the research from 1998 to 2023. The analysis pays particular attention to the way in which the combined impact of financial constraints, dependencies on other projects and imperfections in project management impede the implementation of DIS. Chapter 7 reports the findings of the interviews of senior MOD officials and CEO-level industrialists, paying particular attention to economic and cultural aspects. In Chapter 8, the resulting data are then applied to exploring the hypotheses underpinning this research as follows:

a. **Theme one: DIS conceptual approach**

(1) Defence industrial strategies that focus their ambition on high-level, long-term partnering relationships with industry are more likely to yield improved project performance than those that seek solely to define transactional processes.

(2) Defence industrial strategies that seek to develop soft partnerships based on framework agreements with potential suppliers are likely to be more effective in achieving operational independence and in enhancing the sustainability of the defence industrial base than those that rely on the uncertain outcomes of competitive contracts.

b. **Theme two: process management gaps in DIS**

(3) Improvements to individual project outcomes are more likely to result from defence industrial strategies that require the procurement process to take a systematic approach to the identification and eradication of optimism bias.

(4) Improvements to overall procurement performance are unlikely to arise unless the ambition in defence industrial strategies is more tightly aligned with the resources likely to be available in the forward defence budget.

The UK defence industrial environment before DIS

Most defence companies continued as nationalised entities in the years after World War 2. At that stage, procurement was in the hands of the armed services and the Ministry of Supply whose studies found “that on average actual costs were 2.8 times those forecast” (Parliament, House of Commons, 1998, Col 305). The early years of the Cold War saw a growth in the need to integrate new technologies into defence equipment to stay ahead of the threat. Given the unfamiliarity with the systems integration challenge, this led to an approach of proceeding to production despite the level of risk and in the face of constant changes in specification. (MOD, 1998a, Essay 10, para.15).

To address these shortcomings, the 1961 Gibb-Zuckerman Report emerged from the Committee on the Management and Control of R&D aimed at establishing a standardised process in major project procurement based on a range of fixed milestones with proof of completion required before seeking approval to proceed to the next. The first element of the process was to establish a formal Staff Target to define the capability required which was broadly equivalent to today's User Requirement Document. Next, a feasibility study was required to determine the technological and engineering challenges involved. The data emerging would be used to refine the Staff Target as the third milestone in terms of design, performance and capability. A Project Study would follow (equivalent to today's Assessment Phase) to resolve the risks and determine in detail the development work required, its costs and timescale. The final Full Development phase was the fifth milestone and was aimed at producing a production-ready design validated through trials (Parliament, House of Commons, 1998, Col 306).

However, the Gibb-Zuckerman was only partially effective in addressing cost overruns so the 1968 Downey Report from the MOD's Steering Group on Development Cost Estimates recommended amendments. Prime among these was to replace the Project Study phase with a more detailed Project Definition phase which, with an investment of some 15% of project costs, such that "Full Development could be launched with confidence that projects would meet performance, cost and timescale targets" (Parliament, House of Commons, 1998, Col 306). The Downey Report also identified the need for more rigour in ensuring that each phase of the cycle had been fully completed before proceeding. Neither set of recommendations in these two reports were fully implemented. Thereafter, Cold War procurement was increasingly threat-driven as the technological arms race took hold. Costs continued to rise, and delays increased as unfamiliar problems arose in integrating novel technology (Parliament, House of Commons, 1998, Col 308). In considering the 1975 Statement on the Defence Estimates and mindful of the increasing cost of some equipment projects, the Commons Expenditure Committee urged the MoD:

> … to review its philosophy in regard to procurement and consider particularly whether the high standards of equipment, demanded by operational requirements and specifications, could be lowered slightly in the interests of earlier introduction of equipment, lower cost and improved prospects for collaboration (Parliament, House of Commons, 1975, para. 28).

At that stage, UK defence expenditure was 5% of GDP compared with that of France and Germany of 3.8% and 4.1% respectively (Brooke-Holland et al, 2024a, p.15, fn.17). However, given that most defence procurement then involved onshore UK firms, DIS was not then seen as a necessary tool

by which to configure either the market or the industrial base. Rather, where necessary any such aspects were conveyed in the annual defence estimates, periodic defence reviews or indirectly through project cancellations contained in the annual Statement on the Defence Estimates.

Procurement in the 1980s was increasingly dominated by the free market doctrine of the Thatcher government which did not recognise a role for DIS. The first Levene review in 1985 addressed the continuing major deficiencies in defence equipment procurement through a significant reform process which sought to apply the commercial approach inherent in free market doctrine (Bell, 2000). This entailed two primary initiatives: the application of competitive tendering to incentivise firms to improve efficiency and thus reduce costs: and the replacement of cost-plus contracts, which at the time were the norm, with fixed-price contracts based on milestone payments thus incentivising firms to enhance project delivery performance (Bell, 2000, p 30). Where a competitive approach was deemed implausible, an initiative known as NAPNOC ('No Acceptable Price, No Contract') would apply (Bell, 2000). In these circumstances three contracting principles applied: pricing at the outset; benchmarking against a 'should cost' market price; and the ability for a firm to improve profitability through innovation (NAO, 2001a, p.2, para. 5). In the ten years after its introduction in 1992, NAPNOC applied to 1850 contracts at a value of £25 billion (NAO, 2001a, p.2, para.5), an aspect that was set to grow to 50% of all contracts by 2015 as single-source procurement became more routine in MOD (Brooke-Holland, 2024b). To enable the Levene reforms, for each major project, a single prime contractor was appointed to act as the integrator and the coordinator of the activities of the sub-contractors in the supply chain. Taken together, the overall objective was to transfer to industry appropriate levels of risk on performance, cost and time. This was seen as placing risk in the hands of those best able to manage it. It was also seen as reducing MOD's management overhead (NAO, 1994). The reforms also advanced the notion that there was no requirement for a defence industrial policy or an explicit intention to support the UK defence industry (Macdonald, 1999, p.18). The reforms were thus deeply unpopular with industry which also regarded both the pricing process and the associated terms and conditions to be punitive but:

> .. the unhappiness of industry was part of the appeal of the new policy; its confrontational style – sometimes euphemistically described as 'creative tension' - was very much in the spirit of the times: 'no gain without pain' (Bell, 2000, p.31).

As Macdonald (1999) also points out

> One consequence of this change of attitude, however, was the MoD's lack of understanding of industry in the late 1980s. There was also a decline in mutual co-

> operation as civil servants adopted more hostile attitudes during contract negotiations in order to secure the lowest prices possible (MacDonald, 1999, p.18).

The Levene reforms thus represented a cultural transformation across the MOD's procurement organisation. The department was previously accused of a perceived cosy relationship with industry based on the extensive use of cost-plus contracting which provides suppliers with limited performance incentive. Schofield more accurately described the relationship:

> Yet, there was a mutual interest that the provision of complex weapon systems continued in a secure manner. Cost-plus undoubtedly led to inefficiencies, but the MoD built a strong framework of institutional support which helped sustain an indigenous technological and industrial capability across a wide range of military requirements (Schofield, 1995, pp. 161-2).

Kennedy's (1999) more acerbic interpretation also has merit:

> The so-called 'cosy'· relationship between MoD and its main suppliers was in practice a highly regimented relationship largely based on mutual suspicion - what is a contract but a written statement of the distrust each party has of the other? (Kennedy, 1999, p.49).

Clearly, the notion of competition whether as 'creative tension', 'confrontational style', 'hostility' or simply 'mutual suspicion' became deeply embedded and continues to endure as this research will demonstrate.

Deriving policy and strategy in defence

An effective DIS needs to be coherent with the nation's prevailing defence and security policy objectives. These objectives are refreshed periodically through strategic defence reviews or through more constrained assessments aimed at responding to partial changes in the threat landscape or financial context. Following the 1998 SDR, major reviews took place in 2010, 2015 and 2021 with a subsequent modest update in 2023. Each of these took account of significant changes in the global security context and the associated prevailing threats to national interests. As the first post-Cold War strategic defence review, SDR 1998 determined that Russia was no longer a threat but recognised that the experience of the previous decade underlined the need for an expeditionary force posture. Following the 9/11 terrorist attacks in the US, continuing peace support operations in the Balkans gave way to combat operations in Iraq and Afghanistan followed in each case by an extended period of counterinsurgency activity. In parallel, regional conflict in

Libya and Syria saw significant UK involvement. By 2022, the Russian invasion of Ukraine presented the risk of a return to peer-on-peer conflict leading to further NATO enlargement with a renewed focus on Alliance capability and readiness. Simmering tension between the US and China also began to grow. Against this backdrop, the UK economy was performing well until the 2008 global financial crisis but thereafter public expenditure was under pressure throughout the subsequent years of austerity. Further sluggish growth and high inflation followed the shock of Covid 19.

In arriving at a series of policy objectives, successive defence reviews attempt to calibrate the required response, particularly in terms of force structure, according to the available financial resources. The resulting objectives together represent the UK's defence posture and thus define the required readiness levels and force structure that might require the procurement of new equipment and the retirement of legacy systems. Post-Cold War defence policies have also tended to include soft defence measures aimed at conflict prevention through initiatives such as the deployment of military training teams and specialist advisers, and joint exercising with non-traditional partners. As such, the policy objectives represent a statement of intent which is implemented through defence strategy (MOD, 2022b). In essence strategy might be seen as "the bridge that relates military power to political purpose" (Gray, C., 1999, p.17) or, as Porter (2010) writes, that strategy is given substance through the alignment of "power, commitment and national interest to political realities" (Porter, 2010, p.11). Political reality and economic pragmatism are key areas in conducting defence reviews. Across the period of this research, defence policy has displayed continuity in four areas: the centrality of the nuclear deterrent; solid membership of NATO; the need to adapt to growing funding limitations; and, in the face of unpredictable threats, the need to maintain a high-readiness force structure with full spectrum capability. In parallel, technology has brought increased lethality to weapon systems leading to reductions in platform numbers as each generation of equipment comes into service with commensurate reductions in combat mass in that one platform can only be at one place at any one time (Durham, 2023).

Periodic strategic defence reviews seek to balance often conflicting requirements in determining the required policy 'ends' or objectives but often stand accused of being finance-led rather than strategy-led (Chisnall, 2010; Brooke-Holland et al, 2024a; Jessett et al, 2020). As for their effectiveness, as an academic study, three former senior MOD civil servants created a framework which contained five tests: accuracy of threat assessment and validity of the policy response; success of the subsequent defence planning response; selection of appropriate capabilities and force structures; balance between policy, commitments and budget; and the impact on efficiency and effectiveness of the changes to the management of defence (Jessett et al, 2020). Applied to the reviews since 1998, the study deemed four of the criteria to have been consistently met but

determined that none of the pre-2021 reviews resulted in a fully funded force structure requiring MOD to manage the financial gap on an annual basis (the fourth test). This situation has been "a major preoccupation for the senior MoD team for much of the post-Cold War period, slowing the modernisation of the armed forces and adversely affecting operational activity levels and training" (Jessett et al, 2020, p.viii). Given near constant budgetary turbulence, industry has therefore learned to be circumspect over MOD's programme predictions with a consequent dilution of mutual trust. There was also a recognition that the suite of three papers constituting the 2021 Integrated Review was over-zealous in their approach given that "they were crammed with commitments – anecdotally they added up to more than 250 in total" (Jessett et al, 2023, p.3). Again, such an approach raises suspicions in industry that MOD would not have the capacity to deliver such an array which further attenuates confidence. However, the relationship between government and the defence industry is not solely governed by the transactional nature of contracting. Rather, government and their ministries of defence have roles beyond that of customers in that they also function as regulators and sponsors. (Heidenkamp et al, 2013). As regulator, a government applies constraints in areas such as security of information, export control and single source-pricing. As sponsor, governments provide supply-side resources such as skilled and educated people, bespoke infrastructure and research funding. But they also provide ministerial and diplomatic support to exports, particularly where valuable security policy relationships with potential allies are concerned. These aspects need to be reflected both in defence industrial policy and its supporting DIS.

The characteristics of DIS

A DIS seeks to orientate industry towards the military capability and preferred routes to contract that the MOD requires to meet its policy objectives on national defence and security. It is thus a self-standing, top-down approach aimed at achieving optimum alignment between customer and supplier. It also seeks to define a long-term framework for defence procurement which would lead to enhanced sustainability of the defence industrial base. In the UK, the provision of transparent information to both indigenous and offshore industry is intended to provide an incentive towards their participation in the domestic market with approaches that are harmonised towards UK requirements. As such, government decision-making on the content of a DIS is complex given that it needs to recognise that the few firms involved on the supply side are very large global companies which can exercise choice over the world markets in which they participate. As a former UK Minister of Defence Procurement put it: "Not surprisingly, and perhaps as a consequence, government policies relating to defence industry (if they exist at all) can seem somewhat contrived, ill-considered and contradictory" (Heidenkamp et al, 2013, p.1).

The terms 'industrial policy' and 'industrial strategy' are widely used interchangeably. For this research, the OECD definition of the former is adopted based on the work of Pack and Saagi (2006) and adapted by Warwick (2013):

> Industrial Policy is any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention. (Warwick, 2013, p. 16).

The supporting industrial strategy should realistically describe the implementation of policy through a range of defined objectives, targets and evaluation criteria with accompanying detail on resources and risk management (Warwick, 2013, p.16). To that end, Jacobs et al (2017) provide the definition of industrial strategy applicable to this research which pays particular attention to the significance for defence procurement of 'market conditions':

> The purpose-driven coordination by the state of its supply-side economic policies that relate to the productive capacity of the economy, and the market conditions in which investment and production occurs (Jacobs et al, 2017, p.2).

A DIS has its roots in the extant version of Defence Industrial Policy (DIP) as the 'ends' in the DIS strategy triad. SDR 1998 provided some of the elements of both a DIP and a DIS but a detailed policy was published in 2002. The policy focused on increased collaboration with industry through which to promote open and fair competition, achieve optimum value-for-money and coordination of R&D investment: partnering with industry was seen as an effective tool. It also considered that, with defence manufacturing fast becoming a global business, the definition of the UK defence industry should be agnostic towards offshore corporate ownership. Hence, critical factors would be "where the technology is created, where the skills and the intellectual property reside, where jobs are created and sustained, and where the investment is made" (MOD, 2002a, para.11). Of particular significance, it also recognised the tension that exists in procuring optimum capability for the armed forces through competitive processes whilst also seeking to sustain a viable onshore industrial base:

> The Government is responsible for providing the Armed Forces with high quality equipment at best value for money for the taxpayer. It is also firmly committed to the UK manufacturing sector, and to promoting a strong and competitive UK defence industry, bringing economic and technological benefits to the nation. The Government must take

> decisions within a policy framework that recognises the tensions between these two objectives (MOD, 2002a, p.3).

While the supply-side interventions are broadly common across the wider manufacturing industry, a DIS needs to take a different approach to 'market conditions' given the specific constraints that governments adopt in meeting their defence equipment requirements. These requirements flow from the defence posture and force structure articulated in the extant strategic defence review. In defence and security strategy, resources (the means) predominately embrace finance (the defence budget) and people, both military and civilian. These are the fundamental ingredients that act as the fuel by which to generate the 'ways' towards creating an appropriate force structure and the associated readiness levels. The 'ways' consist of tangible aspects such as training systems, fighting equipment, logistics and infrastructure which are blended with intangible aspects such as doctrine, information and organisation: brought together, these components are deemed to create military capability. This framework represents the Defence Lines of Development (DLODs) where capability is defined in UK doctrine as the nexus of training, equipment, personnel, infrastructure, doctrine, organisation, information and logistics (frequently abbreviated as TEPIDOIL) (Fisher, 2023). As well as imposing a discipline to recognise the full costs of a capability, the framework offers modest opportunities for trade-offs between the component elements of capability. Hence, decision-making about priorities and trade-offs bears heavily on the ultimate effectiveness of an industrial strategy. However, a DIS would not be convincing unless its ambitions are coherent with the financial resources available. Against this backdrop MOD needs to recognise two potential trade-offs. First, there is a trade-off between capability and cost such that, while exquisite technology might be highly desirable, it could be unaffordable given the financial resources available. Secondly, there is a trade-off between the outcome of procurement decisions and the sustainability of the indigenous defence industrial base. All these factors combine to form a component of perceived national credibility in the deterrence equation.

In conveying the MOD's intent on future capability and industrial capacity, SDR 1998 set a baseline but was not a full DIS, unlike those published in 2005, 2012 and 2021. In terms of the required components, there is common ground across these latter three publications. Prime amongst these components are the linked concepts of sovereign capability and operational independence albeit expressed in variable language. Thereafter, a comprehensive DIS needs to describe the requirements for fielding future technology and the preferred route to contract through which to procure equipment. Here, governments have choices over the basic 'make or buy' decision across the spectrum between the two schools of thought of open competition on the global market or indigenous development and production. Linked to this decision is the preferred approach to

contracting which will vary according to the type of equipment and embraces competitive tendering and single source procurement, each of which might be achieved through an MOD-industry partnership. The desired approach to achieving value-for-money is woven through all these considerations. Competitive procurement is deemed to deliver optimum value for money but may not guarantee security of supply for critical logistic support or affordable upgrade after fulfilment of the initial contract. This represents a narrow definition of value for money in that it takes no account of the lost opportunities for the domestic economy in terms of even modest onshore industrialisation and employment. As such, open competition on the global market suits some nations with modest military ambitions and limited defence industrial capacity. At the other extreme, a nation might favour a protectionist approach whereby they preserve an extensive onshore industrial base regardless of cost to provide for the needs of its own armed forces and to export to allies. This approach provides greater certainty over operational independence and security of supply but adopts a broader definition of value for money based on the overall economic advantage represented by high-grade research and extensive job creation (MacDonald, 1999). However, only the largest economy countries could maintain an industrial base extensive enough to meet their entire defence equipment needs. Rather, most nations take a blended approach between these two poles based on what they judge to be the key industrial capabilities that they determine as being necessary to retain onshore.

Judgements on the 'make or buy' decision are based firstly on a determination of 'sovereign' capabilities which are deemed so fundamental to national security that they cannot be sourced offshore (such as cryptography and offensive cyber) or that there are legal impediments for so doing (such as counter proliferation of nuclear technology). In addition, consideration of operational independence not only needs to guard against interruptions in offshore supply and equipment support but also needs to allow a national response to unforeseen urgent operational requirements "where systems engineering skills and design knowledge must be available" (HMG, 2021a, p.19). The term is not intended to signify procurement independence of the sort that might be achieved by sourcing all defence requirements onshore. Rather, it recognises that the UK has not sought to retain a defence industrial base with full spectrum capabilities since the end of the Cold War but has collaborated with allies or imported on the open market. Thus, operational independence relies on the ability to "negotiate with other nations arrangements to share the technologies needed to support and develop such capabilities through life (HMG, 2021a, p.80). The key outcome is unfettered access to the industrial know-how and related intellectual property required to support, upgrade and, in future, replace military equipment. While some countries might seek to solve these aspects by reverting to state ownership of defence manufacturing, the privatisation legacy from the Thatcher era is inherent in UK DIP and there is no appetite to reverse

it except in extremis. For example, for reasons of security of supply, two industrial entities involving forged steel (MOD, 2021a) and high-grade electronic devices (MOD, 2024a) have recently been taken into public ownership. These examples demonstrate that emphasis also must be placed on the nature of supply chains particularly where the provision of unique components is concerned. Meeting all these requirements calls for an onshore defence industrial base with deep systems integration expertise and constant exposure to the 'noble work' of design, development and advanced manufacturing which generates both intellectual property and tacit knowledge within a firm and thereby enhances its sustainability.

Secondly, a DIS should provide guidance on the future technologies that MOD perceives as being core to providing the winning edge in future capabilities. These decisions are closely related to the policies on sovereign capability and operational independence. Coverage should include details of where the associated research and development is to be conducted and how it will be funded. Industry will be particularly keen to know what opportunities exist for co-development and joint funding, especially where there are aspirations for technology demonstrators and prototypes. Likewise, aspirations over the exploitation of commercial technology need to be included. In such cases, clarity on the subsequent ownership or access to the resulting intellectual property will be a major factor in industry's investment decisions. Consideration of international collaboration and technology transfer through the offshore procurement of advanced equipment are also plausible options. Greater detail on priorities and the underpinning rational for the selection of technologies is periodically covered in MOD publications on Defence Technology Strategy which, except for the 2006 version (MOD, 2006a) are not harmonised in time with the release of a DIS.

Thirdly, on routes to contract, throughout the period of this research and in line with the Levene reforms, competition has remained the basis of UK procurement. However, there has been a progressive increase in the creation of long-term MOD-industry strategic partnerships. The concept arose from a 1994 government initiative focused on the construction industry to address "the inefficiencies of traditional methods of procuring and managing major projects" which was also embraced by the MOD's estates organisation (NAO, 2001b). Thereafter, the 1997 Smart Procurement Initiative (MOD, 1998b) stressed the need to take a through-life approach to equipment procurement, upgrade and support which required closer collaboration between government and industry, and which was inherent in the partnership approach. The full model as advanced in DIS 2005 saw initial equipment procurement being accompanied by a support arrangement based on incentivised performance (MOD, 2005a, p.37). Given its history of adversarial relationships with industry, MOD also saw partnering as defining "how the parties

conduct themselves and the working attitudes that are valued (MOD, 2005a, p.133). That said, the department recognised the need to be explicit on matters of contract:

> A 'Partnering Arrangement' is not generally a legally binding form and it can be applied to any contractual relationship. It differs from a formal 'Partnering Agreement' in which the MOD and a supplier form a legally binding, collaborative entity" (MOD, 2005a, p.134-Fn 2).

In a subsequent Defence Select Committee enquiry, Hartley, expressed concern that partnering was a vague term that may not lead to cost-efficient outcomes and could see a return to the cosy relationship that existed before competitive bidding became the norm (Parliament, House of Commons, 2006, Ev 85). He added that a smaller defence industrial base with greater protection and guaranteed work for the key sectors could also lead to domestic monopolies. Fitzpatrick also expressed valid reservations over how partnering might work with foreign or multi-national firms which lack a footprint in the UK (Parliament, Hose of Commons, 2006, Ev 85), later writing that:

> Strategic partnerships must overcome the inevitable divergence between the partners' primary goals, respectively strong military capabilities and high returns on investment, and between the distinctive cultures of a Department of State and of a commercial organisation (Kirkpatrick, 2008, p.306).

A subsequent academic study confirmed that "the concept of partnership suppliers is widely accepted within the defence industry as the best way forward. During associated interviews, it was evident that the need to partner with the MoD was recognized across both the MOD and the supply base. (Johnsen, Howard & Miemczyk, 2009, p.13). The same study emphasised that real partnerships "involve a high degree of mutuality and interdependence and are characterized by commitment, coordination, interdependence and trust developed over a long period of time" (Johnsen, Howard & Miemczyk, 2009, p.9). The study correctly concluded that the associated ethos of transparency and trust would develop only slowly requiring sustained effort from both MOD and industry.

This substantive move towards through-life procurement and partnerships placed considerable importance on life cycle costing which was then in its infancy such that the Defence Select Committee recognised that value for money judgements were not yet well informed (Parliament, House of Commons, 1998, Col 312). The then Minister of Defence Procurement told the same inquiry, "… whether or not you are getting value for money are, at the end of the day, subjective

decisions" (Parliament, House of Commons, 1998, Q 2019). This underpins Kirkpatrick's point that "Value for money is one of the most ubiquitous phrases in defence acquisition but also one of the least understood" (Kirkpatrick 2008, p.298). Nevertheless, in articulating its options for the routes to contract, a DIS needs to explain how value for money is assured in each case. This is particularly significant given that, in an era of increasing partnerships, sole source procurement was becoming more common with the attendant need to update the former NAPNOC approach.

For most of the period 2010-17, "The proportion of live equipment contracts let each year is now broadly split 50:50 between competitive and non-competitive contracts" (NAO, 2017a, p.18). Of note, in 2017, of the 22 major equipment projects valued at above £400 million, had an average value of £1.06 billion and a total contract value of £23.4 billion. Of this latter figure 57% arose from non-competitive contracts. Ensuring value for money in these cases was addressed through the Defence Reform Act (2014) with the advent of the Single Source Contract Regulations which applied to all contracts above £5 million. This provides a legally binding framework through which the MOD seeks to obtain value-for-money despite the lack of competition. The framework is operated by the independent Single-Source Regulatory Office (SSRO) with oversight by the MOD. Government-to-government and international collaborative contracts are excluded. In some years, these latter categorise have amounted to 80% of the total single-source contract value (Brooke-Holland, 2024b). The SSRO sets an annual baseline profit rate which is varied on a case-by-case basis according to the level of risk held by the contractor. The 2024-25 rate is set at 8.24% and, although below global defence industry norm, firms recognise that any figure closer to 10% would be regarded as politically contentious. The final price also takes account of the allowable overheads. Scrutiny of a supplier's bid and the ongoing pricing is detailed and intrusive leading to adversarial interactions between MOD and suppliers.

Other major defence manufacturing nations also struggle with defence procurement, but few have traditionally adopted a DIS approach. In France and Germany there is a very tight relationship between the defence industry and the state with an automatic supposition of domestic supply which sees government control exercised through the award of contracts. Successive EU directives on competitive markets provide an exemption for aspects of national security. While the same is broadly true in Italy, there is an Italian Defence Industrial Policy which seeks to retain onshore autonomy together with advanced capability in technological development aimed at enhancing global competitiveness (MOD It, 2021). The Russian invasion of Ukraine has prompted the EU to issue its first European DIS aimed at consolidating the European defence industrial base and harmonising its output through increased national investment and collaborative procurement (EU, 2024). Until recently, the US had seen no need of a defence industrial strategy. Rather, the

Pentagon has historically proved adept at reconfiguring its domestic defence industrial base to balance capacity and demand by contracting for a range of government-funded prototypes followed by competitive development and production contracts. Nevertheless, the US government published its first defence industrial strategy in 2023 focused on the sustainability of its entire defence industrial ecosystem, embracing both government-owned entities and private industry (DOD, 2023). Even without an indigenous industrial capability at prime level, Australia has published a very effective series of defence industrial strategies which describe their approach to partnering with global defence firms in a way that promotes the growth of high-grade domestic supply chains: the absence of political spin in the text is particularly striking (AuG, 2024).

The culture of the UK defence equipment enterprise

The UK's defence equipment enterprise consists of four elements. The end customers are the four front-line commands (Navy, Land, Air and Strategic Command) which set the requirement and currently hold the budgets. With the exception of strategic programmes such as those associated with the nuclear enterprise, the front-line user command would routinely provide the designated Senior Responsible Owner (SRO). A common requirement across government procurement, the SRO is responsible to the departmental accounting officer and to parliament for financial control and affordability and for the delivery of project objectives. The SRO is further responsible to ministers for adherence to government policy (IPA, 2023a). The MOD Head Office provides policy guidance, strategic oversight and exercises financial control. Defence Equipment and Support (DE&S), which is designated by the government as an Executive Agency (with additional flexibility in pay policy), is the MOD's principal delivery organisation: there are others for infrastructure, digital services, submarines and nuclear warheads. The UK defence industry together with their global counterparts are the equipment suppliers. Operating in the global market poses dilemmas for defence firms. The bidding process for major contracts is lengthy, detailed and expensive. Likewise, the development of the technologies for future military capability requires significant investment in research facilities, and in suitably qualified and experienced people. In addition, the return on investment from operating in a firm's domestic market must be judged against the opportunity presented by other global customers. In bidding for a contract and setting a competitive price, questions arise over short-term returns versus longer-term sustainability. Aspects such as where the intellectual property generated should reside between customer and supplier are also germane. Without access to valid and granular information on customer governments' requirements and intentions, judgements over investment are difficult. In essence, firms can be incentivised to participate according to the market characteristics that can be deduced from a nation's DIS. Criticism is levelled at the defence firms in that they are seen as industrially inefficient, technologically over-optimistic and high in cost (Gray. B, 2009, Hartley, 2011).

The three MOD customer elements in the enterprise together comprise both civil servants and military personnel amounting to some 20,000 people (NAO, 2020a, p.5). The military cohort is mostly located at the front-line commands with 1,084 located at DE&S alongside 10,516 civil servants (MOD, 2024b, p.126). The remainder are MOD Head Office civil servants located in Whitehall supported by a small military cohort. A significant distinction between DE&S and the MOD Head Office is that the former is a delivery organisation whereas the latter is a policy organisation focused on supporting ministers, deriving strategy, corporate planning and corporate governance including accountability to parliament. There are 111 senior civil servants (Bands 1-4) in DE&S (MOD, 2024b, p.91) and 356 in Head Office (MOD, 2024c, p. 86). The civil service comprises 30 'professions' and those in Whitehall departments are more senior and mostly drawn from the prestigious 'policy profession' with some in MOD Head Office also holding formal commercial accounting qualifications. Conversely, DE&S consists of project managers, engineers, technical specialists and commercial staff. Many hold qualifications through the Chartered Institute of Procurement & Supply (MOD, 2024b, p.91).

Culturally, the policy profession, particularly at senior level, has been typecast by a 2021 study by the Social Mobility Commission (SMC) across the entire civil service asserting that "the right accent and a studied neutrality seem to win through at every stage of their career" (SMC, 2021). Studied neutrality is deemed to exhibit three characteristics:

> … a particular received pronunciation style of speech; emotionally detached and understated self-presentation; and an intellectual approach to culture and politics that prizes the display of in-depth knowledge for its own sake (and not directly related to work) (SMC, 2021, para 8).

Unsurprisingly, "those from low socio-economic backgrounds find this code alienating and intimidating but one which they must assimilate in order to succeed" (SMC, 2021, sect. 2.5). Elsewhere, a study by a former permanent undersecretary aimed at improving the quality of policy formulation recognised this syndrome adding a concern that:

> One of the most important attributes of good leadership is promoting a culture which rewards the inconvenient truth, rather than – as is much more typical, certainly in Whitehall – finding such contributions rather embarrassing and to be avoided at nearly all costs (Slater, 2022).

Much corroborating evidence appears in a paper within the *Reimagining Whitehall* workstream of the Reform think tank which analyses senior leadership culture and was based on 27 interviews with the most senior past and present personalities in Whitehall (Pickles and Sweetland, 2023). Three additional cultural traits emerge: senior leadership reluctance to take ownership of change; a dismissive view of delivery in favour of policy formulation; and a close interest in avoiding accountability. On the former, despite eleven significant reviews of the senior civil service during the period of this research:

> A remarkable consensus – including among many working within the civil service – has therefore developed about the key flaws in the Whitehall machine. From specific skills shortages to inadequacies in operational experience, high staff churn to extreme risk-aversion and over reliance on process, repeated reviews and action plans have highlighted the same problems. And yet, with some improvements, these problems largely persist (Pickles and Sweetland, 2023, p.8).

The second point on delivery is germane to MOD in that the Head Office is typically policy-focused whereas DE&S is strongly delivery focused.

> This reflects a wider civil service pathology that prizes 'clever' policy brains above operational expertise. As one former permanent secretary bluntly expressed it: "fast streamers don't want to be John Manzoni [Chief Operating Officer], they want to be Jeremy Heywood [Cabinet Secretary] (Pickles and Sweetland, 2023, p.8).

On the alignment of authority and accountability, which again is an important issue in the governance of major MOD equipment projects, a former permanent secretary reflecting the view of his peers said:

> ...the big problem with all these promotion systems is everyone refers decisions up all the time … And they've never grown the muscles of proper decision making, taking accountability, owning the judgement, holding yourself responsible afterwards. Whereas if you've been in the police or the army, operating overseas in smaller teams, all that kind of thing, you have no choice but to do that, because that is just the way you grew up and learn those habits very early on in your 20s. (Pickles and Sweetland, 2023, p.44).

In the 2024 Civil Service People Survey covering some 57,000 MOD civilians of whom 46% responded, the satisfaction scores were on a par with the other 16 government departments except

in three areas in which MOD had the lowest scores. These were 'My Manager' (72% versus the mean of 78%), 'Resources and Workload (71% versus 76%) and 'Leadership and Managing Change' (41% versus 52%). Of note, satisfaction with 'Pay and Benefits' was just 31% versus a mean of 34%. The DE&S was surveyed separately with scores mirroring most of those of the broader MOD (within 3%) except for the 'Employee Engagement Index' (measuring pride, inspiration, attachment, advocacy, and motivation) with a satisfaction score of 57% versus 63%. 'Organisational Objectives and Purpose' at 73% was also eight points below broader MOD. These data are reflected in the MOD assessment of current risks with "The capacity and skills of our workforce" appearing as the principal concern (MOD, 2024c, p.4) based on the existence of 116 skills pinch points (deficit of skilled staff) assessed as significant or above (MOD, 2024c, p.14). Many of these pinch points have become embedded over a long period as identified by an NAO analysis which determined that, "The largest shortfalls are in science and engineering, project management and information. The Department has had shortfalls in these trades since at least 2012" (NAO, 2019, p.9). These skills represent the engine room of DE&S: such shortfalls mean that delivery teams are understaffed which places individuals under increased pressure and leads to delays in project delivery. The NAO also reported a that:

> The Department's Acquisition Review also highlighted that there is a culture within the Department which prioritises passing review points and approvals above delivery of outputs and outcomes. One of the key aims of acquisition transformation is to increase the pace of delivery. It is important that reforms do not further encourage declaring milestones in the face of capability shortfalls in order to create the perception of fast progress (NAO, 2020a, p.35, para.3.9).

Given its role as a delivery organisation, DE&S is less policy-orientated than MOD Head Office and is culturally more practical. As such, it is heavily focused on the contracting interface with industry where behaviours on both sides are more transactional in nature. Contemporaneous analysis of the 1985 introduction of competitive tendering pointed to the creation of an adversarial relationship with industry (MacDonald, 1999, p.18; Kennedy, 1999, p.49: Bell, 2000, p.31) a feature that, although less pronounced with the progressive introduction of partnerships, is still apparent. Of note, as an Executive Agency, the DE&S has its own internally generated strategy. The organisation's annual report chart's progress against the objectives but nowhere is DIS mentioned. Likewise, in the multi-thousand-page online procurement tool 'Knowledge in Defence', DSIS 2021 merits only eight lines of generic text (MOD, 2025a).

The contracting environment

Defence equipment projects are deeply complex, often extremely expensive and heavily risk laden. For example, military aircraft performance relies on novel design and leading-edge technologies requiring advanced integration skills which together yield high levels of technical risk. In addition, defence aerospace is a long-term endeavour and, increasingly, combat aircraft are designed to be both multi-role and amenable to upgrade as threats change and technology advances. Large projects are often seen as strategic imperatives and are regarded as too important to fail and thus generate significant distortion with the equipment plan. For example, post the 1998 SDR, financial management was plagued by the MOD's unwillingness "to back-track on the carrier strike decision and found itself having to bail out BAE Systems on the Astute and Nimrod MRA4 contracts" (Jessett et al, 2020, p.27).

In terms of resources, the ten-year equipment and support plan 2022-32 stood at £242.3 billion but If all the risks within the plan materialised, there would be a deficit of £7.3 billion (NAO, 2022a, p.7).The deficit would be met either through additional resources from the Treasury but more likely through delaying project delivery dates which requires the run-on of obsolete equipment, further increasing costs (NAO, 2022a, p.17). Forecasting future equipment costs is notoriously difficult: rates of inflation and foreign exchange fluctuations are hard to predict. Defence inflation refers to input costs and is the "average change in both pay and the prices of goods and services that make up the defence budget, adjusted for quality and volume": it is generally higher than consumer inflation (CPI) and the whole economy inflation measure which is used in public sector budgeting to calculate the GDP deflator (MOD, 2022c, p.9). Turbulence in foreign exchange rates can be a factor across the life of the project leading to complexity in resource profiling and a further increase in cost (IPA, 2023b). In Equipment Plan 2016-26 MOD assumptions on the dollar were some 21% better than the market rate at a time when 23% of the equipment plan was denominated in dollars (NAO, 2017a, p.9). In this case, 89% of the gap was covered by forward currency purchase: when forward purchase does not cover the gap, costs fall to the projects concerned (NAO, 2017a, p.31). Projects are also subject to significant cost inflation between successive generations of the same types of equipment not least because of the rising costs associated with each era of novel technology, a facet particularly apparent in aerospace (Kirkpatrick, 2004). Unpredictable budget allocations and the annualarity requirements in public sector accounting represents further challenges.

As for delayed delivery, in terms of track-record across all domains over the period 2010-2020, of the 32 live projects in the Defence Major Projects Portfolio (DMPP) with a total cost of £196.2 billion, only five were predicted to deliver on time. The average delay across the entire portfolio

was 12 months to Initial Operating Capability (IOC - the minimum level at which the capability is usefully deployable) and 26 months to Full Operating Capability (FOC – the project's target level of military capability) (NAO, 2020a, p.8). The most persistent cause was inadequate supplier performance:

> SROs [Senior Responsible Owners] of 10 of the 32 most significant capabilities currently being delivered report serious concerns about supplier engagement or delivery performance, from poor quality control to lack of transparency about progress. The suppliers involved in delivering these capabilities were predominantly a mix of UK firms and subsidiaries of non-UK companies (NAO, 2020a, p.8).

Project delivery teams were also deemed to lack capacity and skills. "Six of the 32 DMPP capabilities face shortfalls of more than 20% in their programme teams. There are shortages of engineering and commercial staff, and some teams are very reliant on consultancy support" (NAO, 2020a, p.8). In 2015-16, DE&S spent £434 million on Private Sector Support (PSS) within its operating budget of £1.22 billion, causing the NAO to give only a qualified sign-off of the annual accounts. Of that amount, £27 million was for contingent labour to fill 292 gaps in the delivery teams. (MOD, 2016a, p.80, Notes 2&3): the equivalent figures for 2023-24 was a total PSS spend of £301 million (operating budget £1.38 billion) within which contingent labour cost £122 million to cover 905 posts (MOD, 2024b, p.136, Notes 3&4). Of note, at the defence select committee hearing on the MOD's 2016-17 Annual Report and Accounts, the then PUS gave evidence on the situation at DE&S in which he pointed out that contractors used as contingent labour cost "on average, about three times more than getting a civilian or civil servant to do the same work (Parliament House of Commons, 2016, Q.42). Other aspects of PSS spend relate to specialist technical support, business improvement consultancy and project management support. While consultants do not occupy decision-making executive roles, their contribution can be significant in the development of capability. For example, in 2024, the Frazer Nash Consultancy won a four-year contract to provide technical design services for naval ships (Alison, 2024, p.1).

Delivery timescales at DE&S also suffered when training capability for the new equipment was not ready for use. There was also ambiguity over both the definition of key milestones and a lack of precision in the evidence that they had been achieved (NAO, 2020a, p.9). In addition, the MOD Head Office did not hold the required management information by which to hold the front-line commands to account over the projects for which they were responsible. Likewise, the portfolio offices in the front-line commands were at various stages of maturity in their project management

capability with doubts arising over the measurement of "capability acquired against original requirements" (NAO, 2020a, p.10). The NAO report concluded that:

> While the Department may be able to deliver some individual capabilities in ways that deliver value for money, the frequent delays, problems with the quality of what is being delivered and poor monitoring information mean the Department has not achieved it for the portfolio as a whole (NAO, 2020a, p.11).

Nevertheless, the MOD considered that its project delivery performance had improved over the previous decade although the NAO cautioned that "it is difficult to compare current performance with past eras on a like-for-like basis" (NAO, 2020a, p.14). The 2009 Gray review on acquisition reported "that the average programme overruns by 80% or circa 5 years from the time specified at initial approval through to in-service dates" (Gray, 2009, p.7). The MOD asserted that the average had now reduced to 46% (NAO, 2020a, p. 14). In commenting, the NAO pointed out that this is not solely a UK problem:

> The Australian National Audit Office reported a schedule slippage of 691 months across 26 major projects as at June 2019. The US Government Accountability Office reported an average delay of more than 27 months in delivering the initial capabilities of the Department of Defense's 2018 portfolio of 82 major programmes (NAO, 2020a, p.15).

Radical past proposals for UK reform have included the creation of a government-owned, contractor-operated (GoCo) procurement organisation to act as a risk-sharing partner with the MOD (MOD, 2016b). In announcing the termination of the competition to parliament with only one bidder remaining by which to make judgements against the public sector comparator, the then Secretary of State for Defence made two contentious points that were seemingly in opposition. First, he stated that "DE&S effectiveness was no longer undermined by an overheated programme" (Hammond, 2013, col 146). Then, in explaining the demise of the GoCo competition, he continued:

> that further work is necessary to develop DE&S financial control and management information systems to provide a more robust baseline from which to contract with a risk-taking GoCo partner (Hammond, 2013, col 147).

More recently, the MOD has asserted that "there is no silver bullet that will fix the enduring challenges that we face" (Parliament, House of Commons, 2023c, DES0042, p.2). Rather, the Department considers that, given the varying nature of defence equipment projects, an approach

based on learning from experience and applying the resulting lessons is likely to deliver more effective reform. At the individual level, DE&S has developed comprehensive learning plans as part of a £9 million annual investment in skills enrichment leading to internal government and external professional accreditation for engineers, contract managers, and for personnel in the finance and accounting, and commercial professions (MOD, 2024b, p.95).

The enterprise is also subject to constant assertion from the NAO and parliamentary select committees that it is riven with optimism bias. It is thus striking that, despite the rapid advances in computer-based project management tools over the past decade and particularly those applied to cost-modelling, imperfections in forecasting continue to exist. A second Levene review took place in 2012 as an examination of the defence operating model. Among its conclusions was that:

> The Department's evidence-based analysis has been weak, and it has lacked transparent and shared management information. This has adversely affected the Department's ability to make well-informed decisions, build strong financial management, increase cost-effective delivery, and it led to poor accountability (NAO, 2012a, p.19).

It further assessed that: "There has also been a culture of over-optimism within the Department, and it often assumes it will meet targets and deliverables without having credible plans to do so" (NAO, 2012a, p.21). This long-running cultural weakness was also identified in SDR 98 as "an inherent optimism in predicting technical risk and costs" (MOD, 1998a, Industry Essay, p.6). A key driver of this misplaced optimism results from the competition for funding within a normally heavily over-heated equipment plan. As Gray (2009) identifies, in these circumstances, it is entirely rational that single-service commanders should feel a moral obligation to specify the best possible solution given that they will be taking people into harm's way … (Gray, 2009, p.29). It is thus puzzling that successive editions of DIS have seemingly been unable to identify remedies to these shortcomings and raise procurement performance.

Other UK spending departments across government also struggle with the procurement of complex capital projects, particularly where there is a plethora of overlapping systems which must ultimately be synchronised to achieve an effective outcome. The 2023/24 Infrastructure Projects Authority report lists 44 MOD equipment projects with average whole (project) life costs of £6.7 billion and a mean project delivery life of 20 years. The same metrics for the 68 wider-government infrastructure and construction projects were £5.6 billion and 12.64 years (IPA, 2024, p.6). By comparison with infrastructure and construction projects, the longer project life of MOD equipment projects renders them liable to increased risk of changes in the financial environment and adds complexity to

forecasting. Five MOD projects were assessed as 'apparently unachievable' as were seven infrastructure and construction projects (IPA, 2024, p11). Of note, the projects common to the previous year's report "have increased their whole life cost by an average of 20%, influenced by high rates of inflation" (IPA, 2024, p.5).

Research findings

In conclusion, the research identified shortcomings in DIS 2005 and DIS 2012 in the treatment of sovereign capability and operational independence, future technology requirements and the optimisation of the routes to contract. DIS 2021 did much to redress the balance particularly in its depth of analysis on operational independence which had seemingly been left to chance in earlier editions of DIS. In all cases, two significant barriers to DIS implementation arose. First, DIS objectives were not harmonised with the funding available in the equipment plan, rendering the strategies implausible through a lack of equilibrium between ends, ways and means. Secondly, cultural barriers were present in the form of organisational resistance and the lack of harmonious relationships between MOD and industry. On the former, as a machine bureaucracy, the delivery organisation's structure militated against the adoption of strategic change. On the latter, despite the move towards partnerships between MOD and industry, the long tradition of competitive procurement undermined the deployment of DIS. In terms of the conceptual hypotheses, high-level long-term partnerships have proved effective in delivering value for money, particularly through integrated support, and in sustaining elements of the UK industrial base. However, successive editions of DIS (except DSIS 2021) have been tentative in embracing the approach wholeheartedly as a strategic imperative, underplaying the role of partnerships in enhancing the sustainability of the industrial base. Likewise, addressing operational independence through a range of partnered framework contracts has been left unexplored yet the approach offers improved resilience against unpredicted deterioration in geopolitics. As for the hypotheses on procurement process, the case studies and interviews as well as the analysis of the cause of turbulence in the equipment plan provide evidence of optimism bias across the defence equipment enterprise. In such cases, best practice across government calls for the use of reference class forecasting which has not been effectively implemented in MOD procurement practice because it is deemed to be at variance with the MOD's approach to assessing uncertainty. On financial management, realistic forecasting would greatly assist in reducing the turbulence in the equipment plan as would an extended portfolio approach and easement for MOD on the public sector annualarity requirement.

As for the research question, given its shortcomings in formulation and deployment, DIS has had minimal impact on improving aerospace project performance. In addition, the sustainability of the industrial base was not prioritised in DIS objective and thus languished until the creation of sector

strategies and the more interventionist themes in DSIS 2021. Finally, the thesis recommends that a future DIS should be wider in scope and be more directive in tone. As such, it should be subject to full cross-government endorsement if it is to deliver change and enhance the credibility aspect of the UK's deterrence posture.

Chapter 2 – Literature Review

The first error is to think that the state has little strategic role in the economy beyond removing barriers to free enterprise, correcting the occasional market failure and redistributing the proceeds of growth. (Rachel Reaves, Shadow Chancellor of the Exchequer, 2023)

Context

Governments traditionally use industrial strategy to address market failure. In UK defence, the aim has focused more on sustaining a market that would provide government with choices in meeting its procurement objectives in acquiring defence equipment and the associated through-life support. In addition, governments have had specific requirements over sovereign capability which call for the onshore generation of intellectual property and for indigenous production capacity. This approach also embraces consideration of the sustainability of the defence industrial base. Such requirements are derived from the routine analysis of the current and future global security situation and must be sufficiently flexible to account for departures from predictions. This is a complex challenge in that the effectiveness of defence equipment in addressing military threats frequently calls for the complex harmonisation of advanced technology and its integration into a 'system of systems' which together requires a lengthy period of development. Changes in specification in the light of new threats also lead to delay and cost growth. These factors rarely exist in a tidy linear form; rather, they present as an ecosystem exhibiting constant interaction and varying levels of coherence. Addressing this challenge calls for high grade management skills in both government and industry in aspects such as equipment definition and specification, accuracy of costing, and project management. The UK MOD seeks to optimise the market's ability to respond effectively by publishing a Defence Industrial Strategy (DIS) to provide a transparent view on future priority equipment and technologies, levels of demand within specific sub-sectors of the defence industry and on associated changes in the approach to procurement. The defence industry values such transparency but also craves stability within the MOD's equipment plan and, particularly in the solidity of associated project funding given the need for firms to invest accordingly in precursor research, people and plant. However, the application of DIS in the UK has not proven effective in eradicating poor procurement performance, particularly in aerospace projects which traditionally exhibit the highest levels of design and engineering complexity.

In examining the associated literature, this chapter seeks to identify the key themes that are relevant to the areas of the research hypotheses in terms of DIS conceptual formulation and deployment and the process management gaps that limit its effectiveness. On conceptual formulation and deployment, the review seeks to determine what barriers to acceptance of a DIS might exist because of its implausible ambition over industry's ability or willingness to align with

the MOD's objectives. On gaps in process management, long-standing imperfections in MOD's risk management and financial control which are central to contract delivery could overshadow the beneficial impact that a DIS might otherwise deliver. Taken together, these aspects should illuminate the possibility that, at the contracting coalface, the detailed processes necessarily required in procuring complex defence equipment leave little capacity within delivery teams to absorb the additional constraints of an overarching strategy. The review therefore initially examines the themes emerging from the literature on the place of broader industrial strategy in UK public policy. Thereafter, it considers the literature on the generic characteristics in seeking to create the market conditions in the post-Cold War environment. It recognises that there has been limited portrayal of industry's perspectives in that there is a minimal body of knowledge on how defence firms operate in the non-traditional market that they now face. In addition, in some cases, the extent of academic analysis is limited for three potential reasons. First, where a defence review or a DIS is preceded by a consultation process as in SDR 1998 and DIS 2012, it acts as a stimulant for engagement and subsequent analysis. DIS 2005 was restricted to industrial consultation but was suitably novel to generate academic interest. However, in the case of DIS 2012, the published strategy was limited in perspective and seemingly ignored most of the consultation input which attenuated academic interest in further analysis. DSIS 2021 reflected solely the Cabinet Office consultation on the limited aspect of post-Brexit reform to broader public procurement. Secondly, Chisnall (who previously wrote MOD policy) considers the limited interest in DIS arises because:

> The policy debates at the front end of a review will tend to attract most of the media attention and the wide engagement of analysts and commentators. This is because discussions on threats and interests appear easy ground for ministers, journalists and academics, whereas the complexities of procurement are far less exciting and require real expertise (Chisnall, 2010, p. 421).

Thirdly, some commentators recognise a post-Cold War change in academic interest:

> In part, this reflected a post-Cold War shift in British academia away from traditional strategic studies towards the rather broader, and arguably more diffuse, subject of security studies ('critical' and otherwise). As academia identified new interests and concerns, national defence policy and strategy became rather less fashionable as subjects for academic research (Cornish and Dorman, 2009, p. 253).

In addition, the variability of Government and MOD transparency on defence policy and its industrial consequences does not encourage serious study. The release of information is often in opposition to the need to preserve the sanctity of highly classified threat and capability performance data. In addition, the defence community (embracing military personnel, officials,

academics, politicians and industry) live in a world of acronyms and jargon which acts as an intangible glue of belonging and serves to obscure clarity of meaning to outsiders (Appendix B lists those in common usage). In this respect, "Transparency has, in essence, been captured by the narrative and is now a function of the process of legitimisation of the narrative" (Thompson and Louth, 2019, p.255). These factors are particularly prevalent in UK defence procurement where 'commercial confidentiality' is also added as a further barrier to transparency (Kirkpatrick, 2008).

Much of the literature tends to use the terms 'industrial policy' and 'industrial strategy' interchangeably. As a minimum, industrial policy should define the 'ends' in the strategy equation of 'ends, ways and means.' However, this research relates to the defence industry as a specific sector and needs to account for the globalised footprint and research-intensive nature of the industrial base which suggests a wider menu for potential government intervention. Scholars regard government interventions into the operation of industry as controversial. Some consider that such interventions cut across the effective functioning of a competitive market and provide opportunities for rent-seeking which further distort their impact (Pack and Saggi, 2006). However, In the defence sector, there are examples where the 'type of intervention' has included nationalisation to preserve onshore security of supply. This approach was applied to Sheffield Forgemasters International Limited to preserve metal casting capability for naval ships and submarines (MOD, 2021a) and to Octric Semiconductors UK to secure gallium arsenide devices (MOD, 2024a). These interventions indicate that, as an imperfect market, the defence sector and its relationship with government is a special case because inaction would have served to undermine national security. More generally, the industrial participants in the defence market are, in principle, independent of government. The 'ways and means' elements of the strategic triad therefore need to articulate how the measures concerned would contribute to a successful DIS in creating appropriate market conditions.

It is also necessary to contextualise the place of the manufacturing sector in the broader UK industrial landscape. In June 2022, there were 2.6 million jobs in manufacturing amounting to 7% of all UK employment. However, service industries involve 30.2 million jobs or 84% of all UK employment (Hutton, 2022). These two elements of the industrial landscape also require markedly different policy approaches in dealing with the era following the 2008 global financial crisis. The consequences of the turbulent period that followed were characterised by "a decade of stagnant living standards, weak productivity and low investment combined with a decade of major change driven by Covid-19, Brexit and Net Zero" (De Lyon et al, 2022, p.5).

UK Industrial Strategy

There is a shared and accurate view across the literature that formulating industrial policy has always been challenging for British governments. First, it is not readily understood in Whitehall what aspects need to be included in an industrial intervention (Beath, 2002). Secondly, to be effective, it needs coordinated input by several departments of state working in harmony over long periods (Milne, 1952; Beath 2002; Wilkes, 2021). Thirdly, where it has featured on the political agenda, the interface between horizontal industrial policy and regional policy is often indistinct to the detriment of both, given that common initiatives focus on aspects such as skills, infrastructure and R&D investment (McCann, 2001; Bailey et al, 2019; Fothergill, 2019). Finally, the negative experience of the initial post-war attempt at a comprehensive industrial policy in the 1960s involving a vertical strategy of 'picking winners' has entered the political consciousness as being a strategic minefield for two reasons.

First, selecting potential winners relied on complex statistical analysis that rarely provided compelling conclusions on the future viability of individual firms. Judgements on whether to invest is sectors with the best prospects or those with greater capacity for improvement was not made clear in the strategy and thus ultimately the number of target firms was limited (Bailey, 2013). In defence procurement, the notion of picking winners is akin to adopting 'national champions' which is a common approach in some nations where the existence of monopoly suppliers is accepted as a desirable characteristic of the defence market. While this notion may have lingered in the UK when the defence industry was largely nationalised, the early 1980's saw a wave of privatisation and the wholesale introduction of competitive procurement. Secondly, events proved that the strategy was easily derailed by other economic factors (Beath, 2002; Pemberton 2016; Wilkes, 2020). There was also a lacuna in industrial policy during the free-market Thatcher era and in the remaining years of the Conservative government that followed, driven both by doctrine and the sense "that it is better not to try than to keep on failing" (Wilkes, 2020). The doctrine of neoliberalism saw that "the historic tensions between finance and industry were definitively resolved in favour of the former" (Silverwood and Woodward, 2021, p.24). The period was characterised by widespread privatisations of state-owned industries with the notion of competition introduced in the public sector. Even with the 1997 return of a Labour government, there was consensus that political intervention and ad-hoc interference were of limited value (Wilkes, 2020, p.14). A 2009 government document emphasised that:

> It is important to stress that the last thing the Government wants to do is revive old theories or to invent a new ideology in managing the economy. This is not about Government seeking to override market forces or ignore market signals. It is about the

> Government matching the influence it exercises in the economy to the strategic needs of business (HMG, 2009, p.5).

The decade or so following 2009 covers the tenure of three governments and four prime ministers (Brown, Cameron, May, Johnson) each with a different approach to the detail of industrial strategy but all faced wider constraints during their period in office. In Brown's tenure there was renewed but tentative interest in industrial strategy, but his agenda was largely dominated by recovery from the global financial crisis and the need to recapitalise the banks (Berry et al, 2021. P.16). On inheriting the aftermath in 2010 and in leading a coalition government, Cameron was "committed to defend the regime he inherited from New Labour" (Byrne and Randall, 2017, p.1). His neoliberal approach saw value in industrial strategy as a tool by which to restore growth, but his attention was largely on the stewardship of austerity and latterly on the Brexit referendum. Following in 2016, May was clear on the need for a "proper industrial strategy to get the whole economy firing" (Silverwood and Woodward, 2021, p.36) but was faced with engineering a Brexit agreement against a lack of consensus in Parliament leading to political paralysis. Not an economic neoliberal, she saw state intervention as necessary in support of her doctrine of social conservatism (Conservative Party, 2017). This placed her at odds with her chancellor such that her relationship with the Treasury was dysfunctional throughout her tenure (Seldon, 2021, p. 310). Thereafter, Johnson was intent on 'getting Brexit done' and had an inherent frustration with institutions (White, 2023). His 'levelling-up' agenda was seen as an attempt "to marry laissez faire rhetoric on trade policy to an anti-establishment sentiment in less affluent parts of England" (Berry et al, 2021, p.16). These contrasts provide valuable insights into the variability of the drivers behind each version of industrial strategy. As Collins (2017) observes: "When as in the case of industrial strategy, policy answers an ideological need, the upshot in inconsistency between successive governments of different complexions" (Collins, 2017, p. 25).

The literature covering this period accepts that, following the global financial crisis and the need to reformulate a post-EU economy, it was appropriate to re-adopt industrial policy supported by a comprehensive implementation strategy (Bailey et al, 2019; Fothergill, 2019; Jones, 2019). Wilkes later points to the pandemic as an impetus for strategic change, commenting, "Crisis eras are often the time to attempt a structural change to the UK's economic model as they provide the motivation for a sustained change to how the economic model operates" (Wilkes, 2020, p.8). An early manifestation of this shift was the 2009 publication of *New Industry, New Jobs* (HMG, 2009a) promising a new activism. The central tenet was a rebalancing of the economy where core actions centred on upgrading skills to meet the needs of the future, strengthening existing R&D and innovation frameworks, and stimulating the pull-through of the resulting technology. As the then

Business Secretary, Lord Mandelson's related mantra of 'less financial engineering, more real engineering' was accepted enthusiastically "but little progress has been made to reaching this goal" (Jones, 2019, p.42). The 2010 Coalition Government continued along similar lines but with greater emphasis on support for eleven key sectors including aerospace, offshore power generation and automotive. In launching the revised industrial strategy, the then Business Secretary, Dr Cable, reflected on past lessons, both about picking winners and the free-market doctrine:

> A good industrial strategy allows for failures and recognises that innovation may strike in an unpredictable place – we must be ready for that too. But as the credit crunch showed, there are huge risks to taking a complacent, hands off approach (BIS, 2012a, p.4).

The strategy embraced five pillars: "access to finance; partnerships with sectors; support for emerging technologies; creating a pipeline of skilled workers; and finally, government procurement and the development of supply chains" (BIS, 2012a, p.2). Each sector was to have a high-level industry-government forum to address barriers to growth and identify how to meet the sector's skills challenge. In addition, eight innovative technologies were identified as being important for future economic growth, ranging from synthetic biology to advanced materials. The launch document pointed out that the strategy was founded on the principle of "a continuing commitment to open and competitive markets as a means to stimulate innovation and growth" (BIS, 2021b, p.4) but sought to address barriers to individual sector growth arising from market or regulatory failures (BIS, 2021b, p.20). It recognised that some barriers were felt more acutely by individual sectors than by others, for example, where information failures in conveying government intent increased the "risk premium attached to investment in capital intensive sectors such as aerospace, defence and life-sciences, due to long product development" (BIS, 2021b, p.27). Consequently, rather than picking winners, the application of the five pillars would be harmonised to the precise needs of a sector in realising its full potential.

Subsequently, the advent in 2016 of the May government saw the adoption of a more detailed and interventionist approach to industrial strategy. As a first step, the Department for Business, Innovation and Skills was reconfigured as the Department for Business, Energy and Industrial Strategy. A Cabinet Committee on Economy and Industrial Strategy at secretary of state level and chaired by the prime minister was also instigated. Such moves in reinvigorating industrial strategy were seen by some as "The Cinderella of government activities, for so long kept well out of sight, had exchanged her rags for decent clothes and strode into the daylight" (Chick, 2018, p.179). A year later, the relaunched industrial strategy appeared in the document, *Building a Britain fit for the Future* (HMG, 2017). The strategy espoused five horizontal initiatives as its foundation aimed at

improving productivity based on ideas, people, infrastructure, business environment and places. Four approved 'sector deals' were announced for life sciences, construction, artificial intelligence and automotive (BEIS, 2017, p.193). There were also a further six in advanced discussion which were announced in early 2019 and included aerospace (BEIS, 2020). Taken together these represented a significant vertical component of industrial strategy exceeding the historical norm. Although broadly aimed at the civil sector, the aerospace sector deal was particularly focussed on propulsion, drones and advanced airframe design which had clear relevance to defence as did the artificial intelligence sector deal and that on skills in the nuclear sector deal. Chosen sectors each had three elements: an industry council; access to new R&D funding; and objectives on generating a future talent pipeline. The selection of four Grand Challenges as a mission-based component was based on bringing together government, industry and academia to address major global problems. These were: the use of artificial intelligence in preventing, diagnosing and treating disease; extending independent living in an ageing society; reducing the energy usage of new buildings; and addressing future mobility through the design and manufacture of zero emission vehicles.

A novel aspect was the creation of an independent Industrial Strategy Council (ISC) with the requirement to create performance metrics and assess progress. Established as a non-statutory advisory group of senior industrialists and academics, in addition to holding the government to account, the ISC conducted evidence-based policy research in key areas such as the 2030 skills mismatch and on international lessons on levelling-up policies. In their final annual report in early 2021, the ISC reviewed the implementation of the 2017 industrial strategy's 142 policies. They considered that, while good progress had been made, "many policies were not operating with the consistency and co-ordination, nor with the scale, necessary for success" (ISC, 2021, p.38). In particular, the ISC felt that the strategy "was light on the labour market and skills policies" (ISC, 2021, p.6), an aspect of particular relevance to MOD as one of the UK's largest employers of apprentices with a cohort of some 20,000 at the time of the ISC report (BFRS, 2025, paras.1-2).

While *Building a Britain fit for the Future* was a comprehensive strategy, it attracted academic criticism on two significant aspects. First, its lack of 'edges' invited industry of all colours to bid for its own sector deals (Wilkes, 2020) and, secondly, the document, "reads like a shopping list" (Chick, 2021, p.30). Further, she comments, "if the White Paper is marked by an absence of analysis, it makes up for it in its proliferation of proposals" (Chick, 2021, p.34). The strategy was rapidly withdrawn by the arrival in mid-2019 of the Johnson government as part of the adjustment to a post-Brexit economy and the ISC was abolished, a move that was unsettling to industry. The business select committee saw the abolition as suggesting that "the Government's commitment to

coordinated industrial policy that can withstand and benefit from independent scrutiny has waned … and was a retrograde step" (Parliament, House of Commons, 2021b).

In contrast to the 2017 version, *Build Back Better: our plan for growth* (HM Treasury, 2021) was a much looser strategy which reverted entirely to horizontal measures with no sector focus. The strategy was based on promoting growth across the three pillars of infrastructure, skills, and innovation. It also espoused the three goals of levelling up, reaching net zero emissions, and 'Global Britain' which were seen as political rather than economic objectives causing industry yet further concern. The level of disquiet was noted in government and a letter from the Business Secretary and the Chancellor of the Exchequer was issued to regain confidence in which it was stated that, "This government remains committed to its industrial sectors" (BEIS, 2021, p.2). Subsequent stand-alone plans for a 'Green Industrial Revolution,' an innovation strategy and a net zero strategy provided further detail. Even after their publication, the academic view on the robustness of the goals was that "plans for building on these three pillars and three priorities remains vague" (Jones, 2021, p.4). Thereafter, the baseline industrial strategy was reinforced by the post-pandemic document *Levelling Up the United Kingdom* (DHLC, 2022) which extended beyond industrial policy and had a strong theme of devolution. It embraced twelve missions of which some, such as skills, R&D, and digital infrastructure were familiar elements of industrial strategy with the remainder covering much of the rest of the government's policy agenda. Valid and familiar academic criticism exposed the weaknesses:

> There are some welcome and ambitious proposals – especially on devolution – that are steps in the right direction. But despite the many pages, there is still a lack of detail behind how these proposals will work, and a shortage of policies which could actually make the missions succeed. Without them, we cannot be confident that this government will succeed where others have failed (Pope, 2022).

Pope (2022) also commented that, while the selection of performance metrics was valuable, the breadth of the ambitious agenda would make it difficult to maintain focus. Likewise, the Institute for Fiscal Studies cautioned that:

> The key question is whether the government can commit the funding, policy focus and reforms needed to deliver on its 'national missions.' Otherwise, there is a risk that the government has chosen its destination with no sense of how it plans to get there (Farquharson et al, 2022, p.1).

In written evidence to the Levelling Up, Housing and Communities Select Committee enquiry into the Levelling-up White Paper, Richards et al (2023) considered that:

> The challenge to the current government in ensuring funding for levelling up goes where it is most required and is adequate to meet the needs is a sizeable one. The current approach is bureaucratic and inefficient while the funding available for levelling up is wholly inadequate. The Centre for Cities estimates that between 1990 and 2014, the post-German reunification 'levelling up' efforts cost the equivalent of around £71 billion per year. The total Levelling Up Fund, by contrast, is £4.8 billion … The current top-down and restrictive approach to allocating funding remains complex, messy and short-term. This is a significant obstacle to the Government achieving its objective of levelling up.

With the departure of the Johnson government in late 2022 and the political turbulence that followed, focus on industrial strategy weakened in favour of short-term initiatives aimed at economic recovery. Nevertheless, as Wilkes (2023) points out:

> As a result, business has been confused, incentives towards long-term investment undermined, and key economic capabilities allowed to wither. No wonder that the UK has seen business investment lag behind the levels seen in its economic peers (Wilkes, 2023, p.4).

In terms of the themes emerging in the past two decades, successive governments have rarely taken a long-term systematic view on industrial policy and strategy: rather, the approach has been politically driven and does not become institutionalised so becoming vulnerable to instantaneous change with each new administration, thus frustrating the private sector's craving for long-term stability (Coyle and Muhtar, 2021). As an example, in giving evidence to the Business Select Committee in their 2020 inquiry into post-pandemic economic growth, Coyle stated that:

> We have a very distinctive pattern of policy seesaws in the UK. A couple of years ago, the Institute for Government documented 29 major skills policy reforms since the 1980s. That is about one a year. We have had half a dozen energy market reorganisations in the same span, and this is an industry where investment horizons can be up to 50 years. Government intervenes all the time. We have had an industry policy in favour of the finance sector, which includes infrastructure investment like the Jubilee line and London City Airport. It included the regulatory environment. The key is to do it purposefully and consistently, strategically over time (Coyle, 2020).

Norris and Adams (2017) list the factors that have contributed the churn in industrial strategy, pointing out that they are not unique to this one aspect of government. They cite, “disagreement about the relationship between industry and government; personal conflict and authority, particularly the relationship between the prime minister and other relevant ministers; fluctuations in resources; and organisational confusion and weakness” (Norris and Adams, 2017, p.8). They add that the prime minister’s personal interest is a key factor in providing stimulus to ministers and their departments. As an insider, Wolf (2017), considers the overriding factor to be the persistent weaknesses in the system of government even when consensus exist across departments (Wolf, 2017). These include inadequate corporate memory; invoking change as a mirage for delivering progress; weak long-term planning capability at the centre of government; and lack of robustness in policy development (Norris and Adams, 2017). The succession of economic shocks ranging from the 2008 global financial crisis with its following period of austerity through Brexit and then the Covid pandemic have led to the significant centralisation of discretionary resources in the Treasury with the attendant “need to guard against financial disorder” (Wilkes et al, 2024, p.4). This sense of ‘the dead hand of the Treasury’ was prevalent during the period of austerity between 2010-16 but underplays the need to provide the opposite impulse to keep both the spenders and the tax-cutters in check, particularly because neither group is likely to be in a position to see the whole problem (Wilkes et al, 2024, p.4). This notion of Treasury orthodoxy has resulted in an imbalance of power across government that is manifest in the “disfunction between the Treasury and the business department” which has led to the latter’s progressive emasculation in its various guises (Wilkes et al, 2024, p.35). However, the literature provides little comment on overcoming the complexity of delivering policy outcomes which require concerted action across several government departments. The machinery of government rarely achieves true alignment and successful integration of effort. Here, the Cabinet Office ought to play a role given that it is a department of more than 2,000 core staff but a total of some 11,000 when its supporting agencies and arms-length bodies are included (HMG, 2025). But its current role is open to question with its responsibilities described as ones of support and promotion rather than implementation and delivery. A coordinating central engine of the machinery of government that monitors and encourages is no substitute for one that commands and controls.

Overall, the key themes emerging which bear scrutiny within the context of DIS include the conceptual challenge of determining a long-term strategy based on a consensus view on the desired relationship between government and industry. As such, the design should take account of the plausible ‘ways’ and realistic ‘ends’ by which delivery might be achieved. In terms of process, successful delivery makes intellectual and resource demands on the machinery of government

which hitherto have seemingly been inadequately managed. With the Treasury's role arguably paramount and the Cabinet Office unwilling to take-on a central coordinating role, the lack of alignment between authority and accountability within and across departments undermines delivery, particularly when public expenditure is under pressure. Taken together, these aspects do not result in the transparent and stable interface with government that industry seeks.

UK Defence Industrial Strategy

The role of defence industrial strategy in setting market conditions became more prominent after the end of the Cold War which saw a 30% contraction in the value of the global defence market during the period 1988-97 (SIPRI, 1998). The UK equipment budget reduced by 38% over the same period (£11.6 billion to £6.0 billion at constant 1997 pounds) (MOD, 1988; Parliament, House of Commons 1998a) but UK defence exports grew by 47% (£4.0 billion to £5.9 billion at constant 1997 pounds) largely due to the sale of Tornado aircraft to Saudia Arabia (HMG, 2020a). In addition, increased competition from the US defence primes called for action in Europe based on "greater international collaboration and restructuring as a means of achieving better economies of scale" (Dodd and Oakes, 1998, p. 55). While DIS has much in common with broader pan-government industrial strategy in terms of skills, R&D and employment, it must also serve specific purposes in the way in which the state seeks to configure its defence and security posture and the industrial base that supports it. Aspects such as the retention onshore of sovereign technology, robust security of supply for existing and future equipment, and the maintenance of a competitive market within a monopsony all provide additional challenges. Put simply, "any government whose acquisition policies include supply from an onshore DIB [defence industrial base] must formulate a DIS which is sufficiently supportive to sustain the desired capabilities within the national defence industry" (Kirkpatrick, 2008, p. 291). But the application of DIS carries political baggage, particularly when applied to procurement choices. As Hartley points out:

> Inevitably, such large-scale spending by a single ministry creates controversy. There are pressures to buy British rather than foreign equipment and to support jobs by buying from firms in areas of high unemployment (e.g., shipbuilding). The view also has been expressed that MOD purchasing should be used as an instrument of industrial policy. (Hartley, 2011, p.95).

The following chapters investigate the extent to which this view has been a driver in individual editions of DIS but the literature identifies three generic characteristics which have been consistent

in shaping the UK's approach: the selection of sovereign capability; reliance on procurement from the US; and the adoption of a partnering relationship with industry as the preferred route to contract for through-life support.

Choices over sovereign capability have often been applied too narrowly and treated in isolation without consideration of operational independence and security of supply. While there has been continuity on the selection of the core onshore disciplines involved (nuclear, cryptography and cyber), assumptions on the broader aspects of operational independence and security of supply were much less well-codified until 2021. In making these assessments of the supply side, Hartley (2011) doubts that governments have sufficient understanding about the sector's performance nor the optimum industrial structure and size of a firm. He further suggests a lack of understanding in government of the extent, complexity and international nature of supply chains in a globalised defence market. It also seemed that government showed little understanding about the nature of domestic supply chains in areas such as their dependence on defence work, their significance to local economies and whether sub-optimal configuration leads to additional costs (Hartley, 2007). Kirkpatrick also points out that the lack of formal codification assumes the continuance of "security of supply in any future international crisis when the priorities of foreign contractors (and of their governments) may diverge from those of the UK" (Kirkpatrick, 2008). He also notes the increased complexity given the nature of the globalised defence market where UK-based prime contractors "may rely extensively on imports of subsystems, components and raw materials which can be obtained more economically from overseas" (Parliament. House of Commons, 2006, Ev w. 85). Some commentators debate that "the notion of national security of supply in advanced weapons has become a redundant concept" in favour of reducing cost through collaborative procurement and transnational restructuring Uttley and Wilkinson, 2019, p.195).

On procurement from the US, heavy reliance on that source, particularly in aerospace, underplays the risk associated with the US legal requirement that, "American forces' operational needs must be met before any states can be supported, an aspect that in subsequent years saw the need to create separate offshore production capacity to meet the needs of export customers" (Louth and Taylor, 2018, p. 15). In evidence to the Defence Select Committee, both Porter and Blagden cautioned that defence reviews had assumed that procurement from the US would always be an option, but it would be wrong to assume that UK and US interests would be permanently aligned (Parliament, House of Commons, 2022a, Qs. 184-5). Equally, while the UK is one of the world's largest exporters of defence equipment, there is still significant dependency on the US for other types of equipment. There is thus a further need to examine this latter aspect against the aspiration over operational independence, "where there may be options to develop sovereign capabilities –

both military and industrial – to enhance resilience and improve mission assurance long term" (Lucas et al, 2022, p.8). On future technology development, the US retained its lead position in the decade after the end of the Cold War in that it had "about a 5-year time advantage over the UK in defence technology exploitation but the related expenditure was some ten times that of the UK's (Hartley, 2007, p.22). Yet it is striking that successive editions of DIS were slow to reflect how the UK would follow the US technology lead in adapting to the changed nature of warfighting. As Dorman (2006) points out:

> … the SDR still contained a good deal of conventional thinking and the approach to the Revolution in Military Affairs and asymmetric warfare debates in the United States was effectively to maintain a watching brief (Dorman, 2006, p.153).

Likewise, on DIS 2012, in evidence on the corresponding reduction in onshore investment in defence technology, Dover and Phythian emphasised the adverse implications for the UK's science and technology ecosystem with no recognition within the strategy of the mitigations required to protect the nation's research and development culture (Parliament. House of Commons, 2013a, Ev. w7).

In terms of preferred routes to contract, competitive procurement based on the 1985 Levene principles had remained the bedrock in the pursuit of value-for-money. However, there have been variations between successive editions of DIS over the significance of other factors in loosening the application of this policy. Among these, the growing application of TLCM has resulted in the adoption of a partnering approach with industry but its treatment in DIS has been inconsistent. For example, "there are no clear, unambiguous and commonly used definitions of 'partnering' or 'partnership' within defence, as the terms themselves seem always to invite further explanation" (Louth, 2012, p.8). In some cases, it has been hard to distinguish the advantages arising from the unique features that partnering delivers over conventional approaches. The long-term partnering agreement (LTPA) with QinetiQ over weapon range stewardship, and test and evaluation capabilities illustrated the inherent ambiguity in such arrangements. As Louth points out:

> It is built on strictly commercial lines with clearly defined requirements, performance obligations and financial rewards, making it a challenge to understand what partnering in defence actually represents in terms of a commercial relationship and contract" (Louth, 2012. pp. 8-9).

Arguments in favour of biasing procurement to onshore suppliers on the grounds of enrichment of the broader economy had not featured in a DIS until 2021 which recognised the social value arising from that approach. Until then, the Treasury was clear that such orders have only a negligible effect on the overall level of UK employment (except during a severe economic depression) and insisted that the MOD's comparative assessment of rival projects should take no account of their presumed effect on employment. (Kirkpatrick, 2008, p.303). A later view points out that the proposed industrial system may not be adaptive enough to meet the challenge of the unpredictable broader range of threats that are likely to arise. It should be designed in accordance with axes of uncertainty rather than from a snapshot of the future. This approach would need to be supported by "a collaborative system between industry and government with systematic information sharing" (Consulting PA, 2021).

In addressing these aspects of complexity, Louth and Taylor (2018) advocate a portfolio management approach to the sector. To that end, they recommend a range of initiatives on government policies, behaviours and practices which cover both procurement processes and industrial strategy. On procurement they see the need: to sustain sovereign capability through industrial partnerships; to create onshore modification ability for imported equipment; to collaborate with peer partners on capability development; but also, to emphasise the role of competition in selecting industrial partners. On broader industrial strategy, they cite the need for proactive programme and supply chain management, and for prioritisation and focus on the critical strategic industrial capabilities. Their strongest point is the recognition that "future defence capabilities remain technology rich" which places a premium on government investment in science and technology and a willingness to "champion experimentation, adaptability and early adoption of disruptive technologies" (Louth and Taylor, 2018, p.1). While many in government procurement agencies would recognise the validity of this latter view, experience of failed projects through inexpert judgments on technology maturation leads them towards a risk averse approach. This is particularly the case in defence equipment which are rightly characterised as systems of systems where the initial integration of new technology also carries high risk. More significantly, Louth and Taylor see the coalescence of this activity in the form of "the government in general, and the MoD in particular, should see itself as the programme director or prime contractor for defence capability generation" (Louth and Taylor, 2018, p.21). This recommendation arises from MOD's own admission that it is largely unsighted on the robustness of its prime contractors' supply chains and their ability to surge in harmony with an increase in military tempo (MOD, 2017a, p.21).

Clearly, such a managerialist role for MOD has the potential to render ambiguous the current protocols of risk transfer from customer to contractor. Apart from requiring the addition of scarce

project management staff, such a move would also need to be integrated within the existing triad of MOD roles of customer, sponsor and regulator (Heidenkamp et al, 2013). Nevertheless, this maximalist approach gained subsequent prominence in 2021 as the UK responded to the need to sustain Ukraine's warfighting capability through the transfer of defence equipment and ammunition (Parliament, House of Lords, 2024). However, given its position as a monopsony customer, a government should already be well-placed to "use its buying power to determine the size, structure, conduct, performance and ownership of its national defence or arms industry" (Hartley, 2020, p. 17). This ability has been deployed in the past when major economic or geopolitical shocks have led to a requirement for either surge of output, as in the 2003 Iraq war, or consolidation of the defence industrial base after the end of the Cold War (Kaldor and Schméder, 1997). The spectre of an all-powerful 'military-industrial complex' that this approach would represent operating with the acquiescence of some elements of government has for decades been viewed with caution by western liberal democracies (Dunlap, 2011). Hence, the political and sociological understanding that a nation exhibits over the role and functioning of the defence industrial base is a key factor in creating the incentive for firms to operate in the defence market and to invest accordingly.

Concluding Appraisal of the Literature

The literature on broader UK industrial strategy is comprehensive across the period but unsurprisingly has little to say about the period between 1979 and 1997 when the Thatcherite doctrine of the free market prevailed. Thereafter, the renaissance of industrial strategy saw a return of academic interest in which there is recognition of the short-termism and its lack of stability as government policy. There is also limited analysis of the validity of, and interaction between, horizontal versus vertical initiatives. *Building a Britain fit for the Future* (BEIS, 2017) contained eleven detailed vertical components known as 'sector deals' falling into the trap of promoting something for everyone. Yet there were few concerns in the literature over the challenge that this approach represented to the departments concerned in synchronising the individual elements of the strategy and securing the relevant funding. More broadly, there is a common theme across the literature that the UK is not adept at creating industrial strategy, largely resulting from the dysfunction in the associated machinery of government, yet few academic authors suggest how this should be addressed. Critical assessment is also missing about the overtly political presentation of industrial strategy which applies a 'soundbite' approach of 'magical thinking' to asserting easy solutions to difficult problems (White, 2024). Apart from undermining its credibility as policy, such a weakness limits the appeal to successive governments even of the same political party. The implementation of the skills agenda is one such example where the 2017 industrial strategy gave minimal detail beyond the headlines whereas the 2021 version prioritised technical skills based on

a transformation programme for further education colleges and a reinvigoration of apprenticeship schemes (ISC, 2021). Of note, the 2021 strategy was a Treasury document whereas that issued in 2017 was led by the business department. Strategy by its nature should set out a long-term roadmap by which industry and investors can make decisions based on policy stability such that it provides a dispassionate appraisal of the way in which the engine-room of the UK economy needs to function to stimulate industrial activity.

The literature on DIS demonstrates the complexity in determining a strategy between the minimalist school of thought of buying off-the-shelf on the global market and the maximalist approach of total self-sufficiency in defence procurement (the 'make or buy' decision). Matthews refers to this dilemma succinctly as the need to compromise "between Adam Smith's liberalist free market principles and Keynesian macroeconomic 'interventionist' policies (Matthews, 2019, p.480). The precise position of the cursor between these two poles is determined through the requirement for sovereign capability but other factors constrain decision-making. Consistent elements of defence policy across the period of this research have seen the UK maintaining its nuclear deterrence posture, maintaining a leading role as a member of NATO, whilst also maintaining a high-readiness, full spectrum force structure against a backdrop of increasingly variable threats and tight financial strictures. Against those requirements, academic commentary sees the approach to identifying sovereign capability as unduly complex with an over-reliance on basing assessments of operational effect on superficial analysis. That said, while defence economists accept the necessity of determining sovereign capability and do recognise the pressures to 'buy British', they are critical over the lack of comparative cost data on the alternatives. More broadly, there is academic consensus that governments base their judgements on an inadequate understanding of the structure and performance of the supply chains supporting the UK defence industrial base. In aligning DIS with defence policy objectives on force structure, there is agreement that, despite the original source of the equipment, there is a valid requirement for onshore capability to support, modify and upgrade equipment in a timely manner that aligns with the unpredictable nature and agility of the threat. In view of the dominance of the US as a supplier, the literature recognises the inherent naivety in DIS assumptions on the potential ease of access to offshore intellectual property following an off-the-shelf equipment purchase. There is thus consensus that the UK's interests would be better served by taking a broader view in its assessment of sovereign capability to encompass critical aspects of operational independence and security of supply

On routes to contract, the language on partnering was often seen as lacking precision with little underpinning cost analysis to support that approach (Parliament, House of Commons, 2006, Hartley and Fitzpatrick, Ev.85; Louth, 2012; Louth and Taylor, 2018). In addition, guidance on future

technology requirements tended to be unmatched by detailed government investment plans. More broadly, the literature pointed to an overall reluctance in the strategies to provide robust financial data to underpin its conclusions (Hartley, 2007; Taylor 2021; Watkins, 2021). As for the influence of DIS on project management outcomes, the literature is sceptical over the strategies' potential to deliver improvement. Authors also recognise that the short-termism inherent in the current project-by-project fixation on narrow contracting outcomes does not incentivise long-term market participation which has implications for the sustainability of the defence industrial base. The consensus in the literature is that the exposition of DIS in the period of this research does not provide a plausible balance between ends, ways and means, with the latter as a particular area of neglect. Overall, the literature creates doubts that DIS contributes effectively to underpinning the credibility perspective in the deterrence equation. In addition, the tenuous approach to sovereign capability (including operational independence and security of supply) and the propensity towards US procurement serves to undermine the sustainability of the defence industrial base.

In terms of this thesis, there are three gaps in the academic literature on issues which potentially limit the traction of DIS within the defence enterprise and therefore undermine any potential influence that the strategy might have had on procurement performance. First, the literature is clear on the theoretical advantages of partnering in preserving onshore industrial capability, enhancing value for money and delivering through-life support. However, the barriers to the promotion of long-term strategic relationships with industry arising from the deep legacy of competitive procurement go largely unexplored. Secondly, given the government's acceptance that the UK cannot preserve an onshore end-to-end capability in all areas of defence equipment, the literature does not address how operational independence will be delivered. Shaping the industrial base through procurement choices is resource limited by the equipment budget so alternative commercial arrangements are required which would provide security of supply in times of increasing tension. Thirdly, the implications for DIS deployment of a continually overheated equipment plan are not explored in depth in the literature. The over-ambitious objectives in successive editions of DIS (the 'ends') have been misaligned with the prevailing adverse defence financial landscape (the 'means') within which much tension is generated from project cost overruns. Inadequate project management (the 'ways) exacerbates the problem through the generation of turbulence in the equipment plan arising from inaccurate forecasting of cost and time. The hypotheses at Chapter 1 seek to direct this research towards addressing these gaps.

Chapter 3 – Conceptual Framework

> *The only things that evolve by themselves in an organization are disorder, friction and malperformance*. (Peter Drucker, 1995)

Context

To validate the research hypotheses, it would be appropriate to create a conceptual framework to explore how the various features of the defence procurement ecosystem Interact to influence the eventual outcomes. The first step in the research methodology therefore needs to identify concepts and theories that can be applied to the defence procurement enterprise to guide subsequent elements of the research. Three aspects are relevant. First, the relationship between organisational structures and their permeability to the implementation of strategy is of key importance. Secondly, the degree to which the design of a DIS is appropriate to the special characteristics of the defence equipment enterprise is highly relevant. Thirdly, the nature of the processes of decision-making and forecasting within the procurement ecosystem with its endemic characteristics of uncertainty, complexity and risk is a known problem which could represent a barrier to the implementation of DIS. These aspects could apply in different ways to the four constituents of the defence procurement enterprise. Industry has a vested interest in winning contracts, the front-line customer must compete for funding in an overheated equipment programme, and the MOD Head Office has to provide financial assurance and oversight but the application of the procurement processes by DE&S as the delivery organisation is of paramount importance. The DE&S has responsibility for the assessment of risk associated with the contract forecasts on cost, time and performance which directly influences the relationship with industry. It is also possible that the culture of the organisations at either side of the contracting interface is not homogeneous. Tribalism might exist such that DIS implementation is undermined by self-interested behaviour patterns adopted by groups smaller than the organisation.

The second step in the methodology is to establish whether each version of DIS in the period 1998–2023 provides a plausible route-map of ‘ways’ by which to achieve the selected ‘ends’ or objectives set out in the strategy. If not, it would lack credibility and fail to get traction across the defence equipment enterprise thereby undermining effective implementation. Implementation would also suffer if the strategy failed to address industry’s legitimate needs for transparency on future requirements or if there was a lack of precision on sovereign capability. The analysis will also assess the plausibility of the strategy against the prevailing defence budget and broader economic context. In essence, a successful DIS takes a top-down approach to setting the framework for the way in which the MOD will act as a customer and its aspirations over how the defence industry will respond. Properly implemented, DIS permits industry to make judgements over its investment in

people, capital facilities and research. This analysis will seek to isolate the relevant elements within successive editions of DIS through case studies and elite interviews. Consequently, step three is the consideration of three aerospace procurement case studies which together took place across the period of this research and reflect the content of successive editions of DIS. The aim is to reveal detailed aspects that either support the hypotheses or need to be resolved in the fourth step which comprises 20 elite interviews with senior industrialists, current or former senior defence officials and a former minister. Having validated (or otherwise) the hypotheses, the research turns to recommendations as to how the content and implementation of DIS might be improved.

Informing the hypotheses

Investigation of the first conceptual theme in the hypotheses on the impact of DIS on partnering relationships with industry requires consideration of concepts and theories associated with organisational structure. MOD's procurement enterprise could be characterised as a machine organisation (or machine bureaucracy) given its extensive technostructure consisting of a network of professionals such as engineers, accountants, lawyers and administrators (Mintzberg, 2008). Such a structural capability is necessary to overcome the inherent complexity of defence equipment projects, particularly those in aerospace. But "the machine organization tends to resist external changes in order to maintain its standardized process and steady output" in favour of its preference for "stability, or perhaps more accurately, continual fine tuning of its business model" (Mintzberg, 2008, pp. 349-350). The literature review recognises the complexity and risk inherent in the procurement of advanced defence equipment with each representing a system of systems. The challenge in integrating the individual system elements without prejudicing combat performance or reliability is very significant. The range of technical variables at play draws on the expertise of the technostructure but also seemingly serves to militate against an externally imposed DIS becoming embedded. Analysis of the second conceptual theme on securing operational independence would benefit from consideration of the theories on effective industrial intervention by governments. This hypothesis recognises that the objectives within DIS are not always mutually coherent. There is an inherent tension between seeking to protect sovereign capability and security of supply whilst striving to stimulate a competitive market in the quest for value for money which might erroneously assume the existence of a free market. Conversely, in bringing individual projects to contract, the focus is often on a limited niche of the market where the monopsony/monopoly characteristics limit the room for manoeuvre. It therefore seems appropriate that a DIS should address market configuration rather than simply the routes to market.

The process theme embraces two hypotheses involving procurement process and financial management. The former concerns the complexity of decision-making, forecasting and assessment

of risk under conditions of uncertainty. The literature is clear that management of the equipment programme is hampered by inaccurate costing and limited appreciation of technical risk, particularly in systems integration, but also that related to manufacturing complexity. It thus seems likely that the concepts of moral hazard, adverse selection and optimism bias are relevant. Fortunately, Nobel Laureates Akerlof (awarded in 2001), Arrow (1972) and Kahneman (2002) have contributed to the body of knowledge in this field with remarkable alignment in their conclusions. Of note, optimism bias is widely recognised both internally and externally as a significant shortcoming in public sector procurement, yet the related departmental analysis and remedial action is seemingly superficial. In some cases, analysis is clouded by the perception of a 'conspiracy of optimism' where industry and elements of MOD are deemed to collude by advancing unrealistic forecasts of performance, time and cost to gain funding within an already overheated equipment plan (Kincaid, 2008). While the accusation continually re-emerges in populist political discourse (Parliament, House of Commons, 2023a), Gray (2009) found no evidence of the practice in his independent review of acquisition for the Secretary of State for Defence. Of note, the subsequent independent 2011 Levene Report on Defence Reform made a single reference to the conspiracy of optimism as a problem between MOD 'tribes' but adduced no evidence as to its existence nor made further mention elsewhere and was absent in its recommendations for change (MOD, 2011, p.13). A more elegant approach to this perceived phenomenon, which is discussed later in this chapter, arises from Flyvbjerg's (2021) segmentation of cognitive bias into ten categories that provide insights into the motivations that arise. The fourth hypothesis considers the financial environment within which defence equipment projects must be delivered and focuses on the criticism of financial control which was not prominent in the literature review. Investigation through the case studies and interviews will determine how cost increases are accommodated, particularly those that occur either when problems arise in achieving the required performance specification or when risks become manifest to the extent that delivery must be delayed. These factors, in turn, call for the reprofiling of capital expenditure within the defence equipment plan to prevent departmental control totals being breached. Similarly, cost growth in high-priority projects elsewhere in the programme creates financial pressure which must also be addressed through reprofiling. In addition, the MOD has very limited flexibility in carrying-over unspent capital funding from one financial year to the next, calling for deft management in avoiding the surrender of cash to the Treasury. Against this backdrop, bringing an already complex project to contract with the necessary trade-offs between time, cost and risk leaves little room to adjust for the additional requirements of a DIS.

The theory of the organisation

Mintzberg's writing on business strategy spans more than 50 years and pays particular attention to the relationship between the structure of organisations and the reality of the way in which they function. In his view: "The structure of an organisation can be defined simply as the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them" (Mintzberg, 1979, p.2). He first identifies five mechanisms by which organisations coordinate their work to achieve their objectives: "mutual adjustment, direct supervision, standardisation of work processes, standardisation of work outputs, and standardisation of worker skills" (Mintzberg, 1979, p.3). While most organisations deploy a mix of these mechanisms, conducting complex activity is deemed to require process standardisation and in the case of those activities with the highest complexity, there is also the requirement for standardisation of skills. Secondly, he then identifies the five building-blocks of contemporary organisations: "the operating core, strategic apex, middle line, technostructure, and support staff" (Mintzberg, 1979, p.14). The role of the operating core and the support staff are self-evident but he segments the management function into two levels: the strategic apex is formed of those at the top of the organisation who in modern organisations form the executive committee or similar, while the middle line is the management layer that joins the strategic apex to the operating core. According to Mintzberg and sitting to one side, the technostructure consists of the 'analysts' who "carry out their work of standardising the work of others, in addition to applying their analytical techniques to help the organisation adapt to its environment" (Mintzberg, 1979, p.19). Here, the term 'analysts' is applied to the collective activity of a network of professionals such as engineers, accountants, lawyers and administrators. The third dimension considers the way in which decision-making power is distributed throughout the organisation and the resultant impact on the implementation of strategy. This aspect is codified as vertical decentralisation, horizontal decentralisation and selective decentralisation, where the latter signifies an approach whereby specific units within the organisation are empowered to make decisions within defined boundaries.

Organisational structures

In further developing this analysis, Mintzberg theorises that organisational structures can be classified according to their alignment between three characteristics: "the key part of the organisation; the prime co-ordinating mechanism and the type of decentralisation" (Lunenburg, 2012, p.3). From these Mintzberg determines that organisations can be broadly classified as one of five structural configurations: simple structure, machine bureaucracy, professional bureaucracy, divisionalised form and adhocracy as shown in Table 3.1. Two additional structures were added after further research: the missionary organisation primarily driven by ideology; and the political organisation which lacks the sense of order present in conventional organisations (Mintzberg,

1989). He also adjusted the configuration titles. In particular, the term bureaucracy was amended because, to some commentators, it was seen as a pejorative term as representing, "the locus of excessive control, of managers lording authority over workers, and workers lording control over clients" (Mintzberg, 1989, p. 131).

Configuration Title 1979	Configuration Title 1989	Prime Coordinating Mechanism	Key Part of Organization	Type of Decentralization
Simple structure	Entrepreneurial organization	Direct supervision	Strategic apex	Vertical and horizontal centralization
Machine bureaucracy	Machine organization	Standardization of work processes	Technostructure	Limited horizontal decentralization
Professional bureaucracy	Professional organization	Standardization of skills	Operating core	Vertical and horizontal decentralization
Divisionalised form	Diversified organization	Standardization of outputs	Middle line	Limited vertical decentralization
Adhocracy	Innovative organisation	Mutual adjustment	Support staff	Selective decentralization
-	Missionary organisation	Standardization of norms	Ideology	Decentralization
-	Political organization	None	None	Varies

Table 3.1 - Mintzberg's Organisational Structures Source : Mintzberg, 1979, p.301 & Mintzberg, 1989, p.110.

In terms of where a defence equipment procurement enterprise would fit in this typology, two aspects are predominant: the extent of standardisation and the way in which hierarchical control is affected by decentralisation. This points towards classification as either a 'machine organisation' or a 'professional organisation.' The former is an "Integrated, regulated and highly bureaucratic" closed system with an intense control mentality in a bid to eliminate uncertainty and generate stability (Mintzberg, 1989, p. 133). As such, this type of bureaucratic momentum suits large manufacturing industries such as automotive and aerospace. In addition, many public sector activities commonly follow this structure in cases where there is public accountability for the probity of their actions or a particular need for safety as a characteristic the output. This approach also calls for a sizeable technostructure by which to implement standardisation of process. It is arguable that the higher complexity of systems integration skills necessary in a defence firm leads to an organisation with many mini-technostructures. However, in ensuring that these multiple outputs mesh successfully, high degrees of standardisation are required thus reinforcing Mintzberg's classification. Likewise, at this level of complexity there is doubt over the organisation's true ability to eliminate uncertainty when operating at the leading edge of technology which brings

novel integration challenges and when employing advanced and untried manufacturing processes. As the case studies later demonstrate (particularly that on Crowsnest), in an era before model-based engineering allowed the creation of a digital twin, the limited de-risking of these challenges saw a tendency to accept levels of uncertainty on the assumption supported by scant evidence that there was a low probability of problems arising.

Turning to the professional organisation which achieves coordination through the standardisation of skills rather than of process, “control over their work means that professionals work relatively independently from their colleagues but closely with the clients they serve” (Mintzberg, 1989, p. 175). “But no matter how standardized the knowledge and skills, their complexity ensures that considerable discretion remains in their application” (Mintzberg, 1989, p. 175). This approach is common in management consultancies, public accounting firms and universities. Unlike a machine bureaucracy which generates its own standards, the professional organisation, while still technically bureaucratic in that coordination is achieved through standardisation, many of the applicable standards are often mandated from outside the organisation through professional registration or other specialist self-governing associations. Hence, “whereas the machine bureaucracy relies on the authority of a hierarchical nature – the power of office – the professional bureaucracy emphasizes authority of a professional nature – the power of expertise” (Mintzberg, 1989, p. 175). In the former case, the power of office also embraces the kudos that attaches to membership of the technostructure which recognises status arising from expertise. On this basis, a defence equipment procurement enterprise would be classified as a machine bureaucracy.

In selecting his five (later seven) organisational structures, Mintzberg cautions against assuming that they are “perfectly distinct and encompass all of organizational reality” (Mintzberg, 1979, p.304). However, he recognises that, generically, the technostructure operates at all levels of organisational hierarchy. In particular, he notes that:

> At middle levels, they seek to standardize the intellectual work of the organization and carry out operations research studies of informational tasks. On behalf of the strategic apex, they design strategic planning systems and develop financial systems to control the goals of major units (Mintzberg, 1979, p.31).

Acknowledging the primacy of the technostructure in the machine bureaucracy, Mintzberg characterises it as being obsessed with control based on two aspects:

> First, attempts are made to eliminate all possible uncertainty, so that the bureaucratic machine can run smoothly, without interruption. Second, by virtue of their design, Machine Bureaucracies are structures riven with conflict: the control systems are required to contain it (Mintzberg, 1979, p.319).

It is arguable that these characteristics are observable within the defence equipment enterprise on both sides of the customer-supplier interface which is less rigidly defined and more permeable than that relevant to sectors operating in a free market. In defence aerospace procurement, a constant risk trade-off is in progress between cost, time and capability given that the technology and manufacturing processes involved often yield unanticipated performance and integration challenges. Apart from the contractual implications for suppliers, the level of external political and institutional scrutiny in place brings with it the prospect of reputational damage and ministerial sanction. Hence, the scrutineers and financial controllers in the technostructure work hard to eliminate requirement creep and cost growth which often plays against the interests of engineers and project managers. Such internal tensions are resolved through the primacy of budgetary discipline so can be managed internally provided that the required performance criteria can be met. In other cases which arise either from an initially over-optimistic assessment of a project's development complexity or from externally imposed financial constraints, this preference for stability becomes a handicap. A decision to cancel an ailing project or to reprioritise it within a portfolio of projects to fit a reduced budget profile is often taken too late (Parliament, Hose of Commons, 2024).

On standardisation of process on the customer side, the UK mechanism for defence procurement is highly codified and follows the first four phases of a process known as the CADMID cycle (Concept, Assessment, Demonstration, Manufacturing, In-service, Disposal) within which there are eleven defined stages. In common with all government procurement, progress from one phase to the next is regulated by standardised gate reviews supported by business cases of increasing granularity which are also designed to identify and mitigate project technical and financial risk. Three gateways are relevant to the procurement mechanism: business justification, delivery strategy and the investment decision ahead of contract signature. Business cases must be structured according to the 'five case model' consisting of the strategic case, the economic case, the commercial case, the financial case and the management case. Highly detailed regulatory requirements and process guidance is contained in an array of government documents such as *Managing Public Money* (288 pages) (HMT, 2025), *The Green Book: appraisal and evaluation in central government* (120 pages) (HMT, 2022), and the *Guide to Developing the Project Business Case* (120 pages) (HMT, 2018). The high-level interpretation of these documents is further

contextualised for defence equipment procurement in the *Defence Equipment and Support: Framework Document* (55 pages) (MOD, 2021b) which details for its 12,000 strong workforce the procurement organisation's operating model, departmental obligations and requirements to achieve value-for-money from its £12 billion budget. More detailed operating guidance for staff is contained in an extensive, online management information system known as *Knowledge in Defence* (MOD, 2024d). These standardised processes also have positive implications for guaranteeing the safety of advanced systems.

In some areas, compliance with this extensive process is also required of suppliers, particularly in the preparation of bid proposals and the submission of data. In addition, as an enterprise, defence equipment procurement is also subject to scrutiny by the National Audit Office, the Infrastructure Projects Authority and the Parliamentary select committees for defence and public accounts. In summary, defence equipment procurement is extensively standardised and deeply complex and thus calls on the expertise of large numbers of experienced and highly qualified people, the majority of whom represent the technostructure. The power of the technostructure in a defence setting rests heavily on the expertise and experience of the people involved and their decision-making acumen. Selection of the required people is the role of the civil service recruiting system which segments the functional professions into areas such as commercial, finance and project delivery: there are also specialist professions such as science and engineering. Entry normally requires a relevant degree and is highly competitive (CSC, 2025). Specialist in-house training and development is provided according to discipline underpinned by qualifying for membership of external professional bodies such as the Chartered Institute of Procurement & Supply (MOD, 2024b, pp.90-91). Military procurement personnel who are in the minority follow the same pattern of training and development but tend not to specialise to the same depth. However, the procurement organisation suffers from excessive personnel churn, leading to a weakness in terms of low experience levels on which much of the required expertise and decision-making acumen relies (NAO, 2021a, p.48). This aspect is discussed further in the following section on cognitive bias.

Organisational structure and strategy

The promulgation of a DIS is intended to permeate all elements of the defence procurement ecosystem. On the customer side, this includes: the MOD Head Office in its investment approval and assurance roles; the front-line commands who, as the end user, also hold some of the project budgets; and the procurement organisation which negotiates contracts to meet time, cost and performance criteria and provide project management. Of note, in this context, the budget holder does not have full financial freedom. Rather, while there is a delegated project ceiling of £400 million to front-line commands, authority to commit expenditure above £100 million is subject to

Head Office scrutiny. In addition, all projects must be supported by an endorsed business case. As a result, while a budget holder's power is limited, there are in-year freedoms to manipulate individual cost elements to remain within the control total. On the supplier side, the firms comprising the UK defence industrial base and their supply chains are the primary audience as are offshore suppliers with or without manufacturing footprints in the UK. In terms of the successful delivery of aerospace projects, the key success factor lies both with the procurement organisation and the chosen supplier and is dependent on their collective expertise in managing risk. Both entities can be described as machine bureaucracies and both are exposed to the impact of bottom-up acquisition reform initiatives competing with top-down strategic imperatives arising from a DIS. They also determine their own internal business strategies based on their own goals and imperatives. An important organisational characteristic for this research is therefore the way in which strategy is formulated and implemented in a machine bureaucracy. Mintzberg determines that:

> We emerge from this discussion with two conclusions. First, strategies must be formulated outside the machine bureaucratic structure if they are to be realistic. Second, the dichotomy between formulation and implementation ceases to have relevance in times of unpredictable change. Together these conclusions tell us that Machine Bureaucracies are fundamentally nonadaptive structures, ill-suited to changing their strategies (Mintzberg, 1979, p.319).

Mintzberg explored this conclusion further in a study tracking the formulation and implementation of strategy over an extended period in eleven organisations representative of his typology of structures (Mintzberg, 2008). He sought to discriminate between applying a deliberate, formulated strategy, and strategy as an emerging pattern of behaviour. He was clear that management was "mesmerized by the myth of control" but adds that, "If deliberate strategy is about control, then emergent strategy is about learning" (Mintzberg, 2008, p.5). To that end, he hypothesises that: "Purely emergent strategies may be rare—they imply no control. But hardly less rare are purely deliberate strategies—they imply no learning—even though that is what most of the literature prescribes" (Mintzberg, 2008, p.5). He also sought to discriminate between the implementation of strategy as a transformational activity and its implementation through reprogramming already existing plans. Four of the organisations studied were deemed to be machine bureaucracies and shared common characteristics in that they were mature organisations operating in an environment exhibiting long-term stability with only occasional disruption. Earlier research on machine bureaucracies recognised that, given their propensity towards standardisation based on the need to maintain a constant output, the resulting optimisation of their structure lacked the

flexibility to absorb external change (Mintzberg, 1989). Consequently, their approach resulted in a preference towards fine-tuning the business model rather than towards significant change unless driven by a crisis. He cautions that the bureaucratic momentum represented by formal planning meant that, "the focus on strategic planning as programming can render the management insensitive to important changes taking place in the environment" (Mintzberg, 2008, p. 352). Implementation was also affected by where in the structure information is concentrated: "As people who are naturally in touch with the specific situations at hand take individual actions … patterns form, in other words, strategies emerge" (Mintzberg, 1989, p.150). He concludes:

> The machine configuration is ill-suited to change its fundamental strategy, that the organisation must in effect change its configuration temporarily in order to change its strategy (Mintzberg, 1989, p.150).

The fuel in the engine room of the UK's defence equipment procurement enterprise is the MOD's ten-year equipment plan currently consisting of some 1800 projects at a cost of £242 billion (NAO, 2023). This tightly drawn plan is under constant financial pressure both from government budgetary strictures and the cost growth of individual projects as risks materialise. Adherence to project delivery dates and the requirement to meet performance specifications are highly relevant to the armed forces in meeting their capability requirements. There are also cost implications in running-on old equipment if the replacement is overdue. Likewise, procurement performance shortfalls attract political and media criticism. In some extreme cases, poor performance can lead to project cancellation. Against this backdrop, those involved in procurement are immersed in the detail of contracting and then delivering their individual project which, as Mintzberg suggests, represents a significant bureaucratic momentum. It is therefore possible these factors leave little spare capacity to absorb the type of strategic change embraced by a DIS and thus prevents it from becoming embedded.

The theory of industrial intervention

In creating a Defence Industrial Strategy (DIS), the UK government is seeking to manipulate the supply side of the market to meet the objectives that, "We must not only ensure that our forces have the right kit and equipment, but that we maintain capabilities onshore to produce and support critical elements for our national security and ensure that our supply chains are sustainable and resilient" (HMG, 2021a, p. 2). With a 2024 turnover of £35 billion (ADS, 2025, p.3), the UK's defence industrial sector is stable, mature and operates in a comparatively large domestic market which is open, competitive, technologically advanced and stimulated by the UK's world-class science ecosystem. In terms of a European comparison, the defence industrial sector had a total 2022

turnover of €118 billion (ASD Eur, 2022, p.14). Within this figure the French turnover was €50.9 billion (including exports of €27 billion), that for Germany was €24.5 billion (including exports of €6.5 billion) (Calcara and Simon, 2024, p. 1398) and for the UK €26.7 billion (including exports of €13.3 billion) (ADS, 2023). Of note, there is no common data definition for defence exports. Whereas SIPRI uses the value of actual transfers between customer and supplier, some nations (such as the UK) use the figures for sales' contracts signed, with delivery potentially taking place over several subsequent years. Clearly, if the figures arising from the two methodologies are aggregated over a decade, then the values converge. That aside, whilst direct comparisons are misleading given also the peaks and troughs in a nation's equipment plan and the major swings in export revenues, the comparison between the French core domestic revenue of €23.9 billion and that of the UK at €13.4 billion indicates the impact of the openness of the UK defence equipment market, largely to the advantage of the US.

While DIS is a vertical industrial strategy, a wider consideration was included in the 2021 version stating: "So with our partners across government, we have a vision to unlock the potential of the defence and security industries to make a virtue of the immense social value they bring to our nation" (HMG, 2021a, p. 2). However, with a monopsony buyer and a supply-side characterised as an oligopoly but sometimes a monopoly, UK defence equipment is not traded in a free market. This aspect determines the nature and extent of the application of industrial policy and its accompanying industrial strategy. Examination of the theory of industrial strategy could also reveal inherent limitations in the effectiveness of a DIS in its ability to influence grassroots contracting activity between customer and supplier. In applying industrial strategy to the defence sector Gansler (1987) is clear that, because there is not a free market nor is it plausible to create one, application of the 'theory of the second best' is appropriate where:

> Each individual sector of the economy must be treated as a special case. Each must be analysed on its own merits to determine what combination of domestic or international competition might be best under the circumstances" (Gansler, 1987, p. 48).

This analysis is highly germane to the UK defence market. The Levene reforms of the mid 1980s which left competitive defence procurement to market forces in the pursuit of value-for-money was an attempt to pursue a 'first best solution'. In its purest form, this approach would amount to off-the-shelf procurement with no government investment in R&D and with the contract going to the lowest compliant bidder. However, the customer's notion of competition by default could not

flourish in a post-Cold War world where industrial consolidation limited bidders to a relatively small number of suppliers at prime contractor level.

The theory of 'second best'

The theory of second best rests on the early work of Lipsey and Lancaster (1956) which drew on the post-war interest in the discriminatory reduction of trade barriers. They determined that there were exceptions to the 'first best' economic equilibrium represented by the Pareto criterion on measurable efficiency. Pareto optimisation assumes that resources are allocated as efficiently as possible such that, "it is impossible to make anyone better off without making someone else worse off" (Hahnel, 2014, p.34). In defence procurement, aspects that would undermine the Pareto equilibrium to the detriment of all but the chosen contractor might be customer constraints on sovereign requirements, intellectual property access or implausible expectations of risk transfer. Given the nature of these constraints in the defence equipment market then the 'second best' theory applies which rests on the condition that:

> If there is introduced into a general equilibrium system a constraint which prevents the attainment of one of the Paretian conditions, the other Paretian conditions, although still attainable, are, in general, no longer desirable. … The general theorem of the second best states that if one of the Paretian optimum conditions cannot be fulfilled a second best optimum situation is achieved only by departing from all other optimum conditions. (Lipsey and Lancaster, 1956, pp. 11-12).

In essence, even in the Paretian optimum, some constraints are deemed to exist which, for example, might arise in terms of limitations to the configuration of production capability or through policy action on taxation. In the theory of the second best, one or more additional constraints can arise which undermine at least one of the conditions for Paretian equilibrium. These types of additional constraints exist in the defence equipment sector, which is neither a free market nor, potentially, is there symmetry of knowledge between customer and supplier. Conversely, defence departments occupy a compelling governance position over industry in the roles of customer, regulator and sponsor with an overriding requirement to deliver a sustainable defence and security posture. Nevertheless, even experienced bureaucracies would find that selective intervention "through first best instruments of coordination, subsidization and capital market promotion" would exceed their administrative capability (Pack and Westphal, 1985, p.118). In updating the application of the second best approach, Warwick (2013) theorises the need for a framework that focuses on "interventions that help build systems, create networks, develop institutions and align

strategic priorities" (Warwick, 2013, p.47). In seeking to identify a theoretical role for government in its relationship with industry, where strategic intervention is necessary (as in the case of a DIS), he advocates a 'soft' form of industrial policy. This approach is aimed at mitigating the risks of government failure, rent-seeking and protectionism by placing government in a facilitative role as a way of overcoming coordination problems. This would seem highly relevant to DIS in that:

> This approach is somewhat wider than – but does not displace – the 'market failure' rationale. It addresses the broad set of interactions between groups of key institutions that create the operating environment and learning context for firms. Implied in the systems approach is that governments interact with firms in numerous ways, and that an essential government role is to engage in dialogue with business in order to establish where public support is best deployed in order to capitalise on positive externalities, without the process being captured by any special interest group (Warwick, 2013, p.22).

This represents a conceptual shift away from the hard-edged 1985 Levene reforms. Also, while not directly challenging Hartley's perspective on governments as a customer exerting power over the market by their procurement choices (Hartley, 1998), it does alter the dynamic of the route to contract. Warwick's framework points towards a government-industry partnership approach, he guards against the creation of a cosy relationship in his condition "without the process being captured by any special interest group (Warwick, 2013, p.22).

Intervention in the defence industry

Warwick recognises that common elements of industrial policy and strategy such as growth in productivity and employment may not be sufficient to satisfy the full range of government objectives. Citing DIS as an example, he points out that broader goals might need to be closely integrated with other wider government policies. This is an important aspect in creating a DIS in that there needs to be a golden thread of coherence between national defence and security policy, the resulting force structure and the characteristics of the market represented by the industrial base deemed appropriate in meeting the equipment and support needs. This aspect is further explored in Chapters 4 and 5. Warwick also considers that "Perhaps the large number of dimensions to industrial policy, broadly defined, is one of the reasons why no clear taxonomy for industrial policies has yet emerged" (Warwick, 2013, p.17). In seeking to rationalise the approach he lists some possible dimensions of a framework for industrial policy which begins with precision over the aim and clarity about the target group. The most compelling element is that aiming to define the rationale:

> Is the philosophy that the distribution of economic activity should generally be left to the market, is there a role seen for correcting market failures or, indeed, is market failure regarded as endemic? To what extent does thinking based on new growth, evolutionist and institutionalist models shape the approach taken to addressing market failure? How is systems failure viewed? What about government failure? Are there areas where government action can be particularly effective in reducing distortions or unlocking inertia? (Warwick, 2013, p.17).

It then follows that identification of the specific policy domain is necessary between, say, outputs such as products or inputs covering labour, capital and technology. This then leads to 'policy orientation' in terms of the choice between horizontal or vertical strategies. It is stressed throughout that, "Knowing the aims and objectives of industrial policy is of particular importance when it comes to carrying out *ex post* evaluation of its success" (Warwick, 2013, p.17). However, two factors hamper the historical evaluation of the effectiveness of industrial policy and strategy: first, "Since there is no unanimity about the important elements, there is no consensus about what constitutes 'industrial strategy'" (Pack and Westphal, 1985, p. 88). Secondly, there is a problem in empirical analysis, most of which is centred on developing rather than mature economies, in that it is difficult "to assess the behavioural additionality of policies and to analyse if the [industrial] policy itself was truly responsible for the final outcome" (Warwick, 2013, p. 22). While there are instances where government intervention has seemingly brought success, there are many examples where there are no detectable improvements. But overall "the difficulty of constructing a single agreed-upon counterfactual precludes a robust conclusion" (Pack and Saagi, 2006, p.284). Nevertheless, Warwick's theories are taken up by subsequent UK consideration of industrial policy by the Institute for Public Policy Research (Jacobs et al, 2017) and the Institute for Government (Wilkes, 2020). The latter study, entitled *How to Design a Successful Industrial Strategy,* developed a detailed framework for design and implementation within the context of the UK economy.

Theories of uncertainty and risk

Forecasting project outcomes in terms of time, cost and performance is rarely based on perfect information at the outset. Yet creating the impression of initial certainty when supporting data is tenuous 'bakes-in' risk into the contracting process which can have profound consequences when reality dawns as the project progresses. In the public sector, early forecasts of the time and cost to achieve project outcomes become embedded in budgetary allocations and, for defence, in the

plans for subsequent integration into the force structure, a process that also carries additional costs. Ultimate failure to meet these criteria results in funding turbulence within inflexible budget arrangements and consequent reputational damage to both customer and supplier. Given the complexity of defence equipment procurement both the customer and the supplier need to conduct robust risk analysis at the outset, updated as the project progresses. Technical risk, design risk, integration risk and business risk can become manifest at different stages in the project but sometimes arise simultaneously, leading to a level of cumulative risk that becomes untenable and calls for cancellation of the project. The robust assessment of risk in terms of its likelihood and impact which relies on accurate information is thus a vital factor in successful project delivery to time, cost and performance. However, complex projects involving leading-edge technology and untried manufacturing processes are hallmarked by uncertainty and do not necessarily yield a full suite of information at the outset. The level of ambiguity involved can also be exacerbated by the way in which both customer and supplier are each incentivised by their own perception of the validity of data and thus accept different levels of risk in pursuit of a successful project outcome. But the interpretation of the information available to both parties can be distorted by three interlocking concepts: moral hazard; adverse selection and optimism bias. It is thus important to establish how each of these concepts applies to defence procurement and whether their individual or collective influence crowds-out the potential effect of DIS on both the contracting process and subsequent project performance.

Decision-making and forecasting in conditions of uncertainty has generated much economic literature which has gown incrementally over past decades, some of it achieving Nobel Prize recognition such as that by Kahneman (in 2002) and Arrow (in 1951): the latter pointed out that:

> Among economic phenomena which have in some way been tied up with the existence of uncertainty, three classes may be distinguished:
> (1) those which by their very definition are concerned with uncertainty;
> (2) those which are not related to uncertainty by definition but nevertheless have no other conceivable explanation;
> (3) those whose relationship is more remote and disputable (Arrow, 1951, p.406).

This analysis underlines the challenge inherent in making judgements over project risks at the outset. In terms of the second category, Arrow adds that, “They would not arise in the absence of risk, and they indicate that the reactions of individuals to a given risk situation are not all the same” (Arrow, 1951, p.408). This potential lack of standardisation in the perception and magnitude of risk

represents a challenge for the MOD procurement process. To that end, the risk management process in tightly defined such that a risk is deemed to be "a significant, unplanned, and uncertain event or situation that, should it occur, has an effect on at least one project or programme activity, or business objective" (MOD, 2022d, para.2). As such, the use of the term 'uncertainty' and its likelihood call for further definition as it applies within the procurement process. Hence, uncertainty is deemed to arise:

> "… from any situation where the outcome cannot be precisely predicted. Uncertainty includes both the variability of estimates, typically captured as a three-point estimate, and the potential occurrence of specific threats and opportunities" (MOD, 2022d, para.4).

Of particular note, when an individual risk is realised, uncertainty is removed (the probability of occurrence is now 100%); it is then classified as an 'issue' which, in turn calls for specific management action (MOD, 2022e, sect.6). Given that it is a common risk, a related MOD Summary of Evidence on *the Drivers of Defence Cost Inflation* draws a distinction between 'cost inflation' and 'cost growth'. The former embraces intergenerational cost escalation between subsequent epochs of technology but also includes classic defence inflation in terms of pay and prices of goods and services. However, cost growth embraces "optimism bias, a poor understanding of risk and assumptions, and workforce challenges" (MOD 2022c, p.4). The latter point reflects the possibility that workforce capability may not be predictable at the outset given that low experience levels on the supplier side might not be transparent, particularly within the supply chain. This research will explore through the case studies and interviews the quality and interpretation of the data on which initial forecasts of time and cost were made. In so doing, it will seek to determine whether information was available but withheld, and whether optimism bias filled any data vacuums.

Moral hazard

Although the term 'moral hazard' has its modern roots in the insurance industry, the underpinning concept of incentivising exposure to risk is evident in medieval theology. At that stage, the term was not deemed to be pejorative: rather, it was derived from a game of dice (known as hazard) that early statisticians (or moral scientists) studied in developing their understanding of chance (Rowell and Connelly, 2012). Usage in the insurance industry ultimately came to mean the potential for a lack of care by an insured person in the knowledge that any loss would be met by a third party. In early work on relating economic phenomena to uncertainty Arrow points out that, "insurance means preferring a certain small loss to the small chance of a large loss (Arrow, 1951, p.407). Later work goes further:

> Because of the moral hazard, complete reliance on economic incentives does not lead to an optimal allocation of resources in general. In most societies alternative relationships are built up which to some extent serve to permit cooperation and risk sharing. The principal-agent relation is very pervasive in all economies and especially in modern ones; by definition the agent has been selected for his specialized knowledge and therefore the principal can never hope completely to check the agent's performance (Arrow, 1968, p.538).

A RAND study entitled *Persistent Challenges in UK Defence Equipment Acquisition* identifies "the presence of moral hazard whereby consistently underperforming programmes continue to receive funding" (Retter et al, 2021, p.14). More broadly, Flyvbjerg (2014), in reviewing earlier literature adds that: "Typically, lock in and escalation make it impossible to drop projects altogether, which is why megaprojects have been called the "Vietnams" of policy and management: easy to begin and difficult and expensive to stop" (Flyvbjerg, 2014, p.6). Gray (2009) adds that: "Under current governance, while underestimating the cost of a programme can lead to criticism and delay in the delivery of the required equipment, it is highly unlikely to lead to forfeiture of the desired equipment" (Gray, 2009, p.29). This is but one example of moral hazard in that its broader application to contracting processes centres on the assumption of common information between buyer and seller at the pre-contract stage although the former has only limited verification ability. However, differing interpretations of the same data, asymmetry of risk appetite, or simply the inability to make an accurate risk assessment between the two parties might see the supplier willing to take-on high levels of risk in the belief that its position is protected because the customer ultimately bears the cost once the risk becomes manifest. The supplier thus represents a moral hazard to the customer.

Adverse selection

Related to moral hazard, adverse selection hinges on asymmetric information and again was familiar to the insurance industry of the nineteenth century. In this case, the supplier chooses not to reveal information to the customer to create transactional advantage. The concept has its modern roots in the work of George Akerlof in which he uses the example of the second-hand car market to illustrate how market collapse can result from widespread transactions where underlying defects are not revealed to buyers by sellers (Akerlof, 1970). This action distorts the market in that sellers seek to sell defective cars as close as possible to the price of high-quality vehicles thus bolstering profit margins. Average market prices fall as a result and sellers of high-grade vehicles cannot retain competitive advantage so leave the market, leading to a yet greater depression in average prices. Demand for these inferior vehicles fails to rise even in the face of falling prices and

the market collapses. In the defence equipment market, suppliers may not reveal post contract the information that they hold for reasons of concern over the release of proprietary intellectual property or to retain strategic commercial advantage during the life of the contract. As a result, ongoing customer assessments over cost, timescale and ultimate performance may be formulated based on imperfect information. Consequently, expectations on these criteria that are assumed at project outset could potentially become unattainable.

Components of bias in forecasting

Turning to optimism bias, the UK Treasury's *Green Book* (which is described as the "definitive analytical guidance for government" (HMT, 2022, fig.1)) in which the term optimism appears 65 times, defines the concept as:

> … the proven tendency for appraisers to be optimistically biased about key project parameters, including capital costs and operating costs, project duration, and resulting benefits delivery. Optimistic rather than realistic projections result in undeliverable targets and if permitted across the board create institutional failure as all proposals fall consistently far short of promised results (HMT, 2022, Sec.2.4).

The notion that optimism rather than realism pervades project management underplays the range of behavioural biases at play and the way in which they combine in driving the underestimation of cost and overestimation of benefits. Flyvbjerg is deemed to be the world's most cited scholar in project management and draws on earlier work on cognitive bias by Kahneman. Kahneman argues that: "In terms of its consequences for decisions, the optimistic bias may well be the most significant of the cognitive biases" (Kahneman, 2012, p.135) whereas Flyvbjerg considers that: "Cognitive bias is only half the story. Political bias is the other half" (Flyvbjerg, 2021, p.531), stating that:

> Political bias - understood as deliberate strategic distortions - arises from power relations, instead of from cognition, and has long been the object of study in political economy. Political bias is particularly important for big, consequential decisions and projects, which are often subject to high political–organizational pressures (Flyvbjerg, 2021, p.532).

In further developing his research, Flyvbjerg isolated what he regarded as the ten most prevalent behavioural biases in project management. Of these, the four listed in Table 3.2 stand out as being highly relevant to defence projects and represent a useful framework by which to assess the impact of the range of biases on procurement process across the period of this study:

Name of Bias	Description
1. Strategic misrepresentation	The tendency to deliberately and systematically distort or mis-state information for strategic purposes. Also known as political bias, strategic bias, or power bias.
2. Optimism bias	The tendency to be overly optimistic about the outcome of planned actions, including overestimation of the frequency and size of positive events and underestimation of the frequency and size of negative ones.
3. Planning fallacy (writ large)	The tendency to underestimate costs, schedule, and risk and overestimate benefits and opportunities.
4. Overconfidence bias	The tendency to have excessive confidence in one's own answers to questions without recognising one's ignorance of the uncertainty of the world.

Table 3.2 – Extract from Flyvbjerg's Top 10 Behavioural Biases in Project Planning and Management Source: Flyvbjerg, 2021, p.532

There are potentially three components to strategic misrepresentation in defence projects. First, there is the tribalism generated by the competition for resources among the three services to create the military capability that they see as essential. Gray regards this as "perfectly rational behaviour from the perspective of each Service, indeed the Services will feel a moral obligation to specify the best possible solution given that they will be taking people into harm's way" (Gray, 2009, p.29). Secondly, once a major project is announced at the expense of considerable ministerial political capital, the impact of power relationships becomes prominent. Pressure on the Senior Responsible Owner and procurement staffs to deliver according to expectations is likely to be unrelenting. Thirdly, the nature of the MOD's budgetary system means that gaining a programme line of finance in the face of competing projects is of paramount importance and could lead to strategic bias in the presentation of the project financial plan. As for optimism bias, the NAO considers that: "Over-optimism is not just about poor process; there are significant behavioural factors" (NAO, 2013a, p.9). The NAO includes strategic misrepresentation as a deliberate action within optimism bias which conversely Flyvbjerg sees as distinct and non-deliberate, adding that: "In the grip of optimism, people – including experts – are unaware that they are optimistic" (Flyvbjerg, 2021, p. 535). This view builds on the earlier research by Kahneman and Tversky (1977) on the common biases evident in intuitive forecasts conducted against conditions of uncertainty. They conclude that:

> First, that most predictions and forecasts contain an irreducible intuitive component. Second, that the intuitive predictions of knowledgeable individuals contain much useful information. Third, that these intuitive judgments are often biased in a predictable

> manner. Hence, the problem is not whether to accept intuitive predictions at face value or to reject them, but rather how they can be debiased and improved. (Kahneman and Tversky, 1977, p.5-1).

They therefore conclude that a forecaster has two distinct categories of information from which to make judgements. Singular information consists of solid case-based evidence whereas distributional information (also termed base-rate data) consists of knowledge about "the distribution of outcomes in similar situations … the prevalent tendency to underweight, or ignore, distributional information is perhaps the major error of intuitive prediction" (Kahneman and Tversky, 1977, p.2-4). Distributional data forms a reference class and the solution lies in applying statistical analysis to adjust the intuitive estimate towards the average of the reference class. In the same research, Kahneman and Tversky identified the planning fallacy when testing the accuracy of individuals in estimating task completion times. A narrower concept entitled 'planning fallacy writ large' was ultimately developed to recognise the prevalence of individuals to produce plans that were "unrealistically close to best-case scenarios" which makes a distinction with the original broader concept (Flyvbjerg, 2021, p.538).

Finally, overconfidence bias is "the tendency to have excessive confidence in one's own answers to questions and to not fully recognize the uncertainty of the world and one's ignorance of it" driven by an illusion of certainty (Flyvbjerg, 2021, p.538). This innate 'certainty' seemingly arises in the minds of both experts and lay people through a tendency to underestimate variance in outcomes. Flyvbjerg (2021) also emphasises that overconfidence bias is a potential hazard in the way in which risk assessment tools are used in project management. Erroneous inputs influenced by overconfidence bias skew the fidelity of simulation in tools such as the Monte Carlo model which is revealed when comparing actual post-project variance from that assumed in the human-derived inputs to the model. It is thus of concern in managing major projects that: "The human brain excels at inferring patterns and generating meaning based on skimpy, or even non-existent, evidence" (Flyvbjerg, 2021, p.539).

Addressing bias in project management – Reference Class Forecasting

The work of Kahneman and Tversky (1977) on decision-making and risk assessment in conditions of uncertainty pointed to the need to ameliorate the impact of bias by looking outwards at distributional information by which to determine a reference position on risk for similar projects. In essence, many of the components of bias that lead to weak judgements are generated solely from internal perspectives (or an 'inside view') which are insulated from the reality of outcomes in similar projects elsewhere thus leading to underestimation of cost and time, and over-estimation

of performance. Kahneman and Tversky conclude that: “The analysts should therefore make every effort to frame the forecasting problem so as to facilitate utilizing all the distributional information that is available to the expert.” (Kahneman and Tversky, 1982, p. 416). From this concept, Flyvbjerg (2006) developed the theory and method of ‘reference class forecasting’ which applies distributional information from the outcomes of similar projects (also related to their initial costings and subsequent growth) to generate an ‘outside view’ thus obviating bias. In so doing, the aim is not to forecast the probability of specific events influencing the progress of the project. Rather, it “places the project in a statistical distribution of outcomes from the class of reference projects”. Three steps are involved: “identification of a relevant reference class of similar projects; establishing a probability distribution for the selected reference class; and comparing the specific project with the reference class distribution in order to establish the most likely outcome for the specific project” (Flyvbjerg, 2006, p.8). The first application of the methodology is recognised as the use from 2004 by the UK Department for Transport in business case appraisals for large transport infrastructure projects (DfT, 2004). A secondary advantage of the approach is that the resulting forecast is underpinned by robust data which serves to refute any political bias that might arise concerning unwelcome news that project delivery might exceed expectations.

Uncertainty and risk in UK defence equipment procurement

Although introduced into the UK public sector in 2004 and enshrined in the Treasury’s Green Book on investment appraisal, application of reference class forecasting across government departments appears to have been patchy. In defence, procurement projects have continued to exhibit late delivery and cost overruns. As a result, following its consideration of Defence Equipment Plan 2020–2030, the Public Accounts Committee (PAC) recommended that the MOD should conduct a study to determine the drivers of cost inflation in the plan. The PAC asked that this should “not merely be a statistical exercise but should look at attitudes and behaviours within the defence acquisition system, and how commercial realities and competition with other nations drive up costs” (Parliament, House of Commons, 2021a, pp 6-7). The resulting MOD evidence document (MOD, 2022c) accepted that the existence of optimism bias had long been highlighted in NAO reports, PAC and defence select committee reports, and in its own internal studies such as that conducted by Gray (2009). In terms of explaining inadequate risk provision, the MOD’s evidence to the PAC cites drivers including information asymmetry, the level of project complexity rendering it impossible to fully assess all risks, and “cognitive biases such as ambiguity aversion, availability bias and framing bias” (MOD, 2022c, p.15). The paper cites the earlier RAND study, *Persistent Challenges in UK Defence Equipment Acquisition* which points out:

> In addition, as explained by behavioural economics, those cost estimators and decision makers expected to assess cost and risk do not always act 'rationally' but are instead subject to a variety of biases: anchoring and adjustment bias, availability bias, ambiguity aversion, framing bias and others. As these biases cannot be eradicated, it is important to acknowledge and mitigate their impact. (Retter et al, 2021, p.15).

The RAND report goes further and cites without evidence the assertion in the 2011 independent report into the structure and management of the Ministry of Defence that one of the factors driving poor financial control is "the 'conspiracy of optimism' between industry, the military, officials and Ministers" (Levene et al, 2011, p.13). Nevertheless, the MOD's evidence to the PAC correctly points out that, "Optimism bias is not a phenomenon that is unique to defence. The problem affects the delivery of projects throughout both government and the private sector" (MOD, 2022c, p.11). Drawing on its own literature review, the MOD's evidence further considers that the causes of optimism bias in defence procurement are a funding allocation process that invites competition between the three armed services to secure a budget allocation and thus results in bids with unrealistically low costs and high professed benefits. Again, the security of a funding line is seen as offsetting the risk of project cancellation: this syndrome would be regarded by Flyvbjerg as strategic misrepresentation. Secondly, accountability is deemed to be weak in that the frequent rotation of key personnel sees others taking the blame given that the initial decision-maker has departed. This is an example of an incentive to the original decision maker driving cognitive bias. Thirdly, pressures on the procurement organisation to deliver the desired outcomes of the single-service capability sponsors limit the ability to challenge unrealistic costs, over-specification and ambitious schedules: again, Flyvbjerg would see this as power bias within strategic misrepresentation. Finally, moral hazard is inaccurately cited as a driver of optimism bias in that: "Contractors have an incentive to underestimate costs to win contracts, knowing that once projects are underway, they are difficult to cancel due to political pressure, the risk of embarrassment, vested interests and the sunk cost fallacy" (MOD, 2022c, p.11). This represents more of an incentive-driven behaviour rather than an example of cognitive bias. However, underlying this situation, is the problem of low experience levels and high rates of churn among Senior Responsible Owners and delivery teams. A 2021 NAO study entitled *Improving the performance of major equipment contracts* provided data on the extent of the problem (NAO, 2021a). In analysing the management of 20 projects "the median time in post for an SRO was 22 months" and, of the 30 Project Directors involved, "30 PDs had on average been in post for 15 months" and the "median PM [Project Manager] had been in post for 13 months" (NAO, 2021a, p.48). The median running time of the projects was 77 months which means that few of those in the management chain would be motivated to take tough decisions in the

knowledge that project maturity was a long way off and well after they had left their post. This situation increases the risk of cognitive bias on project management.

In a cross-government analysis of over-optimism in projects, the NAO draws a distinction between over-optimism driven by behaviour and incentives with that resulting from other process-related factors (NAO, 2013a). In citing Kahneman and Tversky (1977) on the delusional optimism of executives, the NAO analysis points to an incentive culture of strategic misrepresentation which "may include a desire of individuals to protect and boost their own prospects or the desire to secure investment for a project" (NAO, 2013a, p.9). The analysis also notes that the short-termism inherent in the political cycle and in public sector finance acts as an incentive towards over-optimism. It is puzzling that the NAO analysis makes no mention of the need to adopt reference class forecasting as the government-approved tool by which to offset optimism bias. In addition, the RAND study does not include it in its advice to MOD. However, it does appear in the MOD response to the PAC but in unusually tentative terms for an MOD document which was aimed at gaining the confidence of a parliamentary select committee. Under the heading of "Further Areas to Explore," it includes:

> Embedding the use of reference class forecasting. This technique has been applied in some projects across the department and there are plans to research and promote its use as set out in Part 2. The MOD could consider improving the frequency and consistency of its use once defence-specific reference classes have been developed to support project teams to de-bias initial cost estimates (MOD, 2022c, p.22).

The reticence is arguably valid in that few commercial projects are faced with the same complexity as those in defence which have to address highly challenging system of systems integration involving leading-edge technology and novel weapons whilst also meeting stringent requirements to minimise weight and volume of components within a platform and guarantee its safety. But the statement is correct to point out the need for the development of 'defence-specific reference classes.'

There are therefore two areas that this research project needs to investigate. First, on optimism bias, while the MOD accepts that it is a problematic aspect of their procurement process, there has seemingly been little rigorous depth of analysis on its detailed causes and the associated mitigation required. Secondly, there is seemingly ambiguity over the government policy requirement to apply reference class forecasting in the preparation of business cases. These aspects could be contributory factors in the inability of DIS to effect improvement in project performance.

Summary of the application of concepts and theories

The hypotheses encapsulate the perceived systemic barriers that prevent DIS from having a positive impact on project performance. The conceptual framework is the initial step in exploring them and consists of the application of prominent theories in three areas. First, organisational resistance to the implementation of externally mandated strategy is addressed by Mintzberg's theory on organisational structure and, particularly the characteristics of a machine bureaucracy with its strong technostructure. Secondly, the creation of appropriate industrial intervention aimed at optimising the characteristics of the defence equipment market is considered through the theory of 'second best' as derived by Lipsey and Lancaster but extensively developed for the public sector by Warwick. Thirdly, the challenge of decision-making, forecasting and assessing risk under conditions of uncertainty is approached through the theories associated with moral hazard (Arrow), adverse selection (Akerlof) and optimism bias (Kahneman and Tversky) all of which have been extensively developed by Flyvbjerg against the backdrop of complex project management which led to his derivation of Reference Class Forecasting by which to overcome the prevalence of biases in decision-making. The second step in the research will be informed by these theories in assessing the plausibility of each edition of DIS in terms of its likely effectiveness in achieving its stated objectives in meeting the requirements of the future force structure and the financial context applying at the time. More directly, these theories will be prominent in the analysis of the case studies in the third stage of the research and the interviews comprising the fourth stage. As a cross-cutting issue, the hypothesis on the potential adverse impact on DIS implementation of the constraints inherent in public sector financial management will be investigated in all stages of the research. The most crucial factor to be determined is the extent to which the four aspects of organisational inertia, implausible strategic design, inadequate decision-making and financial inflexibility combine to prevent DIS gaining positive traction.

Chapter 4 –The Labour Government and DIS: 1998 to mid-2010

> *In developing our industrial strategy for the period ahead, we have the benefit of much experience. Almost everything has been tried at least once. (Rt Hon Tony Benn, 1974)*

Political Context

In the run-up to the 1997 General Election neither of the main parties wanted to place the spotlight on defence. New Labour had previously dropped its objection to the UK's nuclear weapon capability and explicitly stated their intention to retain Trident, albeit adding, "We will press for multilateral negotiations towards mutual, balanced and verifiable reductions in nuclear weapons" (Labour, 1997, sect. 12). The manifesto also undertook to conduct a strategic defence review "… that will be foreign policy led, first assessing our likely overseas commitments and interests and then establishing how our forces should be deployed to meet them (Labour, 1997, sect. 12). The manifesto also confirmed that, "We support a strong UK defence industry, which is a strategic part of our industrial base as well as our defence effort" (Labour, 1997, sect. 12). Defence did not appear in the ten commitments describing the 'contract with people' other than by implication at number ten which pledged that "We will give Britain the leadership in Europe which Britain and Europe need" (Labour, 1997, sect. 1). With a 20-point lead in the polls at the start of the campaign, Labour were anxious to avoid jeopardising that position against the traditional Conservative mantra of being strong on defence. Labour ultimately "came under fire for delivering a passionless campaign" nevertheless winning 418 seats resulting in a majority of 179, the largest in the party's history (BBC, 1997a, sect. 10). In launching the subsequent strategic defence review, Secretary of State for Defence Robertson said of defence during the election campaign:

> It provoked neither debate nor controversy during the election campaign. Yet at a deeper level, Labour's changed attitude to defence was an important component in our victory. Indeed, events in the 1980s showed that, without a clear and unambiguous commitment to strong defences as an essential part of Britain's foreign policy, the British people would not trust us with government. The very lack of controversy during this year's election was testimony to a return of that trust (Robertson, 1997).

Meanwhile, by 1997, John Major was leading a minority Conservative government which was deeply divided over Europe, had delivered a lacklustre performance since 1992 and was beset by scandals over the personal behaviour of some of their MPs (BBC, 1997b). The manifesto said little on defence asserting that:

> We have cut unnecessary bureaucracy and increased efficiency, and directed money to support our Services in the frontline. We have made the changes necessary to adapt our Services to the threats which we might now face (Conservative Party, 1997, sect.7).

This statement refers to two earlier studies into the UK's post-Cold War defence requirements. In an attempt to deliver a peace dividend, *Options for Change* in 1990 adjusted the force structure but was not a published defence review. Rather, it was promulgated as a statement to parliament by the then Secretary of State for Defence (King, 1990) with further detail published a matter of routine in the following year's Statement on the Defence Estimates (MOD, 1991). What subsequently became known as a 'mini review made further adjustment in the 1993 Statement on the Defence Estimates (Parliament, House of Commons, 1998, para.42). The second study entitled *Front Line First: the Defence Costs Study* (MOD, 1994) did not address either defence policy or force structure but sought further savings from organisational changes, support functions and infrastructure. The manifesto thus concluded that "We have set out defence plans based on stable levels of funding. There is no need for a defence review, which would raise fear and uncertainty about the future" (Conservative Party, 1997, sect.9). The manifesto also expressed support for the defence industry. As for the key issue of the European single currency, the manifesto determined that the party would keep its options open until the facts were clear. Should sustainable convergence arise and joining was then deemed to be in the national interest, there would be a referendum to seek approval (Conservative Party, 1997, sect.7). Divisions in the party arose immediately with 230 Conservative candidates speaking against the 'wait and see' policy after the launch of the manifesto. As a result, the character of the campaign changed and saw prime minister Major capitulate to the Euro-sceptics (BBC, 1997b, sect.9). In line with historical precedent where divided parties are punished by the electorate, the Conservatives secured only 165 seats, the lowest number since 1906 (BBC, 1997b, sect.9).

On entering government, New Labour did not have a well-formulated set of defence policy objectives beyond the manifesto statement that the UK should be:

> … willing to contribute to wider international peace and security both through the alliances to which we belong, in particular NATO and the Western European Union, and through other international organisations such as the UN and the Organisation for Security and Co-operation in Europe (Labour, 1997, Sect 12).

Such a posture was very much in the grain of that of the previous government and reflected the need for continued international intervention in the ongoing Balkan wars. However, according to a

senior MOD policy staff officer at the time, Foreign Secretary Cook's view on the need for an ethical foreign policy made departmental alignment with the MOD difficult (Chisnall, 2010, p. 420). As for finance, defence expenditure averaged 2.5% of GDP in the period 1997 to 1999 with social security around 12%, health at 6.5% and education at 4.6% (DASA, 1999, p.8). Meanwhile, UK economic growth averaged 3.2% over the same period (OECD, 2008, p.239). Nevertheless, in conducting the 1998 Strategic Defence Review (SDR 98) "Chancellor of the Exchequer Gordon Brown was seemingly unwilling to prioritise defence spending, and the review was never properly funded" (Jordan, 2019).

Six months ahead of the publication of SDR 98, forces from the Former Republic of Yugoslavia accompanied by Serbian paramilitaries invaded Kosovo, ultimately creating 600,000 refugees and internally displacing 800,000 Kosovar Albanians (Freedman, 2000, p.353). NATO's subsequent intervention with air power was controversial given the extant UN Security Resolution 1199 did not authorise the use of force (Freedman, 2000, p.348). Any ambiguity that might have existed in Whitehall about the UK's approach to this and future conflicts was displaced by Prime Minister Blair's Chicago speech in April 1999. Citing the Kosovo war, he said, "This is a just war, based not on any territorial ambitions but on values. We cannot let the evil of ethnic cleansing stand" (Blair, 1999, p.1). He continued:

> Now our actions are guided by a more subtle blend of mutual self-interest and moral purpose in defending the values we cherish. In the end values and interests merge. If we can establish and spread the values of liberty, the rule of law, human rights and an open society then that is in our national interests too (Blair, 1999, p.4).

The same sentiments were evident in the 2001 manifesto (Labour, 2001, p.38) and that of 2005 (Labour 2005, p.85) as was a continuing commitment of support for the defence industry. With Prime Minister Brown replacing Blair in 2007, defence policy was then dominated by operations in Iraq and Afghanistan. In parallel, the global financial system was increasingly under stress with 2008 seeing an international crisis in bank liquidity which dominated UK politics for the remainder of the decade.

Part One – SDR 98

SDR 98 as a pre-cursor DIS

SDR 1998 reflected the lessons from the 1991 war with Iraq and those from the extended period of violent instability in the Balkans. While there was no direct threat to the UK or its overseas territories, the review noted "the emergence of a complex mixture of uncertainty and instability" (MOD, 1998a, para.3) and the primacy attached to NATO membership. This called for an expeditionary defence posture underpinned by more rapidly deployable, joint forces with capability across the spectrum of conflict, not least in the light of terrorist organisations' use of asymmetric approaches to achieve strategic effect. A related industrial strategy was not published alongside the 1998 Strategic Defence Review (SDR 98) nor was there an extant wider industrial policy on which to base such a strategy. Rather, the SDR presented two supporting essays on procurement from industry (Essay 10), and the impact of technology (Essay 3). Together they covered four themes of relevance to industry: stability in the equipment programme; procurement reform; future technology priorities; and dealing with industrial over-capacity. These documents thus fulfilled some of the requirements of both an industrial policy and an industrial strategy in that they provided orientation for industry within the changed post-Cold War environment. However, they did not provide the structural detail that would have provided industry with evidence on which to make investment decisions.

Stability in the equipment programme

On stability in the equipment programme, given the bruising outcomes of the preceding reviews in 1990 and 1994, industry was relieved that the SDR did not cancel further major projects. Confirmation on the procurement of two aircraft carriers and the launch of two armoured vehicle projects were welcomed but both subsequently ran into severe difficulty. In aerospace, continued support for Typhoon by confirming an order for 232 aircraft was central to UK military aerospace firms given that it offered long-term continuance of the end-to-end industrial capability in high performance combat aircraft. Likewise, a future requirement for a carrier-borne fighter (albeit potentially sourced offshore) would see supply chain opportunities for UK industry. Conversely, the existing combat aircraft front-line was to be reduced by 13% with the attendant reduction in industrial revenues from spares and support. However, although helicopter numbers were also reduced, the remaining requirement was just sufficient to sustain AgustaWestland as the UK's sole helicopter manufacturer. The SDR made no explicit mention of the need to identify sovereign capability requirements when considering the characteristics of the future defence industrial base. The review team conducted a wide consultation with industry and academia which contrasted with the previous post-Cold War studies such as Options for Change (King, 1990) and Front Line First

(MOD, 1994) that were conducted in secret. There was also consensus among commentators that the SDR was effective in describing a policy baseline against which force structure and budgets could be built. (Codner, 1998; Cornish and Dorman, 2009; Curtis, 1998; Dorman, 2006; Grattan et al, 2015; McInnes, 1998; Chisnall, 2010).

Procurement Reform

On procurement reform, the SDR objective of 'faster–cheaper-better' rested on further development of the 1997 Smart Procurement initiative (soon to be renamed Smart Acquisition) but did not discuss the industrial requirements within individual sub-sectors. On the interface with industry, the review recognised that "the current relationship was often perceived as adversarial, caused by a lack of mutual understanding and trust" a 1998, Essay 10, para. 22). The reputation of the procurement enterprise was poor with the review citing an NAO assessment that there was an average delivery delay in the top 25 projects of 37 months (MOD, 1998a, p.54). In publishing their annual *Major Projects Review,* the NAO assesses the cost and timeliness of the top 25 or so projects in the equipment plan which together represent some 50% of the total expenditure. The mix of projects in the sample changes from year to year as some mature and others are initiated. The data can also be distorted by the presence of unusually expensive projects such as Trident (£11.8 billion) and Typhoon (then £15.4 billion). Where appropriate, these costs are set aside when calculating cost growth as a percentage of the total costs of the remaining projects in the sample. This was the case in the 3-year period running-up to the SDR. The data for this period (Table 1) indicate the extent of the problem, particularly over slippage in delivery dates. A subsequent RAND study concluded that this problem arose principally from budget-induced delay and technological challenges: cost growth was deemed to be comparable with that experienced in other major defence nations (Cave et al, 1998). The SDR also included the need to create a specialist stream of acquisition personnel with a framework of defined competencies and development schemes aimed at the long-identified need to enrich the professional skills in the procurement organisation (MOD, 1998a, Essay 10, para. 26). A later NAO study on project delivery highlighted the historical churn of personnel in some roles that undermined continuity and impacted adversely on skill and experience levels (NAO, 2004a, p.16).

NAO Report Year	1995	1996	1997
Number of major projects	25	25	25
Total Cost (£ billion)	32	33	36.9
Annual cost growth (%) (less excluded projects)	4.4 (23)	8.7 (23)	7.5 (24)
Average delivery delay on all major projects (months)	35	40	37
Projects on time	4	5	3
Projects already missed delivery date	5	13	10
Project projected to miss delivery date	16	7	12
Projects already more than five years late	6	6	6

Table 4-1 – MOD Procurement Performance 1995-97 (Source: NAO MPR, 1995, 1995, 1997)

Smart Procurement was developed through consultation with industry and promoted the need for formal partnering arrangements particularly where competition was no longer viable. The shortcomings of a hard-edged, competitive bidding process were also recognised as extending timescales in decision-making and adding cost to both the MOD and industry. In addition, Smart Procurement introduced measures to speed-up initial project management by seeking early trade-offs between specification, time and cost. Improvements in forecasting through-life costs were introduced to assist in meeting the budgetary strictures alongside an undertaking to improve efficiency through contractor incentives. Overall, the initiative was seen as the key to both streamlined processes and future financial savings that would ultimately lead to a balanced programme. (MOD, 1998a, Essay 10, para. 8).

Future Technology

The SDR was clear that the conduct of warfare was changing driven both by technological innovation, which in the US was termed the 'revolution in military affairs', and by the increasingly asymmetric threat from non-state actors. But, despite this recognition, there was only a broad analysis of the implications in that "the SDR still contained a good deal of conventional thinking" (Dorman, 2006, p.152). However, there was clear government acceptance that multinational operations (probably under US leadership) would require a distinctive, high-quality UK contribution based on high-end but proven technology. Smart, long-range weapons compatible with US systems were seen as a priority and, where the UK was deficient, US weapons would be procured. Given the accelerating rate of technological change, the approach would rely on a strong, agile domestic

research base as well as the continuing development of a highly skilled and well-educated workforce. On the threat from unconventional asymmetric warfare, such risks called for a wide spectrum of potential responses within which superior technology would be compelling. The SDR therefore recognised that "we will need to consider technology issues from a politico-military as well as a technical perspective" (MOD, 1998a, Essay 3, para 32). However, given budget limitations, there was a need to focus on areas where the UK had the edge including in "communications and information systems, improved explosives, better sensors and advanced simulation" (Essay 3, paras. 2-5). There was a salient interest in the integration of networked data from advanced sensors that could be fused to provide full situational awareness to assist command and control in complex environments. Aerospace figured prominently in the examples of where current projects were already integrating leading-edge technology, citing the airborne stand-off radar in the Sentinel surveillance aircraft and precision weapons such as Storm Shadow, Brimstone and Hellfire. But the review cautioned over the need to avoid procuring defence equipment that was tied to bespoke technology that would rapidly become obsolete. Rather, there would be a future need to insert advanced technology incrementally to maintain parity with both allies and the developing threat. Hence, as a matter of strategy, the review was clear that "the balance of investment will shift in favour of the progressive update of in-service equipment" rather than opting for replacement (Essay 3, para 8). However, there were no explicit roadmaps or certainty over research funding.

Sustaining the defence industrial base

Finally, there was a clear policy commitment towards maintaining an indigenous defence industrial base as a key ingredient of both defence capability and of economic prosperity. As for its size and shape, the SDR recognised that the impact of globalisation was beginning to show in the growing multinational ownership of firms in the defence sector. This was seen as positive in terms of opening further opportunities for procurement collaboration between governments which was noted as being of increasing importance to the UK in delivering value-for-money through shared fixed costs. More generally, the SDR stated that, "We remain committed to securing the best, and each procurement decision will therefore be assessed on its merits, with industrial aspects being assessed against a range of defence-based criteria" (MOD, 1998a, Essay 10, para. 33). In the light of the manifesto commitment to support the defence industry, it was telling that these 'criteria' were not related to the impact on the broader economy or employment but did take account of security of supply and the capacity to perform through-life maintenance and upgrade. Proposals on industrial restructuring were focused solely on European consolidation. The four Airbus partners (British Aerospace, Aerospatiale, DASA and CASA) proposed the creation of a single integrated aerospace and defence firm. British Aerospace ultimately withdrew in early 1999 but the merger between the other companies resulted in the creation of EADS (Thornton, 2020). Consideration in

2012 of a further merger between EADS and BAE Systems (formerly British Aerospace) was thwarted by political objections (Barbaroux and Laperche, 2013).

Coherence with the Equipment Plan

The overall aspiration in the industrial strategy elements of the SDR proved optimistic when judged against the prevailing financial backdrop given that the 1998/99 budget was 29% lower in real terms than that in the mid-nineteen eighties which then stood at 5.3% of GDP (MOD, 1998a, para. 197). The impact of under-performing legacy procurement projects weighed heavily on the equipment budget. By 2003, these legacy projects (Nimrod, Astute, Eurofighter Typhoon and ALARM (a complex weapon)) showed an annual cost growth of 11% and an average additional slippage of 16 months. More positively, the less mature Smart Acquisition projects were running just 2% over cost with an annual slippage of 3 months (NAO, 2004b, p.2)). However, the cost of MOD's initial SDR proposals proved to be some £2 billion more than the Treasury's likely annual allocation (Grattan et al, 2015 p.309). Aspects beyond the review's proposals were therefore brought into play including savings from improvements in procurement processes, additional revenue for the privatisation of the Defence Research Agency and savings accruing from the amalgamation of the single-service logistics organisations: none of these assumptions were without risk (Grattan et al, 2015). By comparison with the 1998/99 defence budget, the eventual SDR settlement resulted in real terms reductions of £500 million in 1999-2000 increasing to £700 million in 2001-02. Further savings were hard to find and rested on additional efficiency measures of 3% per year as well as a reduced investment in weapon stocks. The SDR described these measures as "challenging but achievable" (MOD, 1998a, paras.197-8). At the time, the UK defence industry was facing increased competition arising from the 30% post-Cold War contraction of the global defence market during the period 1988-97 (SIPRI, 1998). The UK equipment budget reduced by 38% over the same period (£7.9 billion (or £9.8 billion after applying the GDP deflator) to £6.0 billion) (MOD, 1988; Parliament, House of Commons 1998a) but UK defence exports grew by 46% (from £3 billion (£4.1 billion with GDP deflator) to £6 billion) largely due to the sale of Tornado to Saudia Arabia (HMG, 2020b). Increased competition from the US defence primes called for action in Europe based on "greater international collaboration and restructuring as a means of achieving better economies of scale" (Dodd and Oakes, 1998, p. 55).

Assessment of the impact of the DIS aspects of SDR 1998

In summary, "this genuinely policy-led review, held at the high point of optimism about future security, ended in the MOD assuming a significant financial risk just as the UK was about to enter a decade of war and stabilisation operations in Afghanistan and Iraq" (Jessett et al, 2020, p.27). Thus, the lack of sufficient headroom undermined the consistency of approach in implementing the

industrial strategy elements. However, the implementation of Smart Acquisition had started to generate improvements in project management and remains the foundation for current defence procurement. The approach to through-life insertion of technology became institutionalised but the aspiration on the consolidation of the European Defence industry showed only marginal progress. Chisnall (2010) makes the valid observation that, in the decades following the SDR, the MOD's tools and frameworks became much more sophisticated in identifying the associated procurement and industrial implementation strategies that need to flow from policy and posture changes. The impact for the SDR was that "downstream deliverables of the review, such as the equipment programme, were effectively divorced from the front-end policy objectives" (Chisnall, 2010, p. 422). From an industry perspective, the SDR provided something of the 'what and why?' of the transformation of defence posture but was short on the 'how?' Nevertheless, it was important in reassuring industry that the new Labour government stood by their manifesto statement of supporting the defence industry (MOD, 1998a, Essay 10, p.10, para. 28). The manifesto also highlighted the beneficial technology spin-off to other industries arising from leading-edge defence research. But, without a full top-down analysis on the required future size and shape of the defence industrial base, the SDR lacked the strategic roadmap that industry was seeking. However, while SDR 1998 made multiple mention of the need to achieve value-for-money (without providing a definition), there were tentative signs that the government was moving away from the strictures inherent in the Levene review towards a more activist approach in line with the Labour manifesto. This was a positive outcome in terms of the sustainability of the UK industrial base.

Part Two – DIS 2005

Building on SDR 98, further industrial policy elements were published in 2002 in two MOD Policy MOD Papers: *Defence Industrial Policy* (MOD, 2002a) and *Defence Acquisition* (MOD, 2002b). The former underlined the commitment to the UK defence industry as both the MOD's primary source of military equipment, and as a key part of the economy. The policy recognised the tension between the need to achieve long-term value for money whilst maintaining "a healthy and globally competitive defence industry" which included "both UK and foreign-owned companies" (MOD, 2002a, p.2). Competitive procurement would remain the norm but, in some circumstances, novel approaches such as industrial partnerships would be required to guarantee security of supply. The policy cautioned that: "Partnering does not mean creating privileged or monopoly suppliers, which could stifle innovation and result in inflated prices for inferior equipment" (MOD, 2002a, p.9). Rather, incentives for industry would arise both from the early sharing of information on future MOD requirements and from the stable cashflows that result from availability-based support contracts. Globally, the texture of the defence industry was also changing with 'super primes' emerging in the US through consolidation and an increased appetite in Europe for joint ventures. The policy also acknowledged the systems integration risk inherent in adopting leading-edge technology and thus re-emphasised the Smart Acquisition doctrine that a greater proportion of project funding should be invested at the earliest stage in the procurement cycle.

Countering insurgency with a limited budget

By 2005, the UK was increasingly committed to counter-insurgency operations in Iraq and Afghanistan as well as peacekeeping in Darfur and Somalia. Of note, operations in Afghanistan had caused considerable overstretch in the armed forces and called for large scale equipment enhancements which were to be funded by defence economies elsewhere: the defence budget remained static at an average of 2.5% of GDP (World Bank, 2023). Consequently, deeper UK consideration of the post-9/11 security environment was required. That analysis was contained in an addendum to SDR 1998, *A Strategic Defence Review: A New Chapter* (MOD, 2002c*)* and followed by a 2003 Defence White Paper entitled *Delivering Security in a Changing World* (MOD, 2003a) and then subsequently by *Delivering Security in a Changing World - Future Capabilities* (MOD, 2004). These policy papers recognised that crises had arisen across a wider geographical area than originally predicted, requiring military intervention in more distant locations and at a "broader range, frequency, and often duration than envisaged in 1998" (MOD, 2003a, p.2). They made only small adjustments to the front line: rather, they focused on support functions and doctrinal developments from the Iraq war. In the latter case, they introduced the notion of 'effects-based operations' supported by 'network-enabled capability' which relied on advanced technology by which to optimise command and control but the 2002 Defence Industrial Policy (MOD, 2002a) had

already highlighted the tension in achieving value-for-money in equipping the armed forces while also sustaining a vibrant on-shore defence industry. These two strategic 'ends' of capability and sustainability were potentially in opposition and would require finesse in determining the appropriate 'ways' and 'means.' A related MOD concern was that, whilst it was clear that the UK could no longer maintain a complete cradle-to-grave industrial base in all areas, without guidance "industry will make independent decisions and indigenous capability which is required to maintain our national security may disappear" (MOD, 2005a, p.6).

The six principles of DIS 2005

The themes from these policies were further developed in the 2005 DIS (MOD, 2005a) which was completed in just five months yet contained an impressive level of detail within its 146 pages. The strategy predicated that in-service enhancement could be focused on software, mission systems and sensors without disrupting hardware or basic platform structure. This in turn called for increasingly sophisticated systems integration at the design stage and the preservation of the related intellectual property throughout the life of the equipment. It was also clear that industry would need to adapt to these new market circumstances with fewer large capital programmes and greater emphasis on through-life support. In meeting this challenge, the 2005 DIS was a comprehensive attempt to provide industry with greater transparency on future defence requirements and to define those industrial capabilities deemed to represent the UK's 'appropriate sovereignty' requirements. The reduced volumes within global defence markets had prompted industrial consolidation leading to the creation of a small number of large, transnational firms that were able to exercise choice over where they invested in plant, people and R&D. The MOD therefore again re-emphasised the statement in DIP 2002 that it was agnostic over corporate ownership. As a result, DIS 2005's objectives were: to give a strategic view on future capability and support requirement; to define which industrial capabilities needed to be retained onshore; to outline the related changes to acquisition processes; and to determine how the issue of excess industrial capability should be addressed. It provided a detailed review of each of the nine core industrial sub-sectors ranging from fixed-wing aircraft to general munitions, with three further chapters covering the cross-cutting capabilities of systems engineering, technology, and test and evaluation. The final section contained an implementation plan but lacked both performance metrics and financial data. More broadly, the strategy was over-ambitious when judged against the prevailing defence financial environment where future budgets would prove to be inadequate to support the strategy's priorities. The 2004 in-year cost growth of F-35 was 17%, that for Nimrod stood at 13% and, for A-400M, 11% (NAO, 2004c, p.9). In addition, the initial costing of the two aircraft carriers had yet to be added to the equipment plan. That said, DIS was regarded by government as a serious endeavour for which the foreword was signed off by two secretaries of

state (Defence, and Trade and Industry), two ministers of state from the same departments and, significantly, by the Chief Secretary to the Treasury. The strategy was based on six overarching principles of government intervention which provide a useful framework for assessing its plausibility. These were: maintenance of 'appropriate sovereignty' to allow operational independence; the application of through-life capability management (TLCM) involving capability upgrade through incremental insertion of technology; the widespread application of systems engineering techniques to facilitate capability upgrade; direct government action in maintaining both key industrial capability and the associated skills where the market would not otherwise sustain them; the achievement of value for money; and the need for cultural change on both sides. These principles were qualified by the MOD's recognition that, while the intent was to be as clear as possible over future intentions, "plans change as the strategic or financial environment changes" (MOD, 2005a, p.16). However, the strategy set an ambitious boundary by seeking to include the entire defence procurement ecosystem.

Appropriate Sovereignty

On the first principle of appropriate sovereignty, the strategy faced the challenge of determining the optimum UK defence industrial base at a time of a reduced future requirement for capital projects. It also confirmed the range of technologies and industrial capacity that needed to be retained onshore, concluding that the key sectors were limited to submarine construction, nuclear reactor core engineering, warship production (other than hulls that were seen as a commodity), small arms ammunition and cryptography. In addition, there was acceptance that, in some areas such as 'complex weapons' (guided missiles and precision munitions), there was simply too much UK industrial capacity in view of likely future requirements (MOD, 2005a, p.9). Given the decision to procure the F-35 Joint Strike Fighter as the future carrier-borne aircraft, the strategy was also clear that there was no longer a need to retain end-to-end design, development and manufacturing expertise in combat aircraft in the UK (a 'cliff-edge' decision reversed in 2018). Rather, the future aerospace focus for BAE Systems would be based on through-life support but also with the prospect of a drone technology demonstrator programme. The MOD also accepted that it needed to be proactive in attracting transnational companies to invest in the UK by providing clarity on the preferred routes to contract. In addition, international collaboration on high-value equipment projects was already driving industrial partnerships, sometimes leading to the creation of bespoke companies aimed at delivering a single project such as the creation of Eurofighter GmbH for Eurofighter Typhoon. However, the strategy's analysis of the nature of the market through the lens of sovereign capability was unrealistic in that it conveyed a sense of the UK controlling its own destiny. For example, given the UK's heavy reliance on US manufactured equipment, it was not clear how security of supply based on the core notion of operational independence could be

assured. Access to US-owned intellectual property was already proving problematic in the case of the F-35 Joint Strike Fighter (JSF) project where there were obvious difficulties over US willingness to share information (Parliament, House of Commons, 2007). The strategy also advanced the prospect of UK firms conducting through-life maintenance and upgrade of foreign-supplied equipment yet without considering the barriers to access to offshore intellectual property.

The House of Commons Defence Select Committee conducted two enquiries into DIS 2005 and showed particular interest in appropriate sovereignty and operational independence. On the plausibility of this approach, Kirkpatrick (2008) pointed out that it assumes the continuance of "security of supply in any future international crisis when the priorities of foreign contractors (and of their governments) may diverge from those of the UK" (Kirkpatrick, 2008, p.289). He also notes that, given the nature of the globalised defence market, UK-based prime contractors "may rely extensively on imports of subsystems, components and raw materials which can be obtained more economically from overseas" (Kirkpatrick, 2008, p.289). This is further complicated by the fact that, in 2005, 25% of the UK defence industrial base was foreign owned by multi-national firms whose global network of suppliers served many of their customer governments. Hartley considered that there was little data in the strategy on supply chains to suggest that their extent, complexity and international nature had been fully researched (Parliament, House of Commons, 2006, Q163; Hartley, 2007). He further pointed out that government showed little understanding about the nature of defence supply chains in aspects such as their dependence on defence work, their significance to local economies and whether sub-optimal configuration leads to additional costs (Hartley, 2007). This issue of the impact on local economies was not satisfactorily addressed until 2021 with the introduction of 'social value' into procurement decisions in line with revisions to the Treasury *Green Book* on investment appraisals (HMT, 2020a). With a minimum weighting of 10% in bid scoring (Cabinet Office, PPN 002, para.3.4), this approach might ultimately favour onshore defence companies in procurement competitions (ADS, 2024a, p.7). Taken together, there was valid scepticism over DIS 2005 about whether the requirements of appropriate sovereignty and operational independence had been fully analysed. Taylor regarded this shortcoming as particularly valid in the case of imported US defence equipment where stringent technology transfer regulations applied (Parliament, House of Commons, 2006, Taylor Ev 89). In the years preceding DIS 2005, UK defence firms saw acquisition of US companies as an attractive hedge against the uncertainties in both the domestic and European markets given that "the basic US assumption is that any technology that will be important for the military must be within the capability of US-based industry and must be protected from foreign access" (IISS, 2006, p.2). At that stage, it was correctly assessed that the US had about a 5-year time advantage over the UK in defence technology exploitation, but the related expenditure was some ten times that of the UK's (Hartley, 2007, p.22).

DIS 2005 highlighted the openness of the UK defence market: Hartley pointed out that, while 32% of MOD equipment spending was with foreign-owned companies, the equivalent US figure was 9% (Hartley, 2007, p.20). Like the US only on a different scale, France seeks to maintain autonomy in defence manufacturing through its sovereign defence industrial base with an import expenditure averaging just 3% (Calcara and Simon, 2021; Trading Economics, 2024, para.1).

Through-life Capability Management

Turning to TLCM, with the modernisation of front-line equipment already embedded in the equipment budget, the focus would move to through-life incremental insertion of technology to address emerging threats. DIS 2005 therefore invited industry to contribute to a long-term vision based on joint planning with the MOD, potentially through a partnering arrangement, to meet future defence requirements in the most effective way. This also required the application of the third principle on adopting a systems engineering approach. This combined approach would allow this incremental approach to replace lengthy and expensive mid-life updates which had historically reduced equipment availability over an extended period. Increasingly, sensors and mission systems were software-driven which provided an avenue for performance improvement without disrupting hardware or basic platform structure. However, the electronic and data architecture of the platform concerned would have to be amenable to this type of approach which placed a premium on access to the intellectual property of the original design. Equally, new platforms would need progressively to adopt open systems architecture with its characteristic of 'plug and play.' This approach to TLCM placed a premium on the retention of systems engineering skills and on the associated design exploitation of novel technologies, particularly in aerospace with its high levels of sophistication. While this expertise had historically been the norm in UK combat aircraft manufacturing, the impending introduction of the JSF meant that much of this specific knowledge would be in the US where limitations of technology transfer applied. The strategy accepted that the advantage in capability and cost was "very clearly in preserving system capability commonality and coherence with the US" However, on the assumption of privileged UK access, the MOD suggested somewhat naively that "we regard it as essential to work with BAE Systems … to sustain its systems engineering understanding of these platforms" (MOD, 2005a, p.67).

Direct government intervention

As for direct MOD intervention (the fourth principle), the strategy asserted that business models in many areas of the defence industry would need to change by focusing on support and upgrade rather than on the design and manufacturing of the next generation (MOD, 2005a, p.6). Dealing with the resulting over-capacity whilst preserving the capability to provide equipment support was deemed to require direct MOD intervention. Two significant cases concerned complex weapons

and helicopters. On the former, while the procurement requirement was predicted to reduce by 40%, there was a clear requirement for onshore ownership of complex weapon intellectual property and industrial capacity. Such an approach was aimed at preserving "absolute confidence in the performance and safety aspects of our weapon systems, particularly as they become more sophisticated" (MOD, 2005a, p.102). The plan involved: suspending weapon competitions on the global market in favour of onshore procurement; industrial restructuring and rationalisation with European partners; and a multi-disciplinary team approach based on open dialogue between MOD and the weapon firms to optimise initial procurement and provide cost-effective support and upgrade. This initiative led to the formation of Team Complex Weapons to deliver sovereign capability subject to a legally binding Portfolio Management Agreement. This arrangement proved successful and continues to endure. It provided the participating companies with a long-term portfolio of requirements alongside pipeline funding but with built-in flexibility for the MOD to change priorities on capability and delivery dates (MBDA, 2015).

DIS 2005 also dealt extensively with the helicopter sub-sector, recognising that, while there was a high onshore concentration of intellectual property related to the existing fleets, there was also a vibrant global market. It concluded that, "AgustaWestland's [now renamed Leonardo Helicopters] systems engineering capability needed to be sustained to maintain our ability to support and upgrade the current fleet" (MOD, 2005a, p.9). This statement recognised the company's role both as a prime and as an original equipment manufacturer (OEM) providing equipment to other firms. In both cases, they retain responsibility for the assurance of safety and airworthiness activity related to design, maintenance, modification and repairs. Future developments in "rotor blades, mission systems, survivability, vibration management and electronic architecture" were also deemed to be of importance (DIS, 2005, p.9). The associated skill-base was unique to the helicopter industry. The preferred solution was to order the firm's Future Lynx helicopter (later known as Wildcat) to meet the future battlefield and maritime requirements subject to value-for-money analysis. In so doing, the strategy was also explicit in the intent to, "promote a more open, predictable but demanding partnered relationship with the company, to provide better value for money and reduce their reliance on our investment to sustain the design engineering skill-base" (MOD, 2005a, p.9). To that end, the MOD would enter into a Strategic Partnering Agreement (SPA) with AgustaWestland by June 2006. The SPA ultimately included behavioural aspects in terms of creating a cooperative and effective working culture based on transparency, openness and respect (MOD, 2005b). Already in place was an equally binding Business Transformation Incentivisation Agreement (BTIA). Taken together, these two initiatives were intended to:

> … incentivise and drive forward business transformation across the full spectrum of MoD business … by improving speed of delivery, reducing costs and increasing operational availability. It will also help ensure a long term, viable and cost-effective support of the MoD's helicopter fleet (Parliament, House of Commons, 2007, p.1).

Value-for-money

On the fifth principle of value for money, the strategy mentioned the term 98 times without providing a definition beyond that it was a long-term concept. But the introduction of TLCM also had connotations for value for money in that industry would be incentivised to invest in driving down costs through long-term partnership arrangements with the MOD. Such an approach would give firms contractual certainty on future orders for through-life support. This approach was particularly relevant in fast-jet aircraft (with BAE Systems) and in helicopters (with AgustaWestland) where in both cases, the MOD was already making extensive use of 'availability contracting.' Here, incentive payments were based on maintaining specific numbers of aircraft available to the front-line. The attraction to industry was in the related long-term, guaranteed cashflow by which to justify their own investment in management information systems, spares inventory, stewardship of intellectual property and sustainment of the required depth of engineering expertise. Given also the rapid advances in technology, the strategy emphasised that open systems architecture design would allow for rapid and cost-effective technology insertion. However, the strategy was right to caution that, while offshore initial procurement might present cost advantages, there were dangers in ceding monopoly power to foreign suppliers which could frustrate periodic upgrades. More broadly, DIS 2005 lacked the financial data by which to assess its coherence with the funding available in the equipment plan: without an agreed definition for value for money, it was difficult to assess the balance between ends, ways and means. Subsequently commenting on this vacuum, Kirkpatrick pointed-out that, the MOD procurement organisation's definition was the solution which meets the requirement at the lowest through life cost whereas, in assessing defence projects, the National Audit Office determined that "value for money should be obtained by seeking the optimal balance of effectiveness, cost, timeliness, security of supply and other relevant matters" (Kirkpatrick, 2008, p. 298). The omission of an agreed MOD definition renders judgements on procurement options difficult and obscures the cost of protecting key industrial sectors. In addition, according to Hartley, the lack of precision over the 'other relevant matters' in the NAO extant definition "might well give ministers opportunities for intervening to distort procurement decisions on a case-by-case basis" (Parliament, House of Commons, 2006, Q160) whereas economic theory suggests that governments should intervene only where markets are failing to work properly. He points out that:

> On this basis, the DIS 'wider factors' need to be related to clear failures in labour, technology (R&D markets and spill overs) and export markets (and that defence procurement is the appropriate solution). Such a case has not been made in the DIS (Parliament, House of Commons, 2006, Ev 104).

The NAO subsequently updated their definition of value for money to "getting as close as possible to achieving the optimum balance between cost, schedule and performance" (NAO, 2021a, p.51, para.5.1). The same report pointed out that MOD business cases "did not always set out a clear definition of value for money against which progress could be measured" (NAO, 2021a, p.51, para. 5.2). At that time, the Treasury was unconvinced on the validity of such 'wider factors:

> The Treasury believes that such orders have only a negligible effect on the overall level of UK employment (except during a severe economic depression) and insists that the MOD's comparative assessment of rival projects should take no account of their presumed effect on employment. (Kirkpatrick, 2008, p.303).

Organisation and culture

The final principle stressed the need for organisational and cultural change on both sides which stemmed from the adversarial MOD-industry relationship arising from the previous decade's iron-handed application of competition. The strategy recognised that "competition at a particular point or level is not the best solution to drive innovation, encourage investment and produce a fair price" (MOD, 2005a, p.18). But the strategy's boldest challenge involved the cultural shift towards partnering behaviours at all levels "so as to encourage trust, openness, transparency and communication" (MOD, 2005a, p.11). Theses aspects would provide the foundations for long-term strategic partnerships with industry for the provision of equipment support and upgrade. However, the adversarial relationship of old was particularly apparent at the contract interface yet there was a lack of clarity in the strategy over resolving the perceived tension between the partial replacement of competitive procurement with industrial partnering whilst also achieving value for money. These aspects were of concern to defence economists given that the strategy did not give a balanced comparison with the existing competitive approach. Hartley considered that partnering was a vague term that may not lead to cost-efficient outcomes and could see a return to the cosy relationship that existed before competitive bidding though the 1985 Levene reforms became the norm (Parliament, House of Commons, 2006, Ev 85). He continued that a smaller defence industrial base with greater protection and guaranteed work for the key sectors could also lead to domestic monopolies. Fitzpatrick also expressed valid reservations over how partnering might work with

foreign or multi-national firms which lack a footprint in the UK (Parliament, Hose of Commons, 2006, Ev 85). Although unrecognised in these commentaries, the defence industry was mindful that, as a minimum, partnership in whatever form might serve to ameliorate at least some of the adversarial relationships that existed between the MOD and industry. In the event, Team Complex Weapons proved successful and the proposed partnering agreements in combat air and helicopters did take root and continue to endure. In the former case, the Tornado availability-based contract with industry introduced in 2003 reduced support costs by £1.3 billion over six years and became the blueprint for a similar approach to Typhoon introduced in 2016 (NAO, 2007a).

Coherence with the equipment plan

While DIS 2005 provided a masterful map of the current UK defence industrial base and its ideal configuration in the future, it failed to take account of the extant budgetary pressures and the adverse affordability trends then apparent in the equipment plan. In departmental settlements in the 2004 Comprehensive Spending Review (HMT, 2004), the defence budget received a real terms uplift of just 1.4% over the 3-year period until 2007-08 at a time when defence inflation was running at 4.1% (MOD, 2017b). Although the 2002 White Papers had scaled back the ambitions in the 1998 SDR, financial management was plagued by the MOD's unwillingness to reconsider the affordability of the aircraft carrier project and to recognise the uncontained cost growth elsewhere in the equipment plan. The NAO's report on the position in 2003 had pointed out that "problems over the Astute submarine and the Nimrod MRA4 aircraft had cost the MOD £1,541 million in cost overruns and the prime contractor, BAE Systems, £1,050 million [as of 31 March 2003]" (NAO, 2004b, p.1). These charges resulted from the need to restructure the projects in the light of project management challenges. Of note, both these projects had been the subject of competitive tendering which, after selection of the preferred bidder (GEC- Marconi for Astute and BAE Systems for Nimrod), resorted to a round of 'best and final offers' on a NAPNOC basis under the guise of risk reduction (NAO, 2007b, pp. 11&95). In both cases it rapidly became clear that these stringent negotiations, culminating in 1997 and 1996 respectively, resulted in unrealistic pricing which stored-up problems for the future. The Nimrod contract had to be renegotiated in 1999 and again in 2002 in the face of mounting technical and resource issues ultimately requiring a reduction of aircraft numbers from 21 to 18. Thereafter, in 2003, the fixed price contract was changed to a Target Cost Incentive Fee contract for design and development only (NAO, 2007b, p. 95). The project was ultimately cancelled in 2010. For Astute, by 2003, BAE Systems had acquired GEC-Marconi and disclosed significant project schedule delay and cost overrun. Again, this resulted in contractual separation of design and development from production with the later contracted under a Target Cost Incentive Fee arrangement. In addition, the MOD made a cash inject of £450 million with the company adding £250 million (NAO, 2007b, p.11). By 2007, project costs for 8 boats had

grown from £2.6 billion to £3.8 billion and the in-service date had slipped from 2004 to 2010 (NAO, 2007b, p.16). In 2025, the ultimate projects cost for 7 boats was assessed as £12.2 billion (at 2025 prices) (MOD, 2025b). These projects represent salutary lessons when contracting authorities leverage industry to bring forward unrealistic pricing in the knowledge by both parties that these represent 'must win' contracts.

Meanwhile, the cost of the Eurofighter Typhoon rose by £1,037 million. In addition, given that the contract would not be signed until mid-2007, the full cost of procuring the two aircraft carriers had yet to be recorded in the equipment plan. Further financial tension was added by the condition on MOD in the Spending Review to make £2.8 billion in efficiency savings across the three-year period (Webb, 2004). Between 2003 and 2005, the top 20 major projects were showing increased cost growth over approved budgets of £2.7 billion (excluding Typhoon whose cost was then commercially sensitive). There was also an increased total delay of 375 months, an aspect that invoked further cost from the need to run-on obsolescent equipment (NAO, 2005a, p.9). The situation had become untenable by 2008 causing the MOD to conduct a major budgetary review entitled the 'Equipment Examination' which ran from April to December 2008. As a result, despite the risk of sustaining a claim for liquidated damages, MOD announced an eight-month suspension of the 2006 contract for the DIS 2005 flagship helicopter project (the AgustaWestland Future Lynx) pending an affordability review. In 2010, five years after publication of the strategy, the defence budget was running a deficit of about £38 billion over the following 10 years (HMG, 2010a, p15). So, whilst DIS 2005 might be regarded as theoretically masterful, in practice, it was simply ill-fitted to the prevailing financial context into which it was launched.

Assessment of the impact of DIS 2005

Although DIS 2005 was systematic in its industrial analysis, it was very ambitious in its approach. It seemed remote from the reality of the current defence budget and particularly the state of the related equipment plan. It was obvious at the time that the financial resources available would be insufficient to fuel enough activity in the defence industrial base to reach into all corners of the defence ecosystem to which the strategy aspired. It was also light on the how challenges inherent in driving the necessary transformation would be addressed. This was particularly the case in shipbuilding where the Defence Select Committee expressed disappointment with the lack of detail on a maritime sector transformation plan and increased concern a year later when little progress was evident (Parliament, House of Commons, 2007, p.3). This ultimately led to a delay in making the final carrier investment decision. As Taylor had previously pointed out to the committee, "the Ministry of Defence shapes industry through procurement choices and, unless the DIS has impact in this area, it will steadily pass into irrelevance" (Parliament, House of Commons, 2006, Ev 89). This aligns with Hartley's consistent view that, as a monopoly buyer, government can apply the resulting

power on industry “to determine the size, structure, conduct, performance and ownership” (Hartley, 2020, p.17). In addition, where governments wish to maintain skills as well as design and manufacturing capability in a sector, a regular drumbeat of orders is vital (Smith, 2022): as such, DIS 2005 failed to link sovereign requirements with procurement action.

DIS 2005 therefore did not achieve a pragmatic balance between the ends, ways and means of the strategic triad. The lack of analysis of the ‘means’ was particularly acute in that the strategy did not show robust financial data related to the proposed activities and anticipated market volumes. This shortcoming denied industry the opportunity to assess their long-term investment plans. The budgetary situation deteriorated in the following years to the extent that crisis management of the equipment budget had to take priority over DIS implementation. In addition, the strategy’s concept of ‘appropriate sovereignty’ and its relationship with ‘operational independence’ did not take root in the face of this turbulent financial backdrop thus leaving open the question of how a sustainable defence industrial base could be delivered. Within two years DIS 2005 had lost both its ministerial champion and its momentum in the face of declining budgets and internal MOD financial barriers to implementation. A laudable closing line in Lord Drayson’s Ministerial foreword stated that “we will review this Strategy every Spending Review period” (MOD, 2005a, p.2). Published in October 2007, the next spending review merely stated that DIS 2005 “was to be updated shortly” (HMT, 2007, p.232) but it never was. In November 2007, Lord Drayson resigned from MOD amid speculation that Prime Minister Brown and his advisers were nor enamoured of government intervention in the defence industry (Wheeldon, 2017, para. 16; Heidenkamp et al, 2013, p.30).

As was the case in 1998, the noble aspirations contained in a defence strategy were therefore thwarted by a compelling need to eradicate a budget deficit and the lack of financial headroom by which to engineer change. In terms of underpinning credibility as an element of deterrence, the lift in confidence represented by the publication of this very detailed strategy was rapidly diluted by the lack of evidence of systematic implementation. Overall, at its launch, DIS 2005 initially appeared to be a laudable attempt to mould the defence procurement enterprise to align with the MOD’s changed requirements. However, its value was rapidly undermined by the financial barriers to its implementation which, in turn, diluted the UK’s overall credibility in the deterrence equation.

Chapter 5 – DIS under the Coalition and Conservative Governments 2010 - 2023

> *We want the words: 'Made in Britain', 'Created in Britain', 'Designed in Britain', 'Invented in Britain' to drive our nation forward. A Britain carried aloft by the march of the makers* (George Osborne, Chancellor of the Exchequer, 2011).

Political Context

In 2010 with the immediate impact of the global financial crisis beginning to subside, Prime Minister Brown called a general election to cement his own mandate having succeed Blair without a Labour Party leadership contest. The 2010 Labour manifesto stated that "Our commitment to defence is non-negotiable. Defence spending has increased by ten per cent in real terms since 1997" (Labour, 2010, p.10:3). It also highlighted the recent creation of a National Security Strategy (HMG, 2008) "to strengthen our response to fast-moving and interconnected threats from terrorism and nuclear proliferation to new challenges like cybersecurity" (Labour, 2010, p.10:3). The manifesto also acknowledged that acute cost pressures remained and that there would be a strategic defence review, including procurement reform. In the face of earlier political criticism of inadequate equipment for the armed forces in Iraq and Afghanistan together with the level of casualties that resulted, the manifesto emphasised increased investment in critical care and rehabilitation for service personnel. On broader international relations, it promoted a UK leadership role in the European Union contrasting this position with the Conservative's marginalisation in Europe with their "anti-European attitudes seen as undermining British influence" elsewhere in the world (Labour, 2010, p.10:4). On recovery from the global financial crisis, the manifesto was strong on the need for radical change in financial institutions and took credit for not allowing "the recession created by the financial crisis to become a depression" (Labour, 2010, p.1:3).

With Cameron now leader of the Conservative Party since 2005, prime in their manifesto coverage was the plan for economic recovery and growth. They sought the electorate's consent for their "programme of public spending control that will deal with Labour's debt crisis and stop the Labour jobs tax that would kill our economic recovery" (Conservative Party, 2010). On national security, the manifesto feared Britain's potential decline in global influence in a more dangerous world where threats "as diverse as state failure, international terrorism and new forms of warfare were being amplified by the impact of climate change and the spread of nuclear weapons technology" (Conservative Party, 2010, p.103). Again, procurement reform and a defence review were planned with the latter potentially establishing a National Security Council and a National Security Adviser. Citing Afghanistan, the manifesto stated that "We will always ensure our Forces have the resources they need to carry out their mission properly" (Conservative Party, 2010, p.106). There were also undertakings on the care of veterans and stronger support for military families. As for foreign policy,

the manifesto stated that we will "renew and reinforce our engagement with the rest of the world and build up British influence by deepening our alliances beyond Europe and the United States" (Conservative Party, 2010, p.109). Particular objectives were a special relationship with India and closer engagement with China (Conservative Party, 2010, p.110). On Europe, the manifesto was decisive in that "we will not hand over any more areas of power and we will never join the Euro" (Conservative Party, 2010, p.103). Opinion polls just ahead of the vote were Conservatives 37%, Labour 29.7% and Liberal Democrats 23.6% (Electoral Calculus, 2010).

In the event, the 2010 election led to a hung parliament that was ultimately resolved by the formation of a Conservative – Liberal Democrat coalition which was subject to a detailed agreement entitled, *The Coalition: our programme for Government* (HMG, 2010b). The document covered 31 areas of government describing agreed policies as well as aspects where the two parties could not agree (Maer and Gay, 2015, p.3). On defence, the Liberal Democrats had campaigned on a commitment against the "like-for-like replacement of the Trident nuclear weapons system" and promoted multi-lateral nuclear disarmament (Liberal Party, 2010, p.65). On international relations the manifesto stated that Britain should be at the heart of Europe and criticised the UK's relationship with the US over the Iraq War, asserting that the subservient relationship neglected "Britain's core values and interests" (Liberal Party, 2010, p.63). The Coalition Programme resolved the difference over nuclear deterrence with the statement:

> We will maintain Britain's nuclear deterrent and have agreed that the renewal of Trident should be scrutinised to ensure value for money. Liberal Democrats will continue to make the case for alternatives (HMG, 2010b, p.15).

There was no other detail on capabilities in the Coalition Agreement but an aim to reduce MOD running costs by 25% was included. There was explicit support for defence exports with the caveat that they are "used for legitimate purposes, not internal repression, and [we] will work for a full international ban on cluster munitions" (HMG, 2010b, p.15). On Europe, the document was also explicit "that Britain should play a leading role in an enlarged European Union, but that no further powers should be transferred to Brussels without a referendum" (HMG, 2010b, p.19). In addition, it stated that "we rule out joining or preparing to join the European Single Currency for the duration of this agreement" (HMG, 2010b, p.9). Of most significance, the statement that "We are also agreed that the most urgent task facing this coalition is to tackle our record debts" ushered-in almost a decade of public sector austerity (HMG, 2010b, p.7). In mid-2010, the net debt to GDP ratio was 68% rising to 85.1% in 2019 ahead of the subsequent impact of Covid alleviation measures (ONS, 2025). Average GDP growth across the same period was 1.8% (ONS, 2020) while defence

expenditure fell from 2.5% of GDP to 2.1% (Statista, 2025). A revised National Security Strategy was published in 2010 HMG, 2010c). While the change of government saw an amended approach to recovering from the global financial crisis with the application of austerity, the ongoing major commitment in Afghanistan left few options for changes in defence posture. Beyond that, it is tempting to consider that, had Labour been in power at the time of the 2011 civil war in Libya, they might have been more tentative over UK involvement. However, the existence of the UN Security Council Resolution and NATO's mandate to act but without committing forces on the ground, seemingly reduced the risk to an acceptable level in the view of Labour MPs. The House of Commons vote was 557 to 13 in favour (Parliament, House of Commons, 2011, para.3).

The Conservative government remained in power until 2024 albeit with five different prime ministers. The 2015 General Election returned a majority Conservative government under Cameron with a manifesto commitment to a referendum on continued EU membership by 2017 which ultimately took place in June 2016: the fallout from the majority vote to leave the EU dominated the rest of the decade. The manifesto also pledged an investment in new military equipment of at least £160 billion over the next decade and made no changes to defence posture (Conservative Party, 2015, p.77). Having succeeded Cameron as Prime Minister, May inherited the UK commitment to combat air operations in Iraq and Syria and the growing concern in the Middle East over Saudia Arabia's intervention in Yemen. Accordingly, the 2015 SDSR had set the UK's defence capability on a path to growth and also pointed out that a decision on the modernisation of the Trident nuclear missiles would be required within this parliament (HMG, 2015, p.35). May sought her own electoral mandate in the 2017 election but the manifesto was consistent on defence issues with its predecessors (Conservative Party, 2017, pp. 41-42). The election results left May with a minority government reliant on Democratic Unionist Party support under a confidence and supply agreement. However, as the victim of major Brexit political discord, May resigned and was succeeded in July 2019 by Prime Minister Johnson who was similarly motivated to call an election in late 2019: defence aspects in the manifesto remained consistent (Conservative Party, 2019, p.53). The Brexit withdrawal treaty was signed in January 2020, just days ahead of the arrival of the Covid-19 virus in the UK. The resulting pandemic dominated the national agenda with associated restrictions and lockdowns until May 2021. Johnson resigned in July 2022 as the result of mass resignations among his ministers, to be replaced briefly by Prime Minster Truss. Her radical but haphazard approach to the economy saw confidence in her leadership evaporate rapidly, leading to her resignation after just 49 days to be replaced by Prime Minister Sunak until Labour was re-elected in 2024. Given the political turbulence of the latter half of the decade and despite combat involvement in Afghanistan, Libya, Iraq and Syria (against Daesh), and Mali, defence was rarely at the top of the Whitehall and Westminster agenda. The most significant occasion was the 2013

parliamentary vote against committing UK forces to military action in Syria. Given the continuing controversy over UK's 2003 involvement in the Iraq war, Prime minister Cameron felt that a vote was politically necessary. Subsequently, Prime Minister May authorised the action in 2018 without a vote "citing the need for action during the Easter recess" (Strong, 2023, p.1).

Part One – DIS 2012

Austerity and hollowing-out

The aftermath of the 2003 Iraq war and the response in Afghanistan to the 9/11 terrorist outrage left a legacy of extended counter-insurgency campaigns in each of those countries. In addition, the impact of the 2007-08 global financial crisis placed the economy under severe pressure. The 2010 Spending Review noted that, "The Coalition Government inherited one of the most challenging fiscal positions in the world. Last year, Britain's deficit was the largest in its peacetime history" (HMT, 2010a, p.5). The Spending Review also noted the continuing uncertainty in the global economy as well as the UK's unsustainable levels of debt interest. Accepting the need for rapid action, departmental budgets other than health and overseas aid saw an average cut of 19%. Defence fared better than most departments, emerging with a cut of 7.5% over the five-year review period which nevertheless required major economies in defence expenditure with significant implications for industry. A full defence and security review (SDSR 2010) entitled *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review* (HMG, 2010a) saw the need to cancel or delay some significant and much-needed major projects. Only one of the two aircraft carriers would be brought into service with a reduced number of F-35 aircraft. The Nimrod MRA4 maritime patrol aircraft was to be cancelled with no plan to fill the resulting capability gap.

The 2012 DIS entitled, *National Security Through Technology*, was formulated against this backdrop of public sector austerity. It acknowledged that urgent action was required to restore the financial integrity of the equipment programme to avoid the need to keep delaying or cancelling projects (MOD, 2012b, p.5). It also emphasised that the MOD was faced with difficult decisions but that it would be "bold and ambitious" in "matching commitments to resources" (MOD, 2012b, p.12). The strategy covered both defence (from an MOD and defence industry perspective) and security (from a Home Office and security industry perspective) which meant that the anticipated precision of the strategy was clouded by generalisation. Defence manufacturing embraces long-term research and development, complex systems integration and advanced manufacturing requiring bespoke, relatively high-risk approaches. Conversely, security relies more heavily on a commoditised commercial market representing huge private sector investment such that buying off-the-shelf is the norm. Unlike DIS 2005, the strategy was signed-of only by a junior minister in each department with no overt Treasury acknowledgement. Extensive consultation preceded the strategy (MOD, 2010b) with the active involvement of industry which had been unnerved by the SDSR 2010 reductions in the equipment programme (MOD, 2012c). MOD managed industry's expectations by stating explicitly in the strategy that there would not be a list of protected capability areas as there had been in DIS 2005. Rather, in view of the constrained financial situation and the unpredictability

of the threat, this strategy rested on two revised core principles centred on a narrower definition of sovereign capability and the route to contract favouring open competition on the domestic and global market.

Sovereign requirements

Sovereign requirements were driven by the new principle of open procurement. Sovereignty was redefined around the twin dimensions of operational advantage (battle-winning edge) and freedom of action, explained as being "able to use a capability effectively, although not at any cost" (MOD, 2012b, p.26). This approach would be taken only for capabilities deemed essential for national security: procurement decisions would reflect affordability and value for money. The strategy outlined four general cases. Cryptography continued to be cited as being at the core of national security. Secondly, on nuclear weapons and propulsion which rely on highly classified technology and intelligence data, suppliers would have to meet the highest levels of trust (MOD, 2012b, p.27). A third case involved the updating of cyber systems, electronic warfare systems and defensive aids in the light of an increased threat where rapid access to intellectual property and technical knowledge would be required. The fourth case concerned capabilities where there was a need for high confidence on performance including sub-systems and their integration into a platform's architecture. This category was left unstipulated beyond stating that there was a need to be an intelligent customer across several dimensions (MOD, 2012b, p.27). Of note, these criteria for sovereignty did not imply that the related capabilities would need to be sourced onshore. Rather, the strategy pointed out that, where a potential offshore supplier was involved two considerations would apply. First, the risk to freedom of action would be assessed against the benefits arising from the likely procurement approach. Secondly, "there will also be a balance of risk between the extent of freedom of action that is practically achievable and the constraints that could arise from measures taken to protect it" (MOD, 2012b, p.27). The rationale behind both these objectives would seemingly be to avoid being hemmed-in by undertakings on the future shape and size of the industrial base that might prove undeliverable in the light of a fast-changing international security environment and the very uncertain economic backdrop. Nevertheless, it represented a very limited approach to the wider concept of operational independence as envisaged in DIS 2005 with its firm relationship between 'appropriate sovereignty' and operational independence **(**MOD, 2005a, p.17). In subsequent evidence to the Defence Select Committee, Kirkpatrick highlighted the failure to specify the capabilities where the UK sees independent freedom of action as essential versus those where reliance on other nations would be acceptable. He continued that no consideration was given to affordability in either case (Parliament, House of Commons, 2013c, Ev w21). He concluded that, "The MoD must give urgent priority to identifying those military capabilities in which the UK must retain Technology Advantage, and the associated technological

and industrial capabilities which consequently need to be sustained onshore" (Parliament. House of Commons, 2013c, Ev 21, para 9).

Route to contract

The 2010 SDSR set the scene for an abrupt change to the preferred route to contract with the statement under its national security planning guidelines that there will be:

> a Defence Industrial and Technology policy that seeks to secure the independence of action we need for our Armed Forces, while allowing for increased numbers of off-the-shelf purchases and greater promotion of defence exports (HMG, 2010a, p.13.)

DIS 2012 therefore introduced the open procurement principle which rested on the default position of open competition on the domestic and global market. The rationale was that the approach "maximises the likelihood of finding a solution to our needs at an affordable cost and at best value for money (MOD, 2012b, p.19). An additional driver was the increasing prevalence of new single-source procurement contracts which in 2010/11 stood at 36% by value and 69% by number (MOD, 2012b, p.19, fn.9). Reflecting also the overriding theme of austerity, the open procurement principle was qualified by a refined and very narrow definition of value-for-money:

> Value for money is the optimal combination of time, cost, and effectiveness, within available resources. It is a relative concept, which involves the comparison of potential and actual outcomes of different procurement options. Value-for money for each programme is determined on a case-by-case basis, depending on the circumstances. Non-quantifiable factors may be relevant to value for money assessments, such as a supplier's track record and financial robustness. The MOD does not consider wider employment, industrial, or economic factors in its value-for-money assessments (MOD, 2012b, p.12, fn.6).

This definition was of concern to onshore companies in that it removed any notion that defence procurement had a part to play in the broader economy. It also undermined the foundations of a sustainable defence industrial base in that it placed emphasis on individual contracts rather than the 'ends' inherent in an overarching defence industrial strategy. At that time, the National Audit Office viewed value for money more broadly as "the optimal use of resources (economy, efficiency and effectiveness) to achieve the intended outcomes" (NAO, 2011a, p.4). MOD's narrow definition of value for money was also seen as being "in striking contrast to the model in continental Europe, where for major projects, a cross-Departmental approach focuses on cost and value to the nation

as a whole" (Parliament, House of Commons, 2013b, p.11). Some saw value for money "as one of the most ubiquitous phrases in defence acquisition but also one of the least understood" (Kirkpatrick, 2008, p. 298). Taylor and Louth concluded that "The subjective term 'value for money' should be outlawed for a period to put pressure on ministers and officials to say precisely what they mean" (Parliament. House of Commons, 2013c, Ev 38).

The strategy professed the advantages of off-the-shelf procurement to be reduced delivery risk to time, cost and specification because the technologies concerned were deemed to be mature and well-understood. There was also recognition that mature technologies may become obsolete more quickly, hence the importance of future proofing (MOD, 2012b, p.20). But there was little recognition that an off-the-shelf approach to procurement rarely brings with it the body of knowledge required to operate in the most testing combat situations. Furthermore, it seldom provides an exact fit with the requirement but necessarily calls for compromise. It was also pointed out by the Defence Select Committee that few other nations of the UK's stature apply the same doctrine and "a decline in the UK defence industrial base seems inevitable" (Parliament, House of Commons, 2013b, p.5). On future proofing, the strategy was silent on the problem of buying a fully developed capability off-the-shelf when access to the required intellectual property for future proofing rests with an offshore owner who is out of reach. However, there was recognition that the MOD must possess the depth of intelligent customer capability to be able to make judgements on the targeting of investment in areas where a suitable solution was not available on the shelf. Given also the significance afforded to contractor-based support activity in DIS 2005, it was odd that this strategy omitted any detail on availability contracting and strategic partnering arrangements with industry.

In terms of international collaboration on procurement, DIS 2012 rehearsed the well-known advantages of economies of scale and access to technology unavailable in the UK while stressing that such an approach would not be detrimental to national sovereignty MOD, 2012a, p.30). In an era where defence aerospace had seen successful three and four-nation collaborations on Tornado and Typhoon, DIS 2012 favoured a single partner approach. This view is based on tensions over workshare and the difficulty in synchronising multi-government decision-making which can lead to additional delay and hence cost. In the case of previous collaborative projects such as Tornado and Typhoon, it was seen as a price worth paying for sharing the development and manufacturing costs which might otherwise might have rendered a project unaffordable for a single nation. Of note, the Future Tempest aircraft is a collaboration between the UK, Italy and Japan (MOD, 2022f). At the time of DIS 2012, the US and France were cited as the obvious partners given gestating treaty relationships. In the former case, the US-UK Defence Trade Cooperation Treaty had been generated

in 2003, signed in 2007 but took until 2012 for the Implementing Arrangements to enter into force such were the security complexities of trans-Atlantic defence trade. It aimed to speed-up the release of technology and simplify access to markets on both sides. As for France, the 2010 Lancaster House Treaty led to effective cooperation on nuclear deterrence, maritime complex weapons and A400M support (MOD, 2018a). Conversely, planned collaboration with France over aircraft carriers, drones and a future combat aircraft ultimately failed over chauvinistic approaches to intellectual property by government and industry on both sides.

Technology advantage

DIS 2012's complex approach to assessing sovereignty in the light of open procurement policy was made more confusing by the overlay of another new concept termed 'Technology Advantage'. Buying off-the-shelf under an open competition could see a case where procurement from an overseas supplier represented optimum value for money. However, there might be an overriding need to select more costly but superior onshore technology: in such cases, 'Technology Advantage' would apply. The strategy recognised such trade-offs would be inevitable. It also gave examples where mechanisms for minimising costs might arise through the application of Technology Advantage. These included: integrating advanced technologies into standard equipment purchased through open procurement; collaborating on technology with key allies; seeking-out high-grade dual-use commercial technology; and relying on synthetic training to ease the introduction of new capability (MOD, 2012b, p.15). While these approaches are potentially plausible in a highly disciplined procurement environment, the MOD's propensity for frequent changes in equipment specification would render implementation difficult (Gray, 2009). As for the balance between project certainty and technological advantage, Taylor and Louth pointed out that defence projects are inherently risky and cautioned that the pursuit of leading-edge technology undermines the certainty on time and cost that prudent financial management requires. (Parliament. House of Commons, 2013c, Ev 36).

Sustaining the Industrial Base

The strategy placed little emphasis on the sustainability of the industrial base but there was an oblique mention on the provision of "a unique environment for industry in the defence and security sectors" (MOD, 2012b, p.8). This latter aspect was further clarified as recognition that the strategy was inherently supportive of the defence and security industries and their contribution to the wider economic objective "to achieve strong, sustainable, and balanced growth for the UK" (MOD, 2012b, p.8), a statement that was seemingly at variance with the new definition of value for money. A related initiative deemed to be of value to industry was the

issue of a novel annual financial publication, *The Defence Equipment Plan 2012* (MOD, 2013a) which was accompanied by an NAO assessment of its robustness (NAO, 2013b). Relatively high-level in approach, the former did not list expenditure on individual equipment. Rather, it aimed to show a 10-year balanced budget across all sectors and was seen by MOD as demonstrating effective financial stewardship while also providing moderate transparency for industry (MOD, 2012b p.6; MOD, 2013, p.5). Nevertheless, the changed interpretation of sovereign capability was not straightforward to interpret and, as future experience was to show, overly complex in its application (MOD, 2021c, p.20). Such a minimalist approach would have inevitably resulted in a shrinkage in the indigenous industrial base despite an MOD assumption that expertise would continue to exist for through-life support and rapid capability enhancements during combat operations. Equally, the approach would place at risk continuity on assurance of safety, operational risk management and support sustainability, all of which place a high premium on onshore access to industrial knowledge. In addition, an environment of reduced order off-takes and lengthening delivery timelines would make it difficult for industry alone to manage its capacity without active engagement and partnership with MOD. In the same vein, Dover and Phythian asserted that, "The February White Paper broke the historic link between UK procurement and UK defence manufacturing" (Parliament. House of Commons, 2013c, Ev w7). While this is an overstatement given that long-term contracts were still in place, they did identify correctly that, "To those manufacturers who are global brands, it provided a further (perhaps erroneous) signal that the UK no longer provides a supportive environment for their activities" (Parliament. House of Commons, 2013c, Ev 7). Taken together, these factors placed at risk the notion of a sustainable UK industrial base by which to deliver the strategy's concept of 'freedom of action' to the extent that would allow operational independence.

Future technology

The strategy's insights on future technology acknowledged that the "global availability of technology combined with an ever-increasing pace of technological change means that we face an increasingly capable and diverse range of threats" (MOD, 2012b, p.33). This statement reflects the experience of counter-insurgency warfare in Iraq and Afghanistan where asymmetric enemies had proved adept at rapidly adapting commercially available technology to lethal effect in aspects such as improvised explosive devices (IED). The strategy also pointed out that spending on military science and technology had declined from 2.6% to 1.2% of the defence budget over the previous decade and announced the intent to sustain investment at a minimum of 1.2% (MOD, 2012b, p.33). At this level of funding, maintaining agility as an intelligent customer was seen as a priority with research investment in the UK to be focused predominately where the global market was weak.

Beyond that, the strategy offered only generalities about the MOD's aspirations about future technology as a list of challenges rather than an intent to invest according to a detailed roadmap. Generalities included: protection against IEDs and CBRN; cyber defence; and data connectivity and management (MOD, 2012b, p.38). This is seemingly an odd list of priorities given the continuing combat requirements for electronically scanned radar, electro-optics and autonomous systems. However, there was an undertaking to publish the future science & technology priority themes annually (MOD, 2012b, p.62).

Despite an acknowledgement that industry would not invest in technology development unless there was a clear route to exploitation, the strategy seemingly justified this lean approach on the basis that the government would seek to access the civil commercial market. Government investment would therefore focus on defence and security technology that is not available commercially off-the-shelf (MOD, 2012b, p.36). In evidence to the Defence Select Committee, Dover and Phythian considered the impact of broader domestic spill over. They correctly emphasised the strategy's adverse implications for the UK's science and technology ecosystem given its lack of recognition of the mitigations required to protect the nation's research and development culture (Parliament. House of Commons, 2013c, Ev w7). This overall approach to the technology elements of a DIS was seemingly partially the victim of erroneous attempts to consider defence and security as a having homogenous technology requirements and similar routes to market. Overall, the strategy was very weak in providing technology investment guidance to industry.

Inward investment

As for stimulating inward investment, there was recognition that the large multinational firms involved in the defence sector served a global customer base and had choices over where they invest (MOD, 2012b, p.47). The strategy described the UK as having a unique environment in that, by comparison with other major nations, the defence market was largely open with a demand for sophisticated high-value products capable of sustained operational use. There was also an expectation that the UK would continue to maintain the fourth largest defence budget in the world (MOD, 2012b, p.47). Government would provide active support for exports including a willingness to enter into government-to-government sales agreements. Of note, the strategy called for the inclusion of exportability to be a consideration early in the procurement cycle for new equipment whereas, in the past, specifications had been so finely tuned towards UK requirements that equipment became uncompetitive and often unaffordable in the export market. A further aspect cited under exportability was the provision of international training for potential customers, particularly flying training (MOD, 2012b, p.55). However, economies dating back to the 2001

Defence Training Review (MOD, 2001) and the formation of the UK Military Flying Training System removed any spare capacity by configuring the training base around the principle of the irreducible minimum. DIS 2012 promoted the need for a joint government-industry approach to determine how this capability might be revived (MOD, 2012b, p.55).

Coherence with the equipment plan

On finance, the NAO 2009 Major Project Report recorded an unfunded gap in the 10-year equipment programme of between £6 billion and £36 billion. The subsequent 2010 SDSR identified within the defence budget as a whole "an unfunded liability of around £38 billion over the next 10 years" (HMG, 2010a, p15). It later pointed out that, "Some £20 billion of this is related to unaffordable plans for new equipment and support. Cancelling or changing major contracts to tackle this problem itself creates further liabilities" (HMG, 2010a, p31). The MOD took corrective action in DIS 2012's companion document, *The Defence Equipment Plan 2012* (MOD, 2013). The 10-year budget was subject to a novel approach in that the core programme was supported by £4.8 billion of centrally held contingency as well as funding of £8.4 billion for identified risk with a further £8 billion of unallocated budget towards the end of the period. The approach to funding set provision for those risks that were assessed to have a 50% probability of arising. In terms of capability sector breakdown, at £35.8 billion, the level of investment in the successor nuclear deterrent and Astute submarines made them the dominant individual programmes. In defence aerospace, total combat air spend would be £44.5 billion. Land equipment was funded at just £12.3 billion (storing-up problems for the future) with surface ships, including the carriers, at £17.4 billion. In its assessment of the 2012 plan, the NAO recognised the degree of prudence that was now evident, concluding that the MOD had laid the foundations of future stability and, with ongoing careful stewardship, "the Department will be able to demonstrate that it has really turned a corner" (NAO, 2013b, p.5). This careful stewardship was still evident in the 2015 plan which maintained a headroom of £9.5 billion with a contingency of £4.3 billion (NAO, 2015a, p.12) but this position would change significantly within months after the 2015 Strategic Defence and Security Review added new equipment requirements (NAO, 2015a, p.29).

Assessment of the impact of DIS 2012

Overall, DIS 2012 left industry in the dark given its lack of granularity. By comparison with DIS 2005 the 'ends' were much less ambitious and the 'ways' much less interventionist given that the 'means' were heavily constrained by the fiscal backdrop. In evidence to the Defence Select Committee, Kirkpatrick was justifiably clear that "The White Paper on National Security through Technology is full of aspirations and good intentions, but it fails to address rigorously the key problems which for

decades have bedevilled the UK's defence acquisition policy" (Parliament. House of Commons, 2013c, Ev w21). For Donnelly, the strategy failed to answer his key question on whether the MOD's acquisition process would be able to deliver the new adaptable force posited in the SDSR 2010 rather than just delivering more of the same. He saw aspects such as the adverse financial climate, the lack of technical expertise in the MOD and the increasing presence of foreign-owned firms in the UK industrial base as militating against radical change. The Defence Select Committee hearing also attracted considerable industrial criticism of DIS 2012 in that it was seen as failing to measure-up to the definition of a strategy in terms of providing an equilibrium between ends, ways and means. Much of the content consisted of describing the status quo with large sections which were nothing more than basic common knowledge (Parliament, House of Commons, 2013b, Qs 1-110). Industry's evidence also pointed out that:

> Against this backdrop, industry was looking for clear, unambiguous guidance from the White Paper on the Government's strategy on sovereign technology requirements and future industrial capacity: we have been disappointed on both counts (Parliament, House of Commons, 2013c, Ev w14, para 6).

The inclusion of security alongside defence, each with entirely different markets and supplier bases, gave rise to both ambiguity and repetition which blurred the central message. In posture terms, given the continuing threat from Al Qa'ida, the strategy was based on a conceptual continuum linking intervention abroad with security at home (MOD, 2012b, p.5). While that might be appropriate at national security strategy level, it ignores the different way in which operational capability is generated between defence and homeland security, not least in the type of equipment involved. Nevertheless, although the MOD stood by the document's purpose as a defence industrial strategy, it was difficult to identify how it might have been seen as valuable to industry as a guide to investment. Likewise, it did not provide a roadmap (or even generate confidence) towards a sustainable UK defence industrial base. It said nothing about equipment priorities and provided little detail on how the rather high-level concepts described would affect the content of the equipment programme. Moreover, consistent application of the strategy's principles on value-for-money, open competition and technology advantage subsequently proved highly complex to apply. Among industry's generic requirements, the minimalist approach to both sovereign capability and value-for-money together with a lack of clarity on future technology requirements diluted the incentive to industry to operate in the UK marketplace. Almost a decade's progress on partnership and availability contracting was ignored. In addition, despite castigating the previous government's legacy equipment programme as being riven with optimism bias, there were no initiatives to

address this serious shortcoming in the procurement process. The Defence Select Committee expressed sympathy for industry's position and asserted that the government had failed to demonstrate "a clear grasp of what is needed for the defence of the United Kingdom" (Parliament, House of Commons, 2013b, p.3). Such a conclusion underscored the adverse impact of the DIS on the credibility element of the deterrence equation.

Part Two - DSIS 2021

The road to recovery

The incoming 2015 Conservative government reconsidered the UK's defence and security posture resulting in the publication of the *National Security Strategy and Strategic Defence and Security Review 2015* (HMG, 2015). The review sought to redress industry's continuing scepticism over DIS 2012 with encouraging remarks about an MOD reset in its relationship with its suppliers. In the expectation of an improved economy, Future Force 2020 that was predicated in SDSR 2010 became 'Joint Force 2025' with an aspiration to deploy an increased expeditionary force of 50,000 personnel "with the ability to project power globally" (HMG, 2015, p.29). Much to the relief of aerospace and maritime industry in particular, several procurement projects were confirmed by the review though with considerable reliance on the US market. Both Queen Elizabeth class carriers were to be commissioned including an air group of 138 F-35 aircraft. Further orders for Typhoon were confirmed with combat enhancements to the radar and weapons. In addition, a fourth Dreadnought submarine was to be ordered. There was also to be an offshore purchase of Boeing P-8 Poseidon Maritime Patrol Aircraft to fill the gap left by the 2010 cancellation of the Nimrod MRA4 and confirmation of an order for, "more than 20 new Protector armed remotely piloted aircraft" (HMG, 2015, p.32). Among the initiatives in the review's chapter entitled *Promote our Prosperity,* it mentioned the creation of long-term partnerships with industry "built on trust and collaboration, through better sharing of information and expertise, and by encouraging industry to play a leading role. The Government will avoid regulation wherever possible" (HMG, 2015, p.73). Yet the review was explicit that the government remained committed to the principles in DIS 2012 of open competition and the tortuous approach to sovereign capability (HMG, 2015, p.75),

Thereafter, to two streams of policy activity followed which were ultimately recognised by industry as being in mutual opposition. First, the MOD launched a series of positive sub-sector strategies starting with the National Shipbuilding Strategy (MOD, 2017c) which presented a detailed pathway by which the sector could be sustained onshore. A Combat Air Strategy followed (MOD, 2018b) offering similar sector sustainability by detailing the £2 billion investment in the future combat air system (FCAS) announced in the 2015 defence review. In parallel and controversially, the publication in late 2017 (MOD, 2017a) of a restatement of defence industrial policy (DIP) provided no new illumination on how the tension between achieving value for money and sustaining the defence industrial base should be managed: it merely repeated the language in the 2002 policy (MOD, 2002a). In other respects, the policy stated explicitly that it was drawing on the firm foundations set out in DIS 2012 with a repetition of the over-complex assessment of sovereign capability and a continued firm commitment to competitive tendering. This approach was in

opposition to the primacy of onshore procurement enshrined in the sector strategies. This muddled misalignment of MOD policy was resolved by DIS 2021 which explicitly withdrew the 2017 DIP. Despite deteriorating control over the defence budget and increased global volatility, the conclusions of SDSR 2015 were only partially updated by a 2018 *National Security Capability Review* (HMG, 2018). In terms of equipment enhancements, little of significance was included. However, in a subsequent report on the *Modernising Defence Programme*, there was an undertaking to enhance readiness by increasing weapon and spares stockpiles funded by adjusting unspecified priorities in the equipment programme (MOD, 2018c, p.3).

By 2021, the UK was feeling its way towards a defence posture outside of the EU as well as recovering from the shocks of the COVID pandemic while also addressing the challenge of climate change. The notions of 'build back better' and ensuring that the nation was stronger, safer and more prosperous were driving government policy (HMT, 2021). These aspects were represented in a major defence and security review which resulted in a suite of papers. The capping paper, *Global Britain in a Competitive Age* (HMG, 2021b) (normally described as just 'the Integrated Review') provided a comprehensive determination on national security, defence posture, international development and foreign policy. The remaining three papers in the suite were: an MOD Command Paper, *Defence in a Competitive Age* (MOD, 2021c); a further government Command Paper *Defence and Security Industrial Strategy* (DSIS 2021) (HMG, 2021a); and a few weeks later, a defence policy paper, *Climate Change and Sustainability Strategic Approach* (MOD, 2021d). The capping paper provided the policy underpinning for DSIS 2021 and asserted that Global Britain would need to accentuate its role as a soft power superpower and "to have secured our status as a Science and Tech Superpower by 2030" (HMG, 2021b, p.4). It also recognised that the notion of full spectrum capability has had to be extended at both ends. At the highest and most lethal end, the nuclear warhead cap was expanded to 260 from 180. At the lower end, there was acknowledgement that the nature of the battlespace had changed with 'sub-threshold' activity now a reality from states such as Russia and a range of non-state actors. Such interventions were difficult to attribute and hard to deter. To that end, NATO and the Euro-Atlantic area would remain as the core focus but with greater emphasis placed on the Indo-Pacific with mentions of sustained engagement in the Middle East and Africa. In the accompanying Defence Command Paper, Russia is described in strident language as representing the most significant threat across the military spectrum with China as a systemic challenge of huge geopolitical significance (MOD, 2021c, p.5). Iran and North Korea are also included as concerns given the way in which each engaged in regional activity and were pursuing nuclear weapon programmes with the potential to become a global threat.

DSIS 2021 was a radical departure from DIS 2012 in the key aspects of simplifying the concept of sovereign capability, removing the default option of competitive procurement and in redefining value-for-money, all aspects that would enhance the sustainability of the industrial base. The driver behind these changes was portrayed as the need to harness defence procurement as a tool of national prosperity based on sustaining "competitive, innovative and world-class defence and security industries, that drive investment and prosperity, and which underpin our national security now and, in the future" (HMG, 2021a, p.14). This significant shift in approach was enshrined in two foundation principles. On sovereignty, the strategy pointed out that experience had demonstrated that procurement strategies could not always deliver national security requirements bounded in the way that the earlier concepts suggested. In particular, the notion of 'technology advantage' contained in DIS 2012 "did not reflect the complexity of the factors in play in defence and security industrial strategy" (HMG, 2021a, p.22). As a result, the very narrow definition of value-for-money in DIS 2012 was replaced by "a more flexible and nuanced approach which demands that we consciously assess the markets concerned" (HMG, 2021a, p.21). This assessment would cover aspects including national security requirement, the availability of optimum technology, collaborative opportunities and the impact on national prosperity. This approach was deemed to allow the use of competitive procurement where appropriate but to recognise that global competition at prime contractor level might, in some cases, undermine long-term value-for-money or might not be compatible with other requirements such as through-life support. In these cases, long-term strategic partnerships would be the preferred option. Taken together, it was recognised that policy change would be required in four areas: acquisition and procurement processes; strengthening productivity and resilience; greater transparency on key technologies and action to promote 'pull-through;' and international co-operation, exports and foreign investment (HMG, 2021a, p.18). Of these, the changes to acquisition policy were the most significant.

Sovereign requirements

Within the acquisition policy changes, the refined approach to sovereign capability was profound with two new classifications of 'strategic imperatives' and 'operational independence.' The former applied to industrial capability that was fundamentally important to UK security and needed to be maintained onshore because of legal or treaty limitations to offshore access. Strategic imperatives therefore applied to aspects such as nuclear warheads, submarine nuclear reactors, cryptography and offensive cyber. Operational independence referred to aspects that had been identified through experience as being high priority onshore capabilities that allow military operations to proceed without external political interference. In these situations, on-

tap access to intellectual property, systems integration skills and design expertise was recognised as a fundamental requirement which could best be met by onshore companies. This much wider sovereignty category of operational independence, which included combat air and helicopters, was contained is a detailed 26-page annex of the strategy. The annex considered all domains and industrial segments (including space for the first time) summarising the extent to which considerations of strategic imperatives or operational independence would apply (HMG, 2021a, p.80). The strategy states that this approach does not suggest 'procurement independence' which would require the long since abandoned requirement for full-spectrum onshore industrial capability (HMG, 2021a, p.21). Rather, where cost advantages apply or where access is needed to technology that is not available within the domestic industrial base, then international partnering would be the preferred route, particularly with the US. In these cases, onshore capability to manufacture critical components, conduct upgrade and integration of additional sensors and weapons, and to execute testing and evaluation would need to be supported by technology transfer.

In aerospace, leading-edge indigenous technology and advanced manufacturing capability were seen as providing global competitive advantage and needed to be sustained onshore. Likewise, there was a need to retain assured access onshore to industry's provision of through-life support. The creation of Team Tempest for the Future Combat Air System (FCAS) was cited as being symbolic of the UK's world-leading aerospace industry and was aimed at ensuring that it "remains sustainable, globally competitive, and at the leading edge of Combat Air system development for decades to come" (HMG, 2021a, p.21). The strategy also pointed out that Investment in helicopters over the past decades had allowed the retention of onshore end-to-end industrial capability including the ability to integrate new weapons and defensive systems, and to upgrade aircraft with new digital technologies. Much of this progress had been achieved through a strategic partnering arrangement leading to a close relationship between the MOD and Leonardo Helicopters (HMG, 2021a, p.98). Again, the provision of onshore industrial through-life support was seen as vital. Space was also cited as a sector where "assured access is fundamental to military operations and UK space industrial capability is vital to operational independence" (HMG, 2021a, p.99). A National Space Strategy was to be published shortly with a view to ensuring that, by 2030, the UK would have the capability to protect space-based assets where necessary through burden-sharing with allies. There were similar initiatives in the strategy for the maritime and land sectors as well as for cross-cutting capabilities. Underpinning these initiatives was the recognised requirement to "promote a more collaborative approach between government and industry" building on the enthusiasm for a more strategic and collegiate relationship on both sides (HMG, 2021a, p.25). The strategy therefore

undertook to increase transparency on long-term procurement priorities and to promote domestic industrial collaboration through the development of road maps (HMG, 2021a, p.29).

Future Technology

Turning to technology and its pull-through to military capability, DIS 2021 recognised that traditional defence procurement processes were becoming incompatible with the need to field fast changing technologies to stay ahead of emerging threats. The Integrated Review Defence Command Paper had made "sustaining strategic advantage though S&T [science and technology] an essential component of the UK's national security and international policy – and strengthening the UK's world-class S&T base" (HMG, 2021a, p.55). The outcome of the 2020 Spending Review with £6.6 billion allocated to defence science and technology over four years was cited as proof of intent and a reversal of the decline in such investment. In parallel, the strategy records an expectation that industry would have the confidence to invest in its own research and development. The strategy was also deemed to represent "an opportunity to change how government and industry work together on R&D" (HMG, 2021a, p.56) based on a more systematic dialogue with a detailed explanation of 'Areas of Research Interest' to be made available to academia and potential new suppliers. But, in a note of caution, the paper emphasised that it was important "that government does not simply hand over technology or IP to a company or institution without ensuring it is suitably protected and effectively exploited" (HMG, 2021a, p.60). Related process changes aimed at faster exploitation included the adoption of common standards and open systems architecture, a streamlined approvals process for low-risk commercially available technologies and better coordinated internal MOD research commissioning processes (HMG, 2021a, p.60).

As for the development of individual technologies, DIS 2021 rested on the foundations set in the MOD's 2020 Science and Technology Strategy (MOD, 2020d). The latter strategy emphasised the need to ensure that "Defence has decisive military advantage in the 'generation-after-next' of capabilities, boldly accepting that potential rewards outweigh the risks (MOD, 2020a, p.10). The priorities were repeated in DIS 2021 as "full spectrum Intelligence, Surveillance and Reconnaissance; multi-domain Command and Control, Communications and Computers; securing and sustaining advantage in the sub-threshold; asymmetric hard power; and Freedom of Access and Manoeuvre (HMG, 2021a, p.57, fn.10). The themes were then contextualised in the Operational Independence annex. For example, under Air Capabilities, the annex pointed to the MOD's intent to develop an air platform protection strategy that would be common to all air assets. It continued, "This will embed the principles of the DSIS to ensure pull-through of technology, through-life spiral development and a partnership with industry to provide confidence to invest and

unlock international markets" (HMG, 2021a, p.97). On Combat Air, the annex pointed out that the UK is among only a small group of nations with end-to-end capability in "cutting edge combat air systems, making skills and industrial capability in this segment vital national assets as we seek to maintain our operational independence" (HMG, 2021a, p.97). Of note, the annex emphasised that:

> … we need to ensure that primes' supply chains and the systems they produce remain open to incorporate innovation and that they can maintain the relative capability of equipment on much shorter cycles than traditional sequences of procurement, mid-life upgrade and obsolescence management in the MOD in particular would have allowed (HMG, 2021a, p.80).

Route to contract

While MOD had a continued responsibility to achieve optimum value-for-money, amendments to centrally mandated Treasury procurement procedures in the Green Book (HMT, 2020a) had redefined the minimum criteria or critical success factors by which this should be assessed. First, these included 'strategic fit' in that the chosen option must meet business needs and be harmonised with other programmes and projects, an important factor in defence where there are often complex dependencies between different types of equipment. Strategic fit should also meet the criteria for operational independence where applicable. Secondly, judgements on value for money needed to take account of whole-life costs. Here, the significant change was that the cost-benefit analysis should include the effects on society overall (defined as social value) unless it was neither proportionate nor feasible to do so. A minimum of 10% of the weighting in competitions was to be applied to this factor (HMG, 2021a, p.42). This was in marked contrast to the position arising out of the 2012 industrial strategy which stipulated that: "The MOD does not consider wider employment, industrial, or economic factors in its value-for-money assessments" (MOD, 2012b, p.12, fn.6)**.** Among legislative change, the single Source Contract Regulations were to be amended to provide a faster route to contract and, following Brexit, the UK could now diverge from the EU's the Defence and Security Regulations. Taken together, these seemingly bureaucratic measures were welcomed by industry given that the past application of the minutiae of these processes led to conflict at contract level rather than collaboration. In parallel, there was an identified need for policy, process and legislative reform to generate greater empowerment of procurement staffs and enhanced simplicity of process with less rigidity in contracting. In particular, the evidence required "to support approvals decisions is being made more proportionate to the risk and complexity of cases" (HMG, 2021a, p.28)**.** There would also be more flexibility in the management of intellectual property with the result that "MOD would seek to secure only those rights (for example, those

relating to technical data and associated software) that are necessary to meet the operational needs of the military user and to deliver value-for-money" (HMG, 2021a, p.32).

As for international cooperation, exports and foreign investment, DIS 2021 was clear that these were the tools by which the defence enterprise contributed in "An increasingly contested and competitive global environment, in which the UK must play an active role in shaping the international order of the future and in strengthening international security" (HMG, 2021a, p.10). The strategy was also explicit in prioritising investment in "forward-looking strategic international partnerships" (HMG, 2021a, p.70) involving collaboration with trusted allies and partners of the type that has been prevalent in combat air for decades. In so doing, the intent was to promote the notion that the UK remains an open and internationally focused market in that, while there is now a strategy which determines the industrial capabilities that are expected to be maintained onshore, this approach does not exclude the involvement of overseas companies. Of note, the supporting activity included the publishing of 'partnering principles' for international collaboration that clarify UK expectations, not least in adopting a starting position for negotiations based on 'best athlete' rather than 'juste retour' and on full decision-making rights. As for defence exports, the strategy rehearsed the UK's prominent performance in international markets but cautioned that this is "extremely reliant on sales of air platforms to the Middle East and is all but unrepresented in exports to 17 of the 20 largest defence importers" (HMG, 2021a, p.75). Government support for exports is not new territory, but the strategy recognised the need to "align priorities and behaviours across government and the industrial sectors" and to develop "a standardised Government-to-Government (G2G) commercial mechanism for defence and security sales" (HMG, 2021a, p.76). These were much needed initiatives which will be based on an enhanced capability to gather market intelligence. Proposed changes to the UK's very robust export licensing system to adapt it for technological change and to provide greater export support for SMEs will also be valuable. On Foreign Direct Investment (FDI), "According to the OECD, the UK is the third least restrictive nation amongst the G20 in terms of its regulatory approach around FDI, making the UK one of the most open environments for investment in the world" (HMG, 2021a, p.78). The size and openness of the UK domestic defence market and the innate global competitiveness of the industry was seen in the strategy as continuing to make it an attractive investment prospect.

Sustaining the industrial base

Four aspects of DSIS contributed to enhanced sustainability of the UK defence industrial base. First, and of most significance to industry, was the recognition that, while competition still had its place, there would now be "greater flexibility in designing capability and acquisition strategies to deliver and grow the onshore skills, technologies and capabilities needed to counter the threats and

exploit opportunities" (HMG, 2021a, p.61). Thematically, these headline changes on industrial strategy provided a welcome shift from the austere doctrine on value-for-money and industrial relationships inherent in its 2012 predecessor, *Security Through Technology* (MOD, 2012b). Secondly, the addition of social value in assessing competitive contract bids also provided industry with confidence that the defence contribution to the wider economy was recognised. Thirdly, the publication of individual sector strategies was welcomed by industry as providing a long-term vision on requirements and investment. Commenting in late 2023 on the Combat Air Strategy and DSIS to a Defence Select Committee inquiry, the defence trade association ADS confirmed that industry regarded the resulting improved interfaces with government to "have helped to foster market engagement, more transparency, greater trust, and more clarity of requirements. However, there are still improvements to be made …" (Parliament, House of Commons, 2022a, Ev FAVC0011, p.3, para.3.5). Fourthly, DSIS 2021 also made inroads into a revised offset (or industrial participation) policy, "forming part of a post-Brexit national security framework built on military capability and economic prosperity" (Matthews and Anicetti, 2021, p.50). This was seen as placing a priority on creating UK onshore capacity to support and modify imported equipment, "thus sending a strong signal about technology transfer to foreign companies and governments that want to sell to the UK" (Matthews and Anicetti, 2022. P.59). Other commentators were positive about the MOD's effort in seeking to align industrial strategy with rest of the Integrated Review papers. "The reset towards a more tailored approach to the defence market articulated in the DSIS is both welcome and timely and specifically targets some of the structural challenges affecting both MOD acquisition programmes and wider industrial competitiveness" (Lucas et al, 2022, p.4).

Coherence with the equipment plan

The financial backdrop against which DIS 2021 was to be implemented was not encouraging. A funding uplift for the 10-year defence equipment plan had been announced ahead of the publication of the SDSR 2015 taking the total to £178 billion from £166 billion. However, this was inadequate to meet the additional procurement costs of £24.4 billion that were subsequently identified in the review, but which had not been accurately assessed within the 2016-26 Equipment Plan (NAO, 2017a). While the Autumn 2018 budget had allocated an additional £1.8 billion to defence, the Equipment Plan continued to remain unaffordable. The £6 billion contingency had been absorbed by individual projects and the programme showed a minimum affordability gap of £4.9 billion. There was "an additional affordability gap of £15.9 billion if all identified financial risks of cost growth materialised and if the Department did not achieve any of the savings assumed in the Plan" (NAO, 2018, p. 6): this would yield a potential affordability gap of £20.8 billion. In the months ahead of the 2020 Spending Review, the National Audit Office assessment of the MOD's 2020-2030 Equipment Plan pointed out that this is "4 years in a row that we have reported that the

Equipment Plan has been unaffordable" (NAO, 2021b, p.4) citing an £8.3 billion shortfall in the first five years of the 10-year plan. Spending Review 2020 subsequently allocated "an additional £24.1 billion over the next four years" (HMT, 2020b, p.7) which was described as government having "begun the biggest investment in defence since the end of the Cold War" (HMG, 2021b, p.21. There was also an undertaking to continue to meet the NATO defence target of 2% GDP. In terms of the profile of Global Britain, this makes the UK the "largest European spender on defence in NATO and the second largest in the Alliance" (HMG, 2021b, p.102)**.** In addition to increased investment in technology, this level of funding would also allow the establishment of a new Space Command, maintain the programmed investment in ships and submarines, procure a minimum of 48 F-35 Lightning aircraft, upgrade Typhoon and develop the Future Combat Air System in line with the previously published Combat Air Strategy. In a Defence Select Committee inquiry on DSIS 2021, both Porter and Blagden cautioned that the defence budget was inadequate for the range of tasks set out in the Integrated Review papers (Parliament, House of Commons, 2022a, Qs. 184-5). They also expressed concern that, in many circumstances, technology cannot be a substitute for mass. Blagden also pointed to a 'jam tomorrow' cycle represented by the decision to relabel Future Force 2020 as Integrated Force 2030 (Parliament, House of Commons, 2022a, Qs. 184-5).

Subsequently, Russia's 2022 invasion of Ukraine prompted a revision of the 2021 Integrated Review posture (HMG, 2023a) which was reflected in the accompanying Defence Command Paper entitled, *Defence's response to a more contested and volatile world* (MOD, 2023a). While the paper focused on policy innovation rather than on new equipment (Jessett et al, 2023), it did give details of increased defence expenditure following the 2023 Spring Budget of £5 billion over two years. But it also pointed out that "the Prime Minister has set out an aspiration over the longer term to invest 2.5% of GDP in Defence, as the fiscal and economic circumstances allow" (MOD, 2023a, p.5). The MOD did not publish a 2023-2033 Equipment Plan as the implementation of the new Command Paper together with the need to manage an extraordinary level of budgetary inflation needed further work. Nevertheless, the NAO provided the Public Accounts Select Committee with an analysis of the underlying data which pointed to an unaffordable plan with a top-end estimate of the deficit of £29.8 billion (NAO, 2023). The PAC commented that

> This is the largest funding deficit in any of the 12 Plans the MoD has published since 2012. It is also a marked deterioration in the reported financial position since last year's Plan, which the MoD judged to be affordable but this Committee concluded was not and that it is characterised by optimism bias (Parliament, House of Commons, 2024, p.3).

Assessment of the impact of DIS 2021

In summary, DSIS 2021 accompanied by the creation of detailed sub-sector strategies represented a radical departure from previous approaches and thus had a very positive impact. The strategy included a more nuanced approach to competitive tendering, an aspect that Taylor pointed out represented a change to the *"*MOD stance that has been in place since the early 1980s" (Taylor, 2021, para.3). Acceptance of defence procurement as a tool of national prosperity by accepting its role in the creation of social value also represented a significant shift from MOD's traditional position (HMG, 2021a). The increased precision over sovereign capability was especially valued by industry as was the detailed explanation of capabilities contributing to operational independence. The term was mentioned in previous editions of DIS but without explanation thus leaving to chance the presence of the required equipment when an operation commenced. Investment in key technologies was also given prominence marking a move away from a platform-centric approach to one of achieving military effect through technology modernisation (Jessett et al, 2023). In essence, this represented a transformation for the armed forces away from an industrial age to an integrated age with faster adoption of the leading-edge technologies. There was a strong emphasis on partnering with industry and welcome changes to the overly bureaucratic approach to procurement. On the former Taylor observed that the strategy conveys "a message of a mutually supportive, partnered approach between the MOD and the private sector" to a greater extent than is currently the case (Taylor, 2021, para.4).

However, there was concern among both industry and analysts over the prospects for full implementation of DSIS 2021. First, the papers comprising the Integrated Review Suite (which included DSIS 2021) together made some 250 future commitments with little underpinning detail and no sense of priorities (Jessett et al, 2023). Secondly, the adverse budgetary position which was dominated by the requirements of the nuclear enterprise meant that there was little headroom for significant transformation. Thirdly, as Taylor points out, that "any procurement policy stance is meaningless unless it is used to shape specific procurement choices, contracts and behaviours. The strategy will be implemented or ignored through spending choices" (Taylor, 2021, para 10). This latter point reflects the limitations of any defence industrial strategy which portrays an ambition that is impossible to realise because of budgetary strictures affecting the equipment plan. Taken together, these facets chart a new and potentially more pragmatic course towards a sustainable UK defence industrial base provided that the equipment plan is brought into balance. By the time that the Defence Select Committee had published its report on DIS 2021, the problematic Afghan withdrawal had taken place and Russia had invaded Ukraine. The Committee was concerned that there was a reluctance in government to revisit the conclusions of the Integrated Review (a refreshed version was published in March 2023). There was also a general concern over "British

military ambitions which are not entirely matched by resources" (Parliament, House of Commons, 2022a, p. 58). Their concluding comment on DSIS 21 stated that, "the commitments made in the Defence and Security Industrial Strategy ought to be implemented fully. We recognise that this will take time – we urge the MOD to ensure that the changes are seen through" (Parliament, House of Commons, 2022a, p. 72). Overall, DSIS 2021 did much to recover the credibility gap created by DIS 2012 by providing a realistic blueprint for both operational independence and the sustainability of a vibrant defence industrial base.

Part Three - The overall impact of DIS: 1998 - 2023

Across the examples in the period of this research, the conceptual design of a DIS and the perceived optimum configuration of the defence industrial base has rested heavily on four factors. First, the assessment of the range of military capabilities that should be regarded as sovereign has been a predominate concern but has proven difficult to determine and complex to apply in practice. The basic tenets of unfettered and timely access to intellectual property and industrial know-how in areas that are critical to creating a winning edge in combat were not fully explored in DIS 2005 and were seemingly sacrificed entirely in DIS 2012 in favour of competitive procurement on the global market. The latter option is only viable if an offshore supplier agrees to extensive technology transfer and full access to the underlying intellectual property. These are aspects that are difficult to embed in a contract even with a trusted ally. Only DSIS 2021 made an accurate assessment of the associated risks of such an approach and promoted the need for a more pragmatic policy based on operational independence. This recognised the implications in offshore procurement of external political interference or limitations on priority in meeting urgent demands. The revised approach also adds to the viability of sustaining an onshore industrial base.

Secondly and related, a DIS needs to articulate how through-life support and upgrade will be procured as an onshore activity, an aspect that also requires access to intellectual property. Here, the early steps in partnering (the third aspect) between MOD and industry using incentivised, availability-based contracts advocated in SDR 98 and DIS 2005 have become a common thread in defence aerospace. Likewise, the DIS 2005 creation of Team Complex Weapons provided an elegant partnering blueprint in dealing with industrial overcapacity whilst also enhancing cost-effective, technology-driven capability. These examples rely on legally-binding partnering agreements. Availability contracting for Tornado and Harrier involving an MOD-BAE Systems partnering agreement saved £1.4 billion over its initial six years and an increase of 15% in Tornado available flying hours (NAO, 2007a). But the subsequent 2012 issue of DIS did not acknowledge the cost savings and equipment availability improvements that had resulted from partnering: rather, it resorted to vague statements on the department's intent. While DIS 2021 redressed the balance, there were indications of varying levels of reluctance in all editions of DIS over the risk of undermining the perceived significance of competition in achieving value-for-money. In the three decades that have passed since the Levene reforms on cost-plus contracting, there seemingly remains a cultural fear of deviating from that doctrine and perhaps also a lack of confidence in the MOD's own single-source regulatory framework. It is also possible that the iron hand of the procurement organisation's technostructure might be at play here.

The fourth aspect is the definition of value for money and how it is to be achieved in the light of the considerations above. Again, a nervousness on deviating from competition on the open market had seemingly led to an (unspoken) approach to value-for-money assessments on a case-by-case basis. While DIS 2012 provided a very narrow and, in the light of sovereign requirements, an unworkable definition, DSIS 2021 finally broke the mould with a much more pragmatic approach which recognised the profound changes in the customer-supplier interface that have occurred since the mid-1980s. Overall, these aspects limit the plausibility of a DIS and stand in danger of creating a barrier to its acceptance on both sides of the customer-supplier interface. Also, when viewed from industry, these generic DIS objectives cannot be achieved successfully by taking a transactional approach in the flawed MOD belief that defence procurement operates in the equilibrium represented by a perfect market. As global businesses, firms have choices as to the markets in which they will participate. They will thus be attracted to those markets where the customer recognises the imperfect nature of the market and adapts their procurement strategies accordingly in the recognition (as in the theory of second best) that not all aspects of a transaction can be optimised. Hartley (2020) and Taylor (2021) are correct to point out that, in the case of the UK, it is the MOD's spending choices that determine the configuration and characteristics of the UK defence industrial base rather than a DIS.

Turning to the influence of DIS on equipment project delivery performance (particularly in aerospace), the approach has yet to prove instrumental in creating the conditions for sustainable success. The Infrastructure Projects Authority 2023-24 report lists eight MOD aerospace platform projects. One is assessed as green (Future Medium Helicopter - successful delivery on time and to budget appears likely), six are graded amber (appear feasible but prompt management action required), with two graded red (F-35 Lightning and Protector – major issues mean that successful delivery on time and to budget appears unachievable and rescoping is required). Both projects graded red have insufficient funding allocation and require additional resources (IPA, 2024, pp.42-49). Protector was approved by the MOD's Investment Approval Committee in 2016 and, by 2019 had exceeded its programme financial tolerances (MOD, 2019b). Both red projects are also offshore procurements from the US which, as government-to-government contracts through the Foreign Military Sales regime, are not amenable to a partnering approach. While successive editions of DIS have been positive about partnering, the MOD has been tentative in adopting a broader and longer-term strategic approach in other sectors. On project financial management, one of the structural impediments to control of the equipment plan arises from the existence of optimism bias in the procurement ecosystem. None of the editions of DIS have recognised this problem and therefore have not set out the range of strategic tools that should be deployed to address it. Any such proposals would first need to analyse the overriding motives for the MOD customer community in

seeking to secure funding within a constantly over-heated equipment plan. This, in turn, generates an adversarial approach to bid scrutiny which undermines mutual trust between customer and supplier. More importantly, it leads to inaccurate costings being solidified too early in the project life cycle and an inadequate analysis of risk. This situation adds to the misalignment between DIS objectives and the resources likely to be available in the forward defence budget. As a result, the strategies do not maintain their implementation momentum because they are misaligned with both the prevailing and future financial environment within which much turbulence is generated from project cost overruns.

Taken together, this situation undermines the credibility of the strategies and renders them inadequate as a planning tool for industry beyond the immediate short-term. Of note, the two political objectives of improved procurement outcomes and preservation of defence industrial jobs are pursued in parallel, rather than as an integrated strategy. Shortcoming in the former attract sensationalised media headlines and instant condemnation from select committees and the NAO. Whereas the slow decline of the defence industrial base is much less visible and is rarely subject to the same treatment. But, while these aspects undermine the incentives for industry to participate in the market, they place a sustainable industrial base in jeopardy which has more serious implications for national security. Given that deterrence is the combination of capability and credibility, the later factor is heavily undermined by a defence procurement ecosystem that appears dysfunctional to those outside observers whom the nation is seeking to deter. Likewise, the inability to deploy effective industrial strategies and a track-record of inadequate financial stewardship places a question mark over the effectiveness of the machinery of government and the maintenance of public trust, both of which are key aspects of demonstrating credibility to potential adversaries and thus deploying effective deterrence.

Chapter 6 – Case Study Findings

> *Every gun that is made, every warship launched, every rocket fired signifies, in the final sense, a theft from those who hunger and are not fed, those who are cold and not clothed.*
> (President Dwight Eisenhower, 1953)

Military history is littered with warnings by Generals on the robustness of plans once the enemy has been engaged. The same is especially true of the implementation of defence industrial strategies (DIS) where the high-level conceptual generalities conceived in the calm of the MOD meet the transactional cut and thrust between customer and supplier in getting a project to contract. Thereafter, predictions on the impact of risks to cost, time and performance can fall victim to the realities of integration complexity, limitations on both human and financial resources, and dependencies on other projects.

The Procurement Process in Brief

Appendix C describes the MOD's procurement processes. In essence, the MOD refers to the project life cycle as the CADMID Cycle consisting of consecutive phases of Concept, Assessment, Demonstration, Manufacture, In-service and Disposal (MOD, 2018d). Procurement is focused on the first four phases. The concept phase leads to project initiation in the form of a User Requirement Document (URD) created by the front-line customer commands (Navy, Army, Air or Strategic Command) under the leadership of a Senior Responsible Owner (SRO). The SRO is accountable to the MOD Permanent Under Secretary and to Parliament for the delivery of the project. Acquisition of IT and nuclear-related acquisition are handled by specialist bodies. Until 2019, the MOD applied a two-gate principle to approvals each of which triggers subsequent activity and investment. These were known as the Initial Gate Business Case which is the catalyst for the Assessment Phase and the Main Gate Business Case which allocates most of the project funding for Demonstration and Manufacture Phases: this process applies to all the case studies in this research. The Concept Phase should identify potential solutions for in-depth study in the Assessment Phase and obtain the necessary funding for that activity. The MOD's Investment Approvals Committee considers the highest value and most contentious projects but can delegate approval to the front-line commands for projects below £400 million. Projects valued at over £600 million must receive Treasury approval.

The Assessment Phase leads to the second gate known as Main Gate which relies on a Full Business Case based on a System Requirement Document (SRD) that meets the users' needs by defining the most cost-effective procurement and technology solution (MOD, 2023b). This requires trade-offs between time, cost and performance to meet affordability criteria. It also requires risk reduction

analysis to ensure project delivery within the tightly defined cost, time and performance criteria. Smart Acquisition guidance is that 15% of the total procurement budget should be invested in achieving the associated refinements and in early risk mitigation. There is also a requirement to develop elements of the Through Life Management Plan and to define the project milestones. Once endorsed for Main Gate investment, responsibility for tendering and contract negotiations passes to the Project Delivery Team at the Defence Equipment and Support organisation (DE&S) which also manages the Demonstration and Manufacture phases. Scrutiny teams in the headquarters of the front-line commands and the MOD Head Office provide assurance on the commercial and financial aspects of business cases. Oversight of the outputs of both the customer's Delivery Team and the DE&S Project Team is provided by an inter-disciplinary Project Board chaired by the SRO. After Main Gate approval, significant changes in time, cost or performance must be notified to the relevant investment approval authority. Where such issues are likely to attract media or parliamentary attention or are deemed novel and contentious, Ministers will be informed. In parallel, since 2016, external independent assurance reviews of major defence projects have been provided by the Infrastructure and Projects Authority (IPA) alongside other projects in the Government Major Projects Portfolio. The Defence Select Committee and the Public Accounts Committee also discharge the need for parliamentary scrutiny.

Selection of the case studies

The three aerospace project case studies in this chapter were selected for their complexity, variations in procurement strategy, and representation across the period of the research from 1998 to 2023. The analysis pays particular attention to the way in which the combined impact of financial constraints, dependencies on other projects and imperfections in project management crowd out the implementation of DIS. It therefore determines how DIS informed both the project requirement definition and the route to contract. It also assesses the way in which MOD-industry relations, particularly in respect of partnering, aligned with the aspirations of DIS. Further, it highlights how sovereignty requirements on both military capability and the sustainability of the defence industrial base were addressed. But it also looks under the bonnet of the procurement process to assess shortcomings in project delivery, the impact of financial constraints and the quality of risk management. In all respects, it recognises that defence equipment procurement is a demanding activity that seeks to manage the tensions between providing the armed forces with the right equipment at optimum value for money whist also "promoting a strong and competitive UK defence industry, bringing economic and technological benefits to the nation" (MOD, 2002a, p.3).

Project & Relevant DIS	Initial Gate (IG)	Main Gate (MG)	In Service Date at IG	Actual In-Service Date	Budget Cost (million)	Actual Cost (million)	Route to contract
Wildcat (helicopter) DIS 2005	2001	2006	2014	2014 (-8 m)	£1,900 (80 ac)	£1,689 (62 ac) (-£140)	Single source Onshore Augusta Westland Target cost incentivised
Crowsnest (helicopter radar) DIS 2012	2012	2016	2018	2021 (+29 m)	£339 (10 sets)	£503 (+£164)	Competition Onshore Lockheed Martin Firm fixed price
Protector (UAV) DIS 2012 & 2021	2013	2016	2021	2025 (+48 m)	£929 (18 ac)	£1,463 (+£534)	Single source Offshore Hybrid US Govt/GAAS Fixed price with redeterminations[2]

Table 6-1 – Case Study Details (Source: NAO MPR PSS 2008 p.55; 2015, p,221; MOD, 2020, p.62).

[2] Redetermination is a term used in fixed-price contracts to describe the risk mitigation measure for both buyer and seller allowing adjustments to be made under specific circumstances such as cost overruns or changes in the baseline profit rate (MOD, 2014a, Single Source Contract Regulations, Annex A).

Case Study One – The Wildcat helicopter

The Wildcat light helicopter was a heavily re-engineered development of the Westland Lynx which originally entered military service in 1977. The army Wildcat variant achieved Initial Gate approval in December 2001 with that for the naval version following in September 2002. Both requirements were combined in June 2006 under a single Demonstration and Manufacture contract for 80 helicopters (45 battlefield and 35 maritime) at a predicted cost of £1.9 billion (NAO, 2008, pp.55-56). By that stage, the Westland company had become a wholly owned subsidiary within the Italian Finmeccanica Group and rebranded as AgustaWestland (Leonardo, 2004a). The procurement process was heavily influenced by the sovereign requirement in DIS 2005 for the sustainment of onshore helicopter design and systems engineering capability (MOD, 2005a, p.9). Subsequent turbulence in the equipment budget caused a hiatus in production and, after a series of re-examinations of the requirement, there was ultimately a reduction in helicopter numbers to 66 (38 battlefield and 28 maritime) (NAO, 2011b, p.98) at an actual cost of £1.689 billion (NAO, 2012b, p.196). In-service dates for both variants were achieved seven months early in January 2014 and January 2015 respectively (NAO, 2010, p. 38). However, the Martlet missile was not fitted to the maritime Wildcat until 2021, and the Sea Venom missile will not be integrated until 2026 (Cartlidge, 2023a, WS-UIN 189160).

Procurement requirement

Helicopter availability became a politically charged issue in the early 2000s with combat operations in Afghanistan and Iraq pointing to shortages of aircraft of between 20-38% (Parliament, House of Commons, 2004d, p.11. para. 12). The MOD thus resolved to rationalise the number of different types in service and to optimise the support arrangements. As a result, the Future Rotorcraft Capability programme was created in 2004 “to identify a future strategy that maximised the capability that could be delivered from the available funding” (MOD, 2005a, p.90). With the original Lynx fleets approaching obsolescence, Initial Gate approval was given in 2001 for the Assessment Phase for a Battlefield Light Utility Helicopter with that for a Surface Combatant Maritime Rotorcraft following in 2002 (NAO, 2008, p.61). In parallel, Westland Helicopters Ltd had proposed developing a ‘Future Lynx’ based on the military Super Lynx 300 which was already in service with export customers (Penney, 2002). An initial UK requirement was drawn up for about 45 replacement battlefield reconnaissance helicopters and, separately, for about 35 light maritime helicopters (NAO, 2008, p.55). However, by 2007, the Future Rotorcraft Capability programme was deemed to be unaffordable with the resulting need to make savings of £200 million and reduce the requirement initially to 34 battlefield and 28 maritime helicopters (NAO, 2009, p.25). As the Wildcat design maturity progressed, it was determined that an element of these economies could be achieved through greater commonality between the two variants by using modern design and

manufacturing techniques which would also reduce production costs (NAO, 2010, p.118, A-3). As a result, the two requirements were consolidated into a single option which would offer 95% commonality. Subsequently, an additional requirement arose leading to a total of 38 battlefield and 28 maritime helicopters (NAO, 2012b, p.196). Key Performance Measures meant that both variants would be required to integrate the outputs from a range of advanced sensors to provide intelligence, surveillance, target acquisition and reconnaissance (ISTAR) information for commanders and to self-target its weapons. Secure network-enabled communications was thus a key user requirement as were defensive aids against missile attack (NAO, 2010, p.125). The battlefield variant would also be required to move troops and materiel around the battlespace and provide firepower for protection of troops on the ground (MOD, 2005a, p.93). Both variants would be machine-gun equipped but the maritime vacant would also carry the Stingray torpedo, depth changes, and the new Sea Martlet and Sea Venom guided missiles, giving it a sophisticated lethality against submarines and surface ships (NAO, 2014, pp.46-7). The requirement also called for an industry-led combined training and support service (NAO, 2010, p.118, A-3).

Defence industrial strategy considerations

DIS 2005 dealt extensively with the helicopter sub-sector, recognising that, while there was a high onshore concentration of intellectual property related to the existing fleets, there was also a buoyant export market. It concluded that, "AgustaWestland's systems engineering capability needs sustainment to maintain our ability to support and upgrade the current fleet" (MOD, 2005a, p.9). This statement recognised the company's role as a prime and as an original equipment manufacturer (OEM) with responsibility for the assurance of safety and airworthiness related to design, maintenance, modification and repairs (MOD, 2005a, p.93). The preferred solution to sustaining this industrial capability in the medium term was explicitly stated as investment in Wildcat to meet the future battlefield and maritime requirement subject to value-for-money analysis (MOD, 2005a, p.93). In so doing, the strategy was also explicit in the intent to, "promote a more open, predictable but demanding partnered relationship with the company, to provide better value for money and reduce their reliance on our investment to sustain the design engineering skill-base" (MOD, 2005a, p.9). To that end, the MOD would enter into a contractually binding Strategic Partnering Agreement (SPA) with AgustaWestland by Spring 2006 (MOD, 2005a, p.9). Already in place was an equally binding Business Transformation Incentivisation Agreement (BTIA) agreed in 2005. The latter applied to all company business with MOD and committed both sides to challenging objectives on schedule, cost reduction and aircraft availability. The SPA also included behavioural aspects in terms of creating a cooperative and effective working culture based on transparency, openness and respect (MOD, 2005b). In announcing the contract award for Wildcat in Parliament, the Secretary of State for Defence emphasised that the BTIA "presents opportunities

for the company to secure bonus payments for performance improvements across the full spectrum of the business relationship and default payments, retained by MOD, if the company fails to improve performance" (Browne, 2006).

Route to contract

DIS 2005 laid out the preferred Route to contract to meet the strategy's objective of sustaining an end-to-end onshore helicopter capability. AgustaWestland possessed world-leading helicopter technologies in rotor blades, vibration control and crash survivability (MOD, 2005a, p.9). The Wildcat embraced all these aspects as well as digital design techniques and advanced manufacturing giving the advantages of a greater inherent strength and lower-cost manufacturing. The increased structural robustness allowed the fatigue life to be extended to 12,000 flying hours thus enhancing value-for-money (Leonardo, 2024b, p.5). The continuation of the engineering challenges associated with these aspects of helicopter design, development and manufacture were seen as important factors in sustaining "the professionalism and effectiveness of the skill-base" (MOD, 2005a, p. 93). Nevertheless, the Assessment Phase was required to validate the Wildcat proposal against other off-the-shelf helicopters. Two procurement strategies were considered: a full competition or a single-source contract for the Wildcat subject to the DIS benchmarking requirement (NAO, 2010, p.117). Reversion to competition remained an option should the Wildcat solution fail to demonstrate its value-for-money. Other candidates included the NH90 produced as a European collaborative programme and an off-the-shelf purchase of the Eurocopter EC120 or EC635 (Ripley, 2004). The Assessment Phase determined that AgustaWestland had proven ability to deliver the required capability, evidenced through their Super Lynx 300 export programmes. Wildcat also represented best value for money overall (NAO, 2008, p.61). Contract signature took place in June 2006. In parallel, the through-life support solution and training requirements were designed as an industry-led Private Finance Initiative (PFI) to be contracted on a single-source basis (NAO, 2011b, p.98). The contract for the required training capital equipment was let to AgustaWestland in early 2011 with the PFI contract for integrated training and support let to the company a year later (NAO, 2011b, p.98). This was a 34-year single-source Integrated Operational Support arrangement with 5-year pricing-periods and exit points. As such, Wildcat was the first UK helicopter to enter service with a fully integrated training and support solution from the outset (MOD, 2023c, p.4).

Financial constraints

At the time of the Wildcat Initial Gate approval in 2001-02, process management of the equipment programme was showing tentative improvement as the measures under Smart Acquisition took effect. However, there was a lack of data coherence by which to make judgements on performance

(NAO, 2001c, p.21). Across the 20 largest projects, while costs remained within overall approved limits, the total slippage in delivery dates stood at 173 months (NAO, 2002, p.8). Within this programme, Eurofighter Typhoon dominated adverse project performance with a cost overrun of £1,269 million and a 42-month delay in delivery. In addition, while then still within its allocated cost, the Nimrod MRA4 was running 31 months late (NAO, 2002, pp. 7-8). Late delivery of replacement equipment imposes opportunity cost elsewhere in the defence budget as legacy equipment must be extended in service beyond its funded life. By mid-2006 and the signature of the Wildcat production contract, the Equipment Programme was running at 11% over budget with the delay to 19 major projects at an aggregate of 433 months (NAO, 2006a, p.5). Over the preceding two years, tighter budgetary control had been exercised by reducing the quantities of equipment to be delivered by individual projects and, in some cases, at a lower specification. Nevertheless, the programme was clearly overheating. Four projects were dominant within this poor performance: Astute submarine (£1.1 billion over cost and 42 months late); Nimrod (£700 million, 89 months); Type 45 destroyer (£635 million, 25 months); and Eurofighter Typhoon which was 54 months late with an allocated budget of £16.67 billion but with a cost to completion remaining commercially confidential (NAO, 2006a, p.24; NAO, 2006b, pp.10, 84, 133, 141). The figure was eventually released in 2009 at £17.96 billion (NAO, 2009. p.10, fig.3). With the subsequent need to fund the two Queen Elizabeth Class aircraft carriers at a cost of £5.1 billion, £1 billion more than the planned figure (NAO, 2009. p.10, fig.3), the MOD opted to conduct a major budgetary review entitled the 'Equipment Examination' which ran from April to December 2008. As a result, Wildcat production was suspended pending the MOD's decision on whether to proceed with the contract. Commenting on the reconfigured 10-year Equipment Plan which was still seen as storing-up problems for the future, the NAO pointed out that, "The decisions did not (and could not) resolve the underlying issue of affordability (NAO, 2009, p.4, para.2).

Continuance of the Wildcat project was confirmed in December 2008 but with numbers reduced from the original 80 to 62 and through-life flying hours reduced by a third, yielding total savings of £194 million (NAO, 2010, p.118). While this decision reduced Wildcat numbers by 23%, it reduced total production costs by just 12%, indicating the significance of 'non-recurring costs' against small offtakes with the constant overhead of research and development, manufacturing tooling and certification (NAO, 2010, p.8). As for future financial risk to the 10-year Equipment Plan, the NAO recognised that there would be a deficit of £6 billion based on MOD's current assumptions but, given the economic uncertainty arising from the global financial crisis, less optimistic assumptions would point to a deficit of some £36 billion (NAO, 2009, p.4). The subsequent 2010 Strategic Defence and Security Review, *Securing Britain in an Age of Uncertainty*, reported that the full defence programme contained "an unfunded liability of around £38 billion over the next 10 years"

(HMG, 2010a, p15) and later pointed out, “Some £20 billion of this is related to unaffordable plans for new equipment and support. Cancelling or changing major contracts to tackle this problem itself creates further liabilities” (HMG, 2010a, p31).

Project delivery

The main Wildcat contract represented a novel approach given its underpinning SPA. This procedure was aimed at reducing project delivery risk by generating mutual understanding based on the creation of a transparent environment, where open book accounting and joined-up engagement would deliver enhanced performance (NAO, 2009, p.13). On the latter, Wildcat benefitted from company investment in the manufacturing process in creating a ‘pulse line’ arrangement mirroring that employed for civilian helicopters which typically have large production runs of more than 1,000 aircraft. Secondly, the company invested in advanced test rigs by which to de-risk systems integration and accelerate the assurance and certification process, particularly aspects related to software (Airframer, 2010, p.1). In parallel, at systems level, the Assessment Phase had successfully de-risked the key requirements related to mission systems, secure communications and engine certification. In addition, company experience from the Super Lynx 300 export programme “demonstrated their capability to insert new T-800 engines, glass cockpit and avionics into the Lynx aircraft” (NAO, 2008, p.61). This level of confidence was not misplaced given that the Interim Critical Design Reviews on the air vehicle and the mission systems were completed on time by August 2009 (NAO, 2009, p.126). Pulse-line production was ready to commence in November 2008 with the first flight successfully achieved in November 2009 in accordance with the contracted schedule (NAO, 2010, p.118). This was a creditable performance given that from April to December 2008, the contract was held in abeyance under the threat of cancellation by MOD because of severe budgetary pressures (NAO, 2010, p.118). Additional work arose in 2011 from the need to meet the airworthiness assurance requirements of the newly formed Military Aviation Authority NAO, 2011d, p.197). Nevertheless, the full Wildcat requirement was met on time and on budget.

The production hiatus and the uncertainty of potential cancellation during the 2008 Equipment Examination was also a challenge for the supply chain. At that time, aerospace manufacturers regarded their supply chains as a strategic resource given that vertically integrated companies had long been an exception. Rather, supply of large sub-assemblies and sensors, and most precision fabrication was then outsourced, leaving the OEM to focus on assembly, integration, testing and commissioning (Bruno and Goldstein, 2024). For the Wildcat, AgustaWestland had signed partnering arrangements with key suppliers including Selex Galileo (a Leonardo company), GKN Aerospace, LHTEC (a partnership between Rolls-Royce and Honeywell), General Dynamics UK,

Thales UK and GE Aviation (AgustaWestland, 2009, p2). While major companies have the financial resilience to withstand a hiatus in orders, smaller companies do not. At that stage, AgustaWestland relied on multiple supply chains involving some 280 SMEs with contract values of £316 million (Finmeccanica, 2011, p.2, para. 2). The supply chain was configured around a production schedule of a 3-month build time per helicopter with one aircraft to be completed each month (AgustaWestland, 2010, p.1). Small firms in the supply chain need to recover delayed orders quickly to preserve cashflow and may not have the capacity to resume supplies should the situation change. Replacing the provider of small military aerospace components also takes time in that it invokes the application of a lengthy requalification process by which to assure integrity of manufacture. To avoid this prospect and preserve the configuration of the supply chain, AgustaWestland took-on the financial risk of advance ordering from some of their SME suppliers to smooth out these small firms' cashflow and keep them engaged (Interview with current industrialist, 5 July 2024).

Project dependencies

The Wildcat sensors and mission system were based on mature technologies that presented minimal integration problems (NAO, 2008, p.61). However, some of the weapon integration was more challenging, particularly for the maritime variant. Initial warning of this issue was recorded in unclassified language against the NAO's report in 2009 on Key Performance Measures (NAO, 2009, p.135). Both Wildcat variants were to be equipped with a heavy machine gun with the maritime variant carrying the Stingray torpedo, neither of which presented an integration issue (MOD, 2013b, para. 2). However, delays occurred in the two guided missile projects (the light-weight Martlet manufactured by Thales and the heavy-weight Anglo-French Sea Venom developed by MBDA) which meant that the maritime variant would enter service without an anti-ship weapon. These guided weapons were to replace the obsolescent Sea Skua missile fitted to the earlier Lynx variant and meant that the Wildcat would be unable to conduct several mission scenarios (NAO 2012b, p. 216). Leonardo Helicopters (by then renamed from AgustaWestland) was contracted in 2014 to integrate the new missiles which required the design and manufacture of a removable aerodynamic 'weapon carrier wing' which was completed ahead of the associated missile trials (Perry, 2019, p.2)

Released in 2008, the Martlet requirement sought a light-weight missile optimised to attack fast inshore attack craft which were then the prevalent threat in the Gulf. Thales received an initial production contract in 2011 and a further contract for the first batch of 1,000 missiles in 2014 for entry to service at Initial Operating Capability (IOC - the minimum level at which the capability is usefully deployable) level in 2018 (Stevenson, 2014, p.1). The cost was £48 million with an additional support contract of £93 million financed through the Team Complex Weapons Portfolio

pipeline funding which involved moving money to this high priority capability from other projects (Think Defence, 2014, p.2). However, in 2022 with its in-service date slipping further, MOD reported to the Infrastructure Projects Authority (IPA) that it was unable to give a delivery confidence assessment as commercial contractual difficulties were slowing down the project (MOD, 2022g, Line 33).Nevertheless, the first successful test firing of a Martlet missile from a Wildcat had taken place allowing an 'interim variant' of the missile to support the Carrier Strike Group 2021 deployment to the Indo-Pacific (Leonardo, 2020, p.1). Initial Operating Capability was declared in late 2022 with Full Operating Capability (FOC – the project's intended level of capability) assessed as 2025, a decade after the first Maritime Wildcat had been delivered (MOD, 2023c, Line 30).

The more complex Sea Venom missile also suffered project delays from two causes: integration into the Wildcat's systems proved unexpectedly challenging (Navy Lookout, 2023, p.1); and the synchronisation of each nation's £943 million funding contribution within the Anglo-French collaboration proved difficult (NAO, 2015b, p. 53). The UK's Assessment Phase was completed in late 2011 with the expectation of letting a Design and Manufacture contract with MBDA in early 2012 for an in-service date of late 2020 (NAO, 2015b, p.60). The UK's approval carried a financial caveat that, "negotiations should be concluded with France before 31 March 2012" (NAO, 2015b, p.53). However, the newly elected Hollande government of 2012 initially withdrew France from the Sea Venom project before reconfirming its commitment in April 2013 (NAO, 2015b, p.53). The contract was placed with MBDA in March 2014, two years later than the UK had planned (NAO, 2015b, p.57). On integration, despite early optimism, further schedule delays arose (MOD 2020a, p.11). The optimism was founded on the manufacturer's assertion that, because Sea Venom maintained common characteristics with the former Sea Skua weapon which had been carried by the previous Lynx helicopter since 1982, integration onto the Wildcat's systems would be straightforward (MBDA, 2014). Again, an 'interim variant' of the Sea Venom was included in the 2021 Carrier Strike Group deployment. However, integration problems remained: in 2022 MOD reported to the IPA that the project was assessed as 'Red' (MOD, 2022g, Line 47), meaning successful delivery of the Sea Venom appeared unachievable (IPA, 2023, p.40). In June 2023, indicating that integration challenges remained, the Minister for Defence Procurement informed Parliament that:

> Aircraft certification is currently forecast to be delivered in 2026. This is the point at which the full weapon system capability for Sea Venom will be provided to the Royal Navy and the final modification of Wildcat can commence (Cartlidge, 2023a, WS UIN 189160).

As such, the MOD had confirmed the IOC date but given no indication as to when FOC would be achieved. From the outset of both these weapon projects, the MOD understood the risk to operational capability represented by the prospect of delays to these air-launched missiles but had no reliable mitigation for this operational shortfall. Until 2023, the gap was partially filled by the existing ship-launched Harpoon missile (Parliament, House of Commons, 2018, p.19, para. 55). Thereafter, an interim solution was to equip eleven Type 23 frigates and Type 45 destroyers with the Norwegian Naval Strike Missile (MOD, 2022h, paras 1-2). The contract with Kongsberg Defence Aerospace was valued at £200 million (Navy Lookout, 2022a, para. 2).

The failings

The Wildcat project was adversely affected by misplaced optimism in the two significant areas of financial stability and the time required to develop the related weapon technology. On finance, it was clear that, although at the outset the Wildcat project was accurately costed and fully funded, tensions were building elsewhere in the equipment plan. The resulting 2008 Equipment Examination created an eight-month lacuna in Wildcat industrial activity and a reduction in the number of aircraft, ultimately adding to unit cost because of the size of the fixed overhead and the disruption to an already configured supply chain. As a senior industrialist involved in the project pointed out: “nothing is cheaper later and time isn't valued in the same way as compliance of terms and conditions or price” (Personal interview, 11 June 2024). As a tool for regulating affordability, budget reprofiling aimed at slowing down delivery or reducing production numbers merely adds to future financial tension as evidenced by the £20 billion deficit in the Equipment Plan revealed in SDSR 2010 (HMG, 2010a, p.31). As for the lack of synchronisation of Wildcat production with the associated weapons for the maritime variant, superficial project definition at the outset failed to recognise the likely timescales for the bureaucratic process of contracting for complex weapons, particularly in international collaborative programmes. As a new weapon, the Sea Venom embraced novel technology leading to uncertainty in its development timescale but its integration with the Wildcat mission system also proved challenging. Initial estimates of both these aspects proved over-optimistic and led to significant delays in delivering the required capability to the front-line.

Conclusions on defence industrial strategy

DIS 2005 was explicit on the requirement for Wildcat as the means to ensure the retention onshore of an end-to-end helicopter systems engineering capability (MOD, 2005a, p.9). The rationale also pointed to AgustaWestland’s possession of the intellectual property related to the existing helicopter fleets with MOD access required for future support and upgrade MOD, 2005a, p.93). This aspect aligns with the 2002 Defence Industrial Policy requirement to balance procurement activity with the need to retain a sustainable defence industrial base (MOD, 2002a, p.1). However, the

implementation of DIS 2005 lost momentum with the departure of its ministerial champion from government some two years after publication (Parliament, House of Commons, 2009, p. 66. paras. 179-80). The then Minister of Defence Procurement, Lord Drayson had applied much energy to the creation of the strategy and expended considerable political capital, often in the face of Treasury and some internal MOD resistance (Kirkpatrick, 2008, p.309). The 2008 Equipment Examination took place after his departure and, in the case of helicopter manufacturing, had the potential to remove the sustainability pathway adopted in the DIS. The cancellation of Wildcat would have resulted in the closure of the Yeovil factory with the loss of 800 jobs and some of those in the 280 SMEs in the supply chain. AgustaWestland was owned by the Italian company Finmeccanica (now Leonardo) which, at the time, was the UK's largest defence inward investor. Despite the risk of sustaining a claim for liquidated damages, MOD's decision to suspend the binding 2006 contract (target cost incentive fee with a maximum price) for eight-months during the early production phase and the uncertainty that it generated over the MOD's future intent, served to undermine Finmeccanica Group's confidence in the UK market (Personal interview, 11 June 2024). Other defence inward investors took note. More broadly, Wildcat represents an example, common in MOD aerospace procurement, where reducing the offtake during the procurement cycle increases unit price and thus potentially undermines value for money. In 2009, Typhoon Tranche 3 offtake was reduced from 76 to 40 aircraft (NAO, 2010, p.188; NAO, 2011c, p.15). The A400M order was reduced from 25 to 22 aircraft in 2010 (NAO, 2015b, p.4), Poseidon from 12 to nine (NAO, 2021a, p.26, note 1) and, in the 2021 Defence Command Paper, that for Wedgetail from five to three (MOD, 2021c, p. 57). The Defence Select Committee's subsequent inquiry regarded that latter decision as "the most perverse, with the fleet cut by 40% for an acquisition saving of just 12%" (Parliament, House of Commons, 2023b, p.21). In the case of Wildcat, cutting the fleet size by 23% reduced total production costs by only 12% yet successive editions of DIS have not addressed this adverse syndrome. Again, this is an example where the treatment of value-for-money at the time in DIS would have been better served by adopting the NAO's extant framework defined as "the optimal use of resources under the headings of economy, efficiency and effectiveness to achieve the intended outcomes" (NAO, 2011b, p.4). As this case study shows, MOD decision-making is heavily skewed towards 'economy', driven by the need to reduce project expenditure in an overheated equipment plan.

Case Study Two – Crowsnest airborne radar

The Crowsnest radar is carried on a Merlin helicopter and provides over the horizon airborne surveillance and situational awareness to defend the UK's aircraft carriers from air and surface attack. In procurement terms, it is one of the four key components of the UK's Carrier Enabled Power Projection (CEPP) capability which includes two aircraft carriers (at a procurement cost of £6.4 billion (NAO, 2020b, p.4), up to forty-eight F35 Joint Strike Fighters (procurement cost £9.4 billion (MOD, 2021e, Tab PPST, Line 22) and logistic support shipping consisting of tankers and three specialised fleet solid support ships (the latter contracted at £1.6 billion (MOD, 2023d, sec.2)). Militarily, aircraft carriers are termed 'high-value assets' not only because of their cost but also because of the compelling nature of their capability and their relative scarcity. As such, they merit robust protection from enemy action. Initial assessment of options for airborne surveillance systems began in 2000 and the formal Assessment Phase commenced in 2012 with a budget of £43 million and an expected in-service date of 2018. Main Gate Approval for contract award to Lockheed Martin UK as prime was achieved in 2016 with the sole-source, fixed price contract signed later that year at £269 million which was subsequently re-baselined to £339 million to include VAT. (NAO, 2020b, pp.24 & 29). As the dominant capability in the UK's Equipment Plan since 1998, the CEPP programme (including Crowsnest) has been heavily scrutinised by the Public Accounts Committee and the Defence Select Committee and, separately, by the National Audit Office on four occasions (2011, 2013, 2017 and 2020). Key project milestones were subsequently reset to attain an Initial Operating Capability (IOC – the minimum level at which the capability is usefully deployable) in late 2020 to allow the first operational CEPP deployment in 2021 jointly with the US. Full Operating Capability (FOC – the project's intended level of capability) was scheduled for 2023 defined as the ability to support the operation of 24 F35 aircraft from one of the carriers with an aspiration by 2026 to support amphibious operations. At an overall final cost of £503 million, Crowsnest was financially a relatively modest project which was nevertheless pivotal in achieving both IOC and FOC for CEPP (NAO, 2017b, p.5). By 2017, it was recognised that Crowsnest was on the critical path for CEPP deployment given that protracted negotiations had delayed contract signature. Pre-contract development work to a value of £41.9 million had mitigated some schedule risk but there was no room for further delay arising from unforeseen technical problems. The risk register recorded that the schedule was potentially too tight to allow adequate time for ship integration training and work-up (NAO, 2017b, p.34).

Procurement requirement

Surface ship vulnerability to air attack during the 1982 Falklands War saw a rapid modification of the Sea King helicopter to provide airborne early warning (AEW) (Hastings and Jenkins, 1983, p.131). An adapted Searchwater radar, then in service with the Nimrod maritime patrol aircraft,

was fitted to 13 Sea Kings with an intended out of service date of 2016, subsequently adjusted to 2018 because of delays to the Crowsnest project (Scott, 2014, p.1). Throughout its life, the Searchwater radar and its supporting Cerebus mission system were upgraded to allow for simultaneous tracking of multiple contacts and automatic secure data transfer between the helicopter and other aircraft and ships. In July 2000, it was announced in parliament that, as part of CEPP, the MOD would "acquire a Future Organic Airborne Early Warning (FOAEW) system to replace the capability currently provided by Sea King airborne early warning helicopters" (Moonie, 2000, UIN 129228). Industrial studies continued over the following decade to narrow the options on both the preferred air vehicle and the type of radar (Think Defence, 2015, p.1). The 2012 Defence Rotary Wing Capability Study outcome was reported to parliament and determined that future helicopter requirements would be met by four core fleets: Chinook, Lynx Wildcat, Merlin and Apache (Harvey, 2012, WS 121). As a result, in all its maritime roles, the Sea King helicopter would be replaced by the AgustaWestland 101 Merlin of which 44 had been in service with the Royal Navy since 2000 in the anti-submarine warfare (ASW) role and were in the process of being upgraded to remain in service until 2040. The Crowsnest procurement concept was therefore to provide ten equipment sets that would be interchangeable with the Merlin's ASW sensors and mission system to allow for a rapid role change to AEW (NAO, 2015b, p.204). The choice of the radar was yet to be determined. Certification of the upgraded Merlin would ultimately become a cause for delay in the Crowsnest project.

Defence industrial strategy considerations

The 2012 industrial strategy, National Security Through Technology (MOD, 2012b) was in place ahead of the determination of the Crowsnest procurement strategy. Crafted in a period of budgetary austerity necessitated by the inherited £20 billion shortfall in the defence equipment plan, achieving value for money was paramount: the associated definition removed any notion that defence procurement had a part to play in the broader economy (MOD, 2012b, p.12, fn 6). The key pillars of the industrial strategy included an expanded approach to open competition centred where possible in buying off-the-shelf on the global market. There was also a new interpretation on operational sovereignty with its subdivisions of 'operational advantage' (battle-winning edge) and 'freedom of action' (minimal dependence on others) (MOD,2012b, p.12). These were to be qualified by the principle of 'technology advantage' in critical areas where "the UK needs either an advanced technology to counter our adversaries or special products or services to maintain our freedom of action, particularly during operations" (MOD, 2012b, p 14). In applying the 2012 industrial strategy to the Crowsnest project, given that the aircraft carriers were deemed to be high-value assets, technology advantage would be of paramount importance in determining the nature of the radar and supporting mission system. A further facet was also germane in that off-

the-shelf procurement was seen "as involving less risk, in terms of capability, timescale, and cost because we are buying mature solutions to our capability requirements, based on well-developed and understood technologies" (MOD, 2012b, p.20). But the strategy also called for future proofing in recognition that mature technologies may become obsolete more quickly. However, the industrial strategy gave no guidance on the priority technologies of the future which would be the target of MOD's development and hence there was little information by which industry could prioritise its own investment. Also given the intense focus on value for money, the strategy saw a mechanism for minimising costs by "integrating advanced technologies into standard equipment purchased through open procurement" (MOD, 2012b, p 14). Against this backdrop, the context for radar development pathway was largely set by the earlier 2005 DIS which highlighted all-weather performance, synthetic aperture techniques, phased arrays, low power consumption technology, and multi-function systems (MOD, 2005a, p.123). The next decade thus saw a rapid transition to electronically scanned (E-Scan) systems replacing mechanically scanned radars which involved a rotating scanner, either through 360° or a limited sector. Electronically scanned radars consist of a multiple array of small, combined transmitter and receiver modules allowing continued operation should one module fail. They also comprise fewer moving parts which together provide greater reliability and lower maintenance costs. In addition, they exhibit greater performance flexibility in their digitally driven detection capability (Leonardo, 2024b). E-Scan radars of interest to the UK during the project period for Crowsnest include the F-35 radar supplied by Northrop Grumman, the radar upgrade for Typhoon supplied by Leonardo and the AEW radar in the Boeing E7 Wedgetail, again supplied by Northrop Grumman. There was thus considerable pre-existing understanding of the technology concerned within the MOD.

Route to contract

By Main Gate approval in 2016, the Crowsnest project was under both time and cost pressures. The Merlin helicopter was confirmed as the air vehicle with Lockheed Martin UK as the prime contractor (MOD, 2017d). The key decision lay in the choice or the radar where the system integration challenge would determine the technical complexity and hence risk to cost and time. There were initially two options: integrating the exiting Sea King AEW fit of the Thales Searchwater 2000 radar with an updated Cerebus mission system into the Merlin or adopting Active Electronically Scanned Array (AESA) technology (Parliament, House of Commons, 2022b, Q157). The former required a complex mechanical arrangement to prevent the radar from being 'blanked' by the aircraft structure. This required a movable arm to pivot the radar below the aircraft once airborne (Pocock, 2017, p.1). The simpler alternative was the use of four AESA scanners contained in pods positioned on the existing torpedo mountings. In terms of performance, AESA radars allow greater discrimination against the clutter of the surface of the sea in detecting small targets with limited

radar cross-sections such as drones and cruise missiles. They also exhibit easier contact identification, greater detection ranges and greater reach from a given height, a significant advantage for helicopter where aerodynamics limits the operating altitude (Leonardo, 2024). Lockheed Martin therefore decided to forward an internal bid based on the Israeli Elta EL/M-2052 AESA radar which, although in service elsewhere, had yet to be developed in the required configuration for the Merlin helicopter and therefore could not demonstrate its capability in initial flight trials. In the event, the performance, risk and cost parameters set by the MOD meant that the Thales Searchwater with its Cerebus mission system was selected (Parliament, House of Commons, 2022b, Q157). The formal Assessment Phase had cost £43 million (NAO, 2016, p. 71). The award of a firm fixed price contract was completed in November 2016 at a cost of £339 million with AgustaWestland and Thales as named sub-contractors (NAO, 2020b, p.24, para.2.3).

Financial constraints

In common with the later stages of the Wildcat project, the Assessment Phase for Crowsnest coincided with a major overhaul of the equipment plan required to address the inherited deficit of £38 billion (HMG, 2010a, p15). The reconfiguration involved segmenting the equipment plan into two affordable categories: the nuclear deterrent and other contractually committed projects; and those where there had been an announced commitment which included Crowsnest but with a delayed FOC of 2022 (NAO, 2013b, p.8, para.15). This approach generated headroom of £8 billion and a contingency against known risks of £4.8 billion. Nevertheless, the budget was still under tension: the National Audit Office reported that, “there is systemic over-optimism inherent in the Department’s assumptions around the costing of risk and uncertainty at both project and portfolio levels” (NAO, 2013b, p.17, para.32). In 2015, the Strategic Defence and Security Review added new capability requirements in creating Joint Force 2025 “with the ability to project power globally” (HMG, 2015, p.92). Included in this force structure was confirmation of a fourth Dreadnought submarine and confirmation that both Queen Elizabeth class carriers would enter service from 2018 with the attendant need to deploy Crowsnest in support (HMG, 2015, p.30). In this latter respect, Lockheed Martin was contracted on a firm, fixed-price contract so had minimal financial leverage but a high risk of reputational damage if the project were to be delayed. While the Equipment and Support budget received a £12 billion uplift to £178 billion, the MOD accepted an efficiency savings target in the Equipment Plan of £5.8 billion. From that point onwards an affordability gap opened in the range £4.9 billion to £20.8 billion in the 2017 plan, reducing slightly by 2020 to the range of £1.8 billion to £17.4 billion. In its analysis of the 2020-2030 Equipment Plan, the NAO pointed out that it was now “4 years in a row that we have reported that the Equipment Plan has been unaffordable” (NAO, 2021b, p. 4). The report added that further funding pressures of at least £20 billion would arise from capabilities not yet included in the plan. The pressure was partially relieved

by a £16.5 billion Treasury uplift in November 2020 and the removal of £22 billion in project costs over the following 10 years. The plans for 2021 and 2022 showed broadly balanced budgets but given this backdrop of financial turbulence across the Crowsnest project period, it was clear that MOD would be forced to accept a minimum cost route in procuring the capability.

Project delivery

Despite the collective optimism on the ease of integration of the Searchwater-Cerebus system, a subsequent NAO report revealed that, "When the Department let the contract, it assessed there was a very high risk that industry would be unable to deliver the initial capability" (NAO, 2020b, p24, para.2.3). Contracting delays left just two years for project delivery before the Sea King AEW went out of service. Nevertheless, despite the problems that followed, the MOD continued to assess that the Crowsnest was deliverable by December 2018: to assert otherwise would have required an admission of a predicted capability gap (NAO, 2020b, p.24, para.2.3). But there was no contingency in the most challenging aspects of mission system integration and flight testing. Progress was also hampered by inadequate supervision of the sub-contractors: their under-resourcing went unrecognised. The problem for Thales lay in the instability of the software in interfacing the legacy operating programs within Searchwater with the upgraded Cerebus mission system. Project milestones were being missed and investigation revealed that Thales was failing to maintain the critically important software documentation. In addition, the framework of software maturity metrics did not provide assurance on the level of work completed nor the remaining risks. This rendered predictions over completion dates difficult to assess with certainty. However, these problems were not being reported either to Lockheed Martin or the MOD on a routine basis (NAO, 2020b, p.28. para.2.4). As a result, it was not possible to take early remedial action to meet the 2018 milestone. Consequently, the contract was amended in August 2018 with the date for initial operating capability agreed as March 2020, just a year ahead of the first international carrier deployment allowing little time for evaluation, training and logistic integration. By January 2019, Thales reported that they could still not meet the system specification or the required timeline and that the project was undeliverable. A recovery plan was agreed in May 2019: Thales doubled its staff cohort and Lockheed Martin increased theirs by a quarter. By February 2020, "Lockheed Martin reported 83 tasks (19%) in the recovery plan had been delayed by between 30 and 322 days, including nine on the critical path" among which was the first flight trial (NAO, 2020b, p.27, para.2.6). There was also a collective under-estimation of the complexity and time required to achieve Military Aviation Authority clearance for the Merlin HM2 in the AEW role. In evidence to the Defence Select Committee's 2022 enquiry into Aviation Procurement, the CEO of Lockheed Martin UK pointed out that the 1997 flight test regime for the original Merlin Mk1 which, at the time was a completely new aircraft, embraced 4,000 flight test points on its route to certification.

By contrast, the flight test programme for the upgraded AEW Merlin required the attainment of 10,000 test points, mainly because of the need to validate the safety case for the software (Parliament, House of Commons, 2022b, Q148). In parallel, the Searchwater/Cerebus software lacked inherent stability requiring continual modifications. Between 2018 and 2020, the MOD withheld payment of some £88 million but did not impose contract penalties, subsequently holding Lockheed Martin to the contracted price of £339 million. Ultimately, in April 2021, three Merlin AEW helicopters with limited Crowsnest functionality deployed as part of United Kingdom Carrier Strike Group 21. The software did not exhibit full stability but provided valuable data by which to reach a predicted FOC in 2024-25 rather than June 2022, a minimum of 24 months late. (Navy Lookout, 2022). The procurement (sunk) cost of Crowsnest was £503 million with radar support estimated at "£150 million over 10 years" (NAO, 2020b, p.45, para.3.17). However, in April 2023, MOD announced to parliament that Crowsnest would achieve its initial operating capability "by Autumn 2023" (Cartlidge, 2023b, UIN 182510). Two years previously, an MOD news story in May 2021 launched a competition by MOD's Defence and Security Accelerator which stated that Crowsnest would be withdrawn in 2029 in favour of a drone-based system but was seeking an alternative solution (MOD, 2021f). Of note, this out-of-service date had not been released by MOD in any of the select committee or NAO enquiries until after the April 2013 parliamentary written answer. On that basis, Crowsnest would offer just 4 years of the specified operational capability for a return on investment on the equipment alone of £140 million/year.

Project dependencies

As one of the four elements of UK's Carrier Enabled Power Projection (CEPP), Crowsnest was tied directly to the build progress of the Queen Elizabeth carriers which was subject to a hiatus between 2010 and 2012 whilst MOD revisited the choice of F-35 variant. (HMG, 2010a, p.5). In 2002, the MOD determined that the carriers would be optimised to support the F-35B (the short take-off and vertical landing variant of the aircraft) as a replacement for the Harrier (NAO, 2006b, p.63). The main investment decision in 2007 at £3.65 billion for two carriers was based on the policy baseline contained in the 1998 Strategic Defence Review which envisaged an in-service date of around 2012, (MOD, 1998a, para. 115). However, the 2010 defence review announced a major change of direction in reducing the project to just one operational carrier to be equipped with the longer-range F-35C carrier variant of the aircraft with the other carrier, which was already on order, being placed in extended readiness (HMG, 2010a, p.5). This in turn required a late modification of the sole Queen Elizabeth class carrier to be equipped with a catapult and arrester system thus delaying its in-service date until around 2020 (HMG, 2010a, p. 23). Ahead of the 2010 defence review, the cost of the carrier build had increased to £5.24 billion: after the review, the cost had risen to £6.24 billion representing a "lower scale of carrier capability, later than planned, and at a significantly

higher cost" (NAO, 2011d, p.5 para.2). In the light of more accurate but increased costings and an assessment of increased delay, the decision on the aircraft variant was subsequently reversed (NAO, 2013c) and announced to Parliament (Hammond, 2012, Col 140). However, the hiatus had already led to an 18-month delay in the programme and a write-off of about £74 million (NAO, 2013c, p.4). A scathing report by the Public Accounts Committee pointed to the 2010 decision as being based on deeply flawed information resulting in a remaining uncontrolled cost growth and noted the two-year delay in delivering "the early warning radar system Crowsnest in 2022 which is essential to protecting the carrier and its crew" (Parliament, House of Commons, 2013d, p.5). The committee was correct to use the word 'essential' against a requirement for CEPP to have full freedom of operational action but, in its defence, the MOD conceded that "this might constrain where the carrier could operate" and considered that risk could be mitigated by using land-based surveillance aircraft or by reliance on allies (Parliament, House of Commons, 2013d, p. 9).

The failings

The Crowsnest project exhibited failings in risk assessment, project management and contractor supervision. The CEO of the MOD's procurement organisation told the Public Accounts Committee that the problem rested mostly with industry's failure to understand the technical risk at the outset and adequately to resource the contract. He continued that, given also the turbulent financial backdrop, the project was under constant cost pressure and contracting delays compressed the timescales. Thereafter, poor programme management and a misplaced sense of optimism together led to a further 18-month delay. Nor was there any contingency in the schedule to allow for the manifestation of risk (Parliament, House of Commons, 2020, Q29). In seeking to justify why the technical risk was unidentified at contract award, he suggested that both sides were under the illusion that this was a relatively low risk solution using known components. However, he acknowledged that there was insufficient probing of the systems integration challenge given that the component modules had been upgraded, an aspect that led to software instability (Parliament, House of Commons, 2020, Q34). On the selection of the radar, the CEO of Lockheed Martin UK told the Defence Select Committee that, based on the parameters laid down by MOD for the competition, the reused Thales radar was selected adding that, "All of us could look back now and say that that potentially was not the right answer" (Parliament, House of Commons, 2022b, Q157). The NAO was clear that this outcome was the result of the MOD and its suppliers jointly underestimating project complexity, pointing out that:

> An internal [MOD] 'lessons learned' review concluded that neither the Department nor industry understood the complexities of delivering the capability. Changes to funding, scope and timetable, together with a fixed price contract, contributed to subcontractor under-performance, which the prime contractor and the Department did not detect until it was too late to meet the target delivery date (NAO, 2021a, p.39, para.37).

In this respect the prime contractor should have instigated a more intrusive validation regime for sub-contractor milestone achievement. However, Thales underestimated the technical and integration challenge facing them and it was the MOD's choice, not that of Lockheed Martin, to select the Searchwater radar. The Crowsnest project demonstrates many of the well-rehearsed weaknesses in the defence procurement process which were articulated in the Gray report of 2009. It is surprising that the complexity of integrating different generations of technology – particularly where it is software-driven – was not more widely understood. Greater knowledge of these aspects might also have added a degree of circumspection over the pricing of the contract which seemingly was so tautly drawn that contractors were continually mindful of the need to control carefully the level of resources applied to the project.

Conclusions on industrial strategy

Two aspects of DIS 2012 concepts contributed to the sub-optimal outcome of the Crowsnest project: 'technology advantage' and the narrow interpretation of value for money. The strategy was adamant on the primacy of open competition on the global market for off-the-shelf solutions. From the outset of Crowsnest, the tentative assessments dating back to 2000 that saw transference of Searchwater as a baseline assumption appears to have restricted thinking when considering alternative radars. Yet DIS 2012 gave prominence to the notion of 'technology advantage' but attempted to nuance this concept through the notion that off-the-shelf technology carried less risk whilst also accepting that its relative maturity called for futureproofing to avoid obsolescence. Crowsnest demonstrated that technology with its roots in the 1980s cannot easily be future proofed in that there is a limit to the ability of software to bridge the generational gap. More obviously, such an approach allows little potential for future growth or adaptation as threats change. Had there been more precise guidance in DIS 2012 on radar technologies along the lines of that included in the 2005 version, a proper cost-benefit analysis of an AESA solution might have gained more traction given the superior technology advantage and growth potential that it represents. The CEO of Lockheed Martin was clear on this point in his evidence to the Defence Select Committee (Parliament, House of Commons, 2022b, Q157). On value for money, the pursuit of the wrong technology coupled with inadequate risk analysis and poor forecasting added time and cost to the project. Given the

outcome of four years of operational service for a through-life cost of £563 million, the Crowsnest project delivered sub-optimal value-for-money. This figure omits the cost of the MOD's management overhead for a project that ran for 25 years. DIS 2012's definition of value for money contained the statement, "MOD does not consider wider employment, industrial, or economic factors in its value-for-money assessments" (MOD, 2012a, p.12, fn.6). In this case, value was to be assessed based on a narrow view of an austere solution for an individual competition rather than acknowledging the advantage that might flow from nurturing new technology such as AESA radar which would have wide future applicability.

Of note, DIS 2012 was also at variance with the preceding 2010 Strategic Defence and Security Review which recognised the dual objectives of providing the armed forces with the right equipment and achieving value for money but pointed-out that, "MOD spending also has a broader economic impact … Industrial policy provides the link between these key issues (HMG, 2010a, p. 30). The intent behind the DIS 2012 definition of value for money could have been to draw a distinction between the MOD's approach to project bid assessment and that applied by the broader machinery of government. If so, the approach would have caused confusion to bidders and would not be seen as attractive to potential inward investors. Taken together, it is questionable that the authors of DIS 2012 understood the implausibility of applying the strategy in the real world. This also builds on subsequent experience on the impracticality of the approach to sovereign capability articulated in the strategy centred on operational advantage and freedom of action which practitioners found overly complex to apply in making judgements over procurement solutions. These shortcomings were ultimately identified and corrected in the 2021 version of Defence and Security Industrial Strategy.

Case Study Three – The Protector remotely piloted air system (RPAS)

Counter-insurgency operations in Iraq and Afghanistan demonstrated the importance of RPAS (or drones) in providing persistent wide-area surveillance. Procured from the US, the UK's initial capability from 2007 was met by the General Atomics MQ-9A Reaper with UK personnel embedded in US-based squadrons from 2004 to gain experience with the system. The UK took delivery of six Reapers in 2007 (one of which was subsequently lost) but continued to locate crews remotely in the US before redeploying to the UK (RAF, 2025a, paras. 9-10). The air vehicle also required an in-theatre launch and recovery team at forward deployed locations (RAF, 2025a, para. 2). Five further UK Reapers were added in 2012. With an endurance of 16 hours, five Reapers could provide continuous surveillance across the Afghanistan theatre for 36 hours. (Hoyle, 2011, para. 5). Apart from flight control cameras, the UK Reapers were fitted with US sensors including a multi-mode synthetic aperture radar and a sophisticated day/night surveillance camera: they were also armed with the US GBU-12 laser-guided bombs and the Hellfire missile (RAF, 2025a, paras. 4, 7). By the 2014 conclusion of combat operations in Afghanistan, the Reaper force had flown some 71,000 hours (MOD, 2015a, para. 4). Funded from the Treasury Reserve until 2015 under the then 'Urgent Operational Requirement' process, Reaper was absorbed into the MOD's core programme in 2016 with its life extended until a more capable replacement was available through normal procurement procedures (MOD, 2017e, p.26, para.54). Meanwhile, the Reaper force was deployed on operations in Syria against Daesh (RAF, 2025a, para. 10).

In parallel, the 2015 Strategic Defence and Security Review confirmed the requirement for a replacement RPAS fleet of 20 aircraft by 2018 (HMG, 2015, p.32). The requirement centred on the need to procure an RPAS which both overcame the operational limitations of the Predator and could be configured as a sovereign UK capability (MOD, 2020b, p.62). The General Atomics MQ-9B SkyGuardian (to be termed the Protector RG Mk1) was selected as the replacement to enter service in 2018 coincident with the withdrawal of the Predator (MOD, 2017f, cell AA-8). By 2019, financial constraints had resulted in a 2-year delay and the project cost for 16 RPAS had risen from £929 million to £1.46 billion (MOD, 2024e, cell P-19). Software integration subsequently proved challenging as did the provision of infrastructure at the airbase. As a result, Initial Operational Capability (IOC) would not be achieved until 2025 (Cartlidge, 2023c), some seven years late and £534 million (or 57%) over the initial budget (MOD, 2024e, cell P-87). Given this marked excursion from the main gate business case criteria which was identifiable early in the project, the MOD Permanent Under Secretary was required to write to the Public Accounts Committee (PAC) to explain the breach of project tolerances (MOD, 2019b, para. 1).

Procurement requirement

Although the MOD ceased publication of Key User Requirements related to individual equipment procurements in 2015, the need for a "deep and persistent armed surveillance, target acquisition, and reconnaissance" capability was listed in the MOD's 2016 submission to the Infrastructure Projects Authority (MOD, 2016c, cells AA:2-14). Building on experience operating the Predator RPAS, the replacement needed to provide global reach and greater persistence with an endurance of 40 hours flying time at a higher cruise speed while carrying an increased weapon payload (MOD, 2020a, p.62). SDSR 15 stipulated a fleet of 20 aircraft but there were both international political and important operational barriers to overcome (HMG, 2015). On the former, as an off-the-shelf purchase procured through the US government-to-government Foreign Military Sales (FMS) regime, the Predator was subject to US restrictions on the release of information**.** Variations in sensor fit and weapon selection were also not permitted (MOD, 2025c, sect. 4). However, the MOD determined that the replacement system needed to be configured as a sovereign capability such that the UK would possess the authority to determine and, where necessary, to modify the mission system, sensor fit and weapon payload without the need for US clearance. Certification and airworthiness would also be a matter for the UK (MOD, 2020a, p.62). The required operational enhancements were centred on the need to avoid geographical limitations. These included: the ability to fly in cloud and icing conditions; certification to allow flight in civil airspace enabled by 'detect and avoid' technology; and the capability to perform automatic take-off and landing to avoid the need to forward deploy crews to maintain visual line of sight needed for manual control in this phase of flight (MOD, 2020a, p.62). Taken together, these enhancements would allow global control from the UK airbase using satellite communications. The sensor fit was to include a synthetic aperture radar and a day/night electro-optical camera for surveillance and targeting supported by a digital data link (MOD, 2020a, p.62).

Defence industrial strategy considerations

Given that it was published during a period of budgetary austerity, DIS 2012 focused heavily on achieving value for money with a definition that removed any notion that defence procurement had a part to play in the broader economy (MOD, 2012b, p.12, fn. 6). In terms of aspects relevant to Protector, the strategy limited the envelope of sovereign capabilities to those where operational advantage (winning edge) and freedom of action (minimal dependence on others) needed to be protected but only when essential for national security (MOD, 2012b, p.25). It also adopted a default position of open competition on the domestic and global markets but qualified by the principle of 'technology advantage.' Technology advantage was deemed to be a route to minimising costs through the integration of bespoke technology into platforms procured on the open market and through mutual development with allies. In so doing, there was a need to

generate intelligent customer capability based on expert systems integration understanding to "evaluate technical, financial, interoperability and security risks" (MOD, 2012b, p.34). Future MOD investment in Science and Technology would be specifically focused on this aspect. DIS 2012 was also clear on the preference for bilateral collaboration on procurement and technology exploitation rather than accept the disadvantages and risks inherent in a multilateral approach. However, the level of collaboration was limited in this case given the chosen procurement strategy. As such, except for those associated with weapons, UK industry had no insight into the integration challenges involved in this novel RPAS capability. Finally, DIS 2012 promoted the wider policy objective of attracting global private sector inward investment in the UK defence and security sectors (MOD, 2012b, p.18).

Route to contract

Three factors in the requirement were dominant in determining the route to contract. First, the RAF had gained invaluable experience from more than a decade of Predator operations and from the relationships that had been developed with the US manufacturer, General Atomics Aeronautical Systems (GA-ASI), and with the Pentagon (EEI, 2023, para. 5). Secondly, there was the need to ensure sovereign control over systems, software and sensors. Thirdly, as an air vehicle that would fly in civil airspace, airworthiness factors such as safety of flight and collision avoidance would require certification by the UK's Military Airworthiness Authority (MOD, 2020a, p.62). These factors pointed to a modified version of a single-source procurement, configured to avoid the inflexibility of the US FMS regime and the additional restrictions inherent in the US International Traffic in Arms Regulations (ITAR) on technology transfer to third party nations (MOD, 2019b, para 7). This approach stretched beyond US Government sales and encompassed private sector manufacture and sales of defence and space-related items and services. As a result, the General Atomics MQ-9B SkyGuardian was selected as the baseline air vehicle given that it satisfied the key criteria of increased endurance (more than 40 hours), all-weather automatic operation, open architecture and nine weapon hardpoints, offering a weapon payload capacity of 2155 kg. It was also configured to meet global civil airspace requirements. There was no other RPAS on the market that met this latter criterion (GA-ASI, 2025a, paras. 2-4). The UK would be the lead customer and, while SkyGuardian had undergone a full development and testing phase, the UK version would see the need for extensive modification to meet sovereign requirements. Nevertheless, at the time of the Main Gate business case submission, an Initial Operating Capability (IOC) of 2018 appeared feasible and matched the out-of-service date for Predator (MOD, 2017f, cell AA-8). As a novel procurement, the route to contract presented some unique regulatory and commercial hurdles. Nevertheless, in mid-2016, the MOD Investment Approvals Committee (IAC) agreed to a hybrid single-source procurement involving a government-to-government FMS contract for the air vehicle

and a Pentagon-approved Direct Commercial Sale with General Atomics for the modifications. This approach required pre-signature approval by UK Government Legal Services and the Single-source Advisory Team, and the creation of a revised Technical Assistance Agreement with the US State Department. (MOD, 2019b, paras. 6 and 11). In 2016, an initial development contract was let with General Atomics. The MOD's equipment plan affordability issues then intervened (MOD, 2020a, p. 8) such that the initial manufacturing contract for the first three aircraft was not signed until mid-2020 (MOD, 2020b, para. 1). The contract was for the first three air vehicles and associated ground control stations with an option for 13 further air vehicles and four ground control stations (MOD, 2020b, para. 11). This option was exercised in mid-2021 leading to a final fleet of 16 Protectors. The positive behaviours exhibited by both sides were seen as providing confidence on delivery (MOD, 2019b, para. 11).

Financial constraints

The financial backdrop for the early stages of the Protector project reflected the same problems as for Crowsnest but included a new uncertainty on foreign exchange costs. Defence expenditure, particularly for equipment procurement had been constrained since 2010. Thereafter, SDSR 15 included new equipment requirements to a value of £24.4 billion that had not been accurately costed within the 2016-26 Equipment Plan (NAO, 2017a, p.15). Despite a Treasury uplift at 1% above inflation until 2020/21, the NAO's analysis of this Equipment Plan concluded that:

> The affordability of the Plan is now at greater risk than at any time since reporting was introduced in 2012 and the Department faces the risk that in future it may have to return to a situation where affordability of the portfolio is maintained by delaying or reducing the scope of projects (NAO, 2017a, p. 10).

The NAO also pointed to the risk of cost growth arising from the immaturity of the high-value projects introduced by SDSR 15 which were at an early stage of development, an aspect where the MOD's track record on financial control was weak (NAO, 2017a, p.10, para.22). Foreign exchange turbulence also undermined MOD optimistic assumptions on the cost of US dollars at some 21% better than the market rate: this at time when about 23% of the equipment plan was denominated in dollars (NAO, 2017a, p.9, para.18). In addition, the PAC registered their concern that the MOD committed itself to the procurement of new equipment without determining how it should be financed (Parliament, House of Commons, 2017, p.8). The committee again cautioned that the Department was seemingly now relying on a "highly ambitious, but still under-developed, programme of efficiency savings from within the Plan and the wider Defence budget" by which to maintain affordability (Parliament, House of Commons, 2017, p.3). These

inadequate foundations were to dog the equipment budget for the following eight years and represented the backdrop against which much of the decision-making on Protector took place.

The project gained Main Gate Approval in mid-2016 at a cost of £816.2 million. In 2018, the MOD decided to delay the project by 2 years to ameliorate these wider affordability challenges (MOD, 2020a, p. 8). The cost of this delay was £325.6 million making the then total project cost £1.14 billion. The elements of the cost growth were: £186.8 million of the direct cost; £64.4 million to address obsolescence that would otherwise have been avoided; £23.4 million of previously undisclosed project cost growth; and £50.8 million of accounting adjustments and foreign exchange costs (MOD, 2019b, para 3). Taken together, Protector had exceeded the project tolerances permitted under the Treasure regulations in *Managing Public Money.* This required the Permanent Under Secretary (as MOD Accounting Officer) to write to the chair of the PAC explaining these divergencies. There was also an opportunity cost of extending the Reaper fleet of £48.6 million (MOD, 2022g, cell Q-46). Nevertheless, the Permanent Under Secretary's letter confirmed that the Treasury had agreed that the value-for-money case remained valid (MOD, 2019b, para.10).

In considering the 2020 Equipment Plan, the PAC recorded their extreme concern that it showed a shortfall £17.4 billion, making the additional comment that, "The Department must get a grip on the serious affordability issues that this Committee has highlighted year after year, rather than accept this situation as normal" (Parliament, House of Commons, 2021a, p.5). Despite a one-off £16.5 billion addition to the equipment budget in late 2020, the situation had deteriorated considerably by the time of publication of the 2023-2033 Equipment Plan which included further force structure enhancements arising from the 2021 Integrated Review's Defence Command Paper but not those contained in the latter's 2023 refresh. The NAO determined that the plan was unaffordable with a deficit of £16.9 billion representing the largest deficit since 2012 when the current equipment planning regime was introduced (NAO, 2023, p.7. para.9). Against a backdrop of increasing pressure from unusually high rates of inflation, the increased costs of the successor nuclear deterrent and from investment in shipbuilding, the MOD estimated that the funding shortfall in the Equipment Plan could be between £7.6 billion and £29.8 billion depending on how much of the embedded risk materialised (NAO, 2023, p.4). Meanwhile, the PAC heavily criticised the MOD's financial discipline, concluding that, "... the MoD has not credibly demonstrated to Parliament how it will manage its funding to deliver the military capabilities that government wants (Parliament, House of Commons, 2024, p.3). By 2025, the final estimate of the Protector project cost had risen to £1.46 billion largely because

of self-imposed delay, adverse foreign exchange rates and investment in additional technical infrastructure costs (MOD, 2024e, cell P-87).

Project delivery

While the Protector air vehicle was manufactured in California, the contract requirements on UK sovereignty meant that there was UK industrial involvement by MBDA UK (MBDA, 2019, para. 1) and Raytheon UK for weapon integration. Also of note, GKN Aerospace was contracted to supply the tail assembly for all sales of the SkyGuardian and Protector (GA-ASI, 2021a, para. 1); nine other major UK firms were also direct suppliers (GA-ASI, 2025b, para. 3). It was estimated that some 200 UK companies were embraced in the supply chain representing a total investment of £400 million in British industry (MOD, 2021g, para. 16). Development flight testing proceeded without difficulty and included a transatlantic flight from the US to the UK in mid-2018 by the first Protector prototype to demonstrate the ability to fly in civil airspace (GA-ASI, 2018, para.1). The same prototype returned to the UK in mid-2021 for airspace integration trials and participation in a major joint UK exercise (GA-ASI, 2021b, para.1). Both these events were conducted by GA-ASI personnel. Meanwhile, RAF personnel based in the US undertook the joint acceptance programme with the company and conducted initial familiarisation. The first operational Protector was completed in September 2020 allowing the acceptance programme to be completed and the aircraft handed over in September 2022 with the first delivery to the UK in September 2023 (RAF, 2023, para. 2). RAF aircrew training commenced in the US in May 2023 and was scheduled to transfer to the UK in late 2024. The ease with which development, acceptance and training took place in the US generated much positive comment about the relationship between the UK MOD and GA-ASI (MOD, 2019b, para.11). However, this entire process was interrupted by the MOD's decision to insert a two-year delay into the project to provide headroom elsewhere in the Equipment Plan. This action resulted in a predicted delay in IOC to November 2023 and Full Operating Capability (FOC) to October 2025 Subsequent difficulties over software integration and infrastructure provision saw a further delay in IOC to 2025 and FOC to 2026 (MOD, 2024e, cell K-19). The hiatus required the MOD to revisit the value-for-money case in the original Protector Main Gate Business Plan. The Treasury was satisfied that the alternatives of developing an alternative RPAS either as a national project or in collaboration with partners or buying the GA-ASI Reaper Block 5 off-the-shelf through an FMS contract were either unlikely to be compliant with the sovereignty requirement or represent improved value-for-money (MOD, 2019b, para.10). Meanwhile, the weapon integration tests for the Brimstone 3 and Paveway IV continued with the former having to be conducted on US-owned Predator aircraft.

Project dependencies

Two related programmes added risk to the Protector project: construction of the operational support building facilities and the generation of trained personnel. On the former, the original intention had been to create shared operational support facilities with the new Boeing Wedgetail surveillance aircraft (based on the Boeing-737) at Waddington (Lincolnshire). However, in late-2020, the decision was taken to base the Wedgetail at Lossiemouth (Moray) to take advantage of the extensive Boeing-737 aircraft engineering infrastructure supporting the existing Boeing Poseidon fleet. Control of the £94 million Protector infrastructure project had been switched during 2019 to the DE&S from the MOD's specialist infrastructure delivery organisation. Subsequent cost growth saw the adoption of an interim solution involving the modification of existing buildings at Waddington (MOD, 2020c, cell AE-6). Taken together and alongside software development problems, these aspects contributed to the ultimate delay in Protector IOC to 2025 as reported to Parliament (Cartlidge, 2023, UIN 190760). As for trained personnel, there was a temporary problem over the availability of specialists in the project team and related advisory functions which, in concert with the initial complexity over contract design, led to a 2016-17 SRO assessment of Amber (feasible delivery dependent on prompt management action) in the MOD's input to the Infrastructure Projects Authority (IPA) (MOD, 2016c, cell AA-3). More importantly, the build-up of the required 45 Protector crews remained behind the target. This was cited as the main risk to the delivery timescale in the Accounting Officer's Assessment report to the PAC on excursions from the approved business case (MOD, 2019b, para. 12). The assumption had been that both ab-initio crews and those already in the Predator force would enter training in harmony with air vehicle deliveries. However, the Covid pandemic had reduced recruiting capacity and the Predator force remained heavily committed to operations. The latter problem was eased by using contract personnel and Royal Australian Air Force exchange officers in the Predator force to release Royal Air Force personnel for Protector training (MOD, 2020c, cell AE-6). However, the cumulative delay to IOC required a run-on of the Predator force at a cost of £48.6 million (MOD, 2022g, cell Q-46).

The failings

In terms of IPA assessment across the seven-year period of the project between 2016 and 2023, it was assessed as Amber (feasible delivery dependent on prompt management action) on four occasions, Amber/Red (successful delivery is in doubt) on two occasions and Red on one occasion (successful delivery appears unachievable) in 2017/18. This latter assessment reflected the financial hiatus on the basis that time and cost criteria would not be achieved. The pattern revealed by these assessments reflects the initial complexity in surmounting US export regulations against a backdrop of inadequate project staff capability. The slow build-up of Protector crews and poor inter-project synchronisation of the operational infrastructure and related cost-growth were noted in 2018/19.

The approach to synthetic training was slow to mature and the integration of the aircraft's 'detect and avoid' capability added to the baseline cost. Extending the project timeline also added additional cost because of the necessary inclusion of support costs into the project's delivery phase. Of note, adverse foreign exchange rates were a constant factor across the life of the project leading to complexity in resource profiling and a further increase in cost. (MOD, 2024e, O-19). Currency fluctuations in the MOD's equipment plan are normally covered by forward purchase from the Bank of England: when forward purchase does not cover the gap, costs fall to the projects concerned. The NAO suggests that the MOD might choose to meet these additional costs from broader defence budget rather than distorting the equipment plan (NAO, 2017a, p.31). Finally, the initial intent had been to include a separate maritime radar sensor as part of the project but was subsequently reconfigured as a stand-alone project. Overall, the need to delay the project for two years because of other early years' pressures in the Equipment Plan together with the poor synchronisation of the non-equipment lines of development (particularly personnel where risk remains) added both significant cost and delay to the project with considerable reputational damage to the MOD.

Conclusions on defence industrial strategy

The Protector project was conceived some two years after the publication of DIS 2012 at a time when the doctrine and technical understanding of RPAS were relatively immature. It is thus understandable that, given the time pressure, the preferred approach relied heavily on the Predator experience and no alternative solutions were considered. The configuration of the requirement and the subsequent route to contract proved to be significant tests of the DIS 2012's approach to sovereign capability. In this respect, Protector's hybrid contracting arrangements were indicative of the challenges inherent in the offshore procurement of leading-edge technology where the transaction involves both government and commercial entities. Success rested on a high degree of cooperation with both the US government and GA-ASI which, despite the need to add a two-year delay to the contract, endured throughout the period. That is not to underplay the legal and procedural complexity in getting to contract in these novel circumstances. In terms of employing open competition on the global market assessed through the lens of technology advantage, Protector demonstrates the tension inherent in securing unfettered access to IP where ownership is split between a foreign government and an offshore commercial entity. It is thus unsurprising that DSIS 2021 ultimately recognised that the principle of technology advantage was simply unworkable. On the positive side, as an intelligent customer, the UK MOD capitalised on the body of knowledge gained through operating Predator RPAS over an extended period. The assessment of system risks throughout the project was robust but the recognition of the failures in the project dependencies, particularly in the generation of trained crews, was lacking. More importantly, the project was undermined by the MOD's poor financial management leading to

delay and cost growth, aspects that overshadowed the application of DIS. While inward investment in UK firms through supply chain industrialisation was a positive outcome, the work was all 'build to print' rather than 'noble work' which involves design, development and mission system integration. Participation in noble work generates both intellectual property and tacit knowledge within a firm that sets it in good stead for future contracts on systems involving leading-edge technology and enhances its sustainability as a defence contractor. Overall, this Protector project demonstrates the limitations of DIS where the primary focus is on managing a bespoke contract and funding it properly across its life without interruption from external factors.

Overall findings on defence industrial strategy

The evidence of influence of DIS leading to a positive outcome in these project case studies was not compelling. Rather, any initial influence that the strategies might have had in framing the equipment requirement was soon overshadowed by one or more of three factors. First, risk aversion undermined the selection of technology worthy of defence equipment as tournament goods (Crowsnest). Secondly, the contracting process paid inadequate attention to long-term operational independence in a way that would lead to a sustainable onshore industrial base (Wildcat, Crowsnest and Protector). Thirdly, inadequate project financial forecasting at the outset with the consequent need for reprofiling, led to cost growth and delivery delay (Wildcat, Crowsnest and Protector). Of particular significance, two of these projects entered service with critical operational shortfalls. Wildcat could not carry the required suite of weapons necessary to fulfil its operational tasks and Crowsnest was unable to provide full protection for the Queen Elizabeth class carriers, a critical weakness when such high value units are deployed. Protector has yet to enter service, so its ultimate capability has yet to be assessed. For DIS, these outcomes demonstrate that there are either weaknesses in the UK formulation of such strategies or that the pressure of contract delivery at the coalface crowds out the possibility of DIS having any impact: both undermine DIS effectiveness.

Taken further, the environment within which DIS is designed to operate is not conducive to its adoption for two reasons. First, in the period covered by this research, a DIS has been inserted into an ecosystem where the uncertainty over funding in the equipment plan could not support the strategy's lofty ambitions. Secondly and related, inadequate project management and basic errors in identifying critical dependencies generated internal barriers to progress such that time slipped away and costs grew. There is also evidence in the Crowsnest case that the consequence of squeezing contractor pricing at the bid stage leads to a contractor applying a limitation on the human resource allocated to the project, leaving no contingency for the unexpected when problems arise. While proper customer scrutiny of the contractor's work breakdown structure

should reveal this weakness, in the Crowsnest case, it went undetected until the situation became critical. More broadly, the case studies demonstrate that, across the ecosystem, poor project definition and inadequate assessment of technical risk at project level suffers from two of the adverse cognitive behaviours described in Chapter 3. Strategic misrepresentation is the deliberate distortion of information for strategic purposes such as the need to secure a funding line in an overheated equipment plan while optimism bias overestimates the prospect of positive outcomes and underestimates the likelihood of negative results. It is therefore striking that there is no mention of the application of reference class forecasting in any of the data associated with these cases. Apart from risking reputational damage, such imperfections in procurement also undermine the credibility of DIS by rendering it impotent no matter how well-formulated. However, DIS rarely ventures into the detail of procurement process leaving the subject instead to periodic change programmes of limited effectiveness (Brooke-Holland, 2019): but, as one of the most significant 'ways' of meeting the strategy's objectives, there would be merit in so doing.

DIS 2005 promoted a list of twelve 'acquisition values' within which were elements on the importance of not exceeding the project finance envelope, understanding that time matters and quantifying risk and managing it effectively (MOD, 2005a, p.132). These are all identifiable imperfections in the case studies. Main gate approval for all the case studies pre-date DSIS 2021 which called for the alignment of behaviours and a positive culture change across government and industry. More importantly, the strategy laid the foundations for a tighter linkage between a DIS and procurement decision-making. It provided a detailed summary on how considerations of 'strategic imperatives' and 'operational independence' should be applied to each of the segments (or sub-sectors) within the UK's industrial and technology base to signal "the broad approach to each segment, with the expectation that this will guide scrutiny of individual decisions in these areas" (HMG, 2021a, p.80). The specific mention of 'scrutiny' is aimed at the delivery organisation and the way in which bidders are down-selected for future contracts. On radar capability, it states that, operational independence would not require the need to retain an onshore industrial capability in every aspect of sensing and detection. However, it highlighted the need to protect access rights to allow the UK to adapt systems through life and accepted the need for targeted investment in areas such as AESA radar (HMG, 2021a, p.104). This approach would apply to the replacement of the Crowsnest radar. On helicopters, after noting that the UK retains the capability to design and develop new capabilities and to upgrade exiting fleets, the DSIS 2021 annex states that, "In practice this means we need access in the UK to the know-how to support and upgrade our fleets to respond quickly to changing threats and operational needs" (HMG, 2021a, p.99). This approach provides a direct link between the recategorized sovereign requirements and the characteristics of the UK industrial base needed to deliver them. Accordingly. It provides industry

with greater incentive to invest and, given that it provides a pragmatic strategic roadmap, it should ease implementation of the strategy. Overall, in line with the first two hypotheses, the findings of the case studies point to the lack of traction achieved by the extant versions of DIS in producing acceptable project outcomes on time and within the forecast budget. In addition, and in line with third and fourth hypotheses, the procurement processes associated with forecasting technical risk proved inadequate which points to the potential impact of cognitive bias. More significantly, the major disruptive impact of turbulence in the equipment budget was a significant factor in undermining project outcomes. These findings are used to formulate the discussion points to be used in the interviews, the findings of which follow in the next chapter.

Chapter 7 – Interview Findings

> *Delivering on our Defence Industrial Strategy to create more defence jobs, more defence apprenticeships in every region and nation across the UK … will save the taxpayer at least £10 billion over the next decade, savings that we would reinvest directly into Britain's defence.* (Rt Hon John Healey, Secretary of State for Defence, 2025)

The context of the interviews

The objectives of the interviews are firstly, to provide triangulation between the analysis of successive editions of DIS covered in Chapters 4 and 5 with the case study finding in Chapter 6. Secondly, elite interviews have the potential to add texture and thus deeper understanding of the way in which successive editions of DIS have been instrumental in achieving improved project outcomes. The findings in this chapter are based on twenty elite interviews where the subjects have been selected to avoid sampling bias. The subjects consisted of ten current or former CEO-level industrialists, one former Minister of Defence Procurement and nine senior, current or former MOD officials at 2-star level and above with either policy or procurement backgrounds. Both cohorts were selected based on a lengthy career, together spanning as much of the research period as possible. The industrialists all have experience as MOD suppliers at prime contractor level and, as OEMs in the supply chain, are collectively representative of the range of firms operating in the UK defence market which includes indigenous companies, inward investors and offshore suppliers.

The interviews were conducted either face-to-face or using Microsoft Teams and were semi-structured around a previously submitted list of questions aimed at illuminating the research hypotheses. Initial transcription was conducted using the AI tool Cockatoo[3] followed by a manual comparison with the original sound recording to produce an intelligent transcription. The initial qualitive coding frame was deductive, based on the data that needed to emerge to validate the hypotheses. This was subsequently combined with an inductive approach as further themes and codes were identified that proved valuable in enriching the interpretation of the data. Coding and initial thematic analysis was conducted using the AI tool Delve[4]. The ethical approach to the research was approved at departmental level. Industrialists are generally subject to confidentiality agreements with their firms: a similar stricture applies to some civil servants. Most interviewees therefore opted to participate unattributably: to avoid the risk of inadvertent identification, it therefore seemed appropriate to treat the small remaining minority in the same way. Hence names of all interviewees are withheld in the text by mutual consent with footnotes recording when the interview took place.

[3] www.cockatoo.com
[4] https://delvetool.com

Addressing the risk of bias in the interviews

The taxonomy of biases associated with qualitative interviews across social science is highly context dependent but four types are deemed to be relevant to this elite interview process: sampling bias**,** interviewer bias, recall bias, and confirmation bias (CASP, 2025, paras. 7-12; Johnson and Reynolds, 2005, pp. 290-294). On sampling bias, given the imperfect nature of the defence market and the vagaries of the procurement ecosystem, this sample might exclude those who left the sector through valid disenchantment. Equally, some of those who remain might simply have become inured to the situation. While either case is possible, long service in the defence industry accompanied by high levels of professionalism is the norm. With a UK defence industry mean salary in 2022 of £50,795 against a manufacturing mean of £32,553 and with 20% of the roles in research and development, often at the leading edge of technology, the defence industry is regarded as an attractive sector (ADS, 2024b, JedHub, 2024). Retention is also assisted by the altruistic notion of contributing to the support of the UK's armed forces. By comparison, DE&S is an arms' length body of the MOD with additional freedoms on workforce management including remuneration so that salaries are more competitive with the private sector than would be the case in the mainstream civil service. The mean salary in the median quartile is £42,218 (MOD, 2024b, p.91). However, there is a high staff turnover of some 10% overall with salaries for lawyers and commercial specialists uncompetitive with the private sector (Parliament, House of Commons, 2023a, para.93). But there is also a similar altruistic motivation amongst most DE&S staff. The latter aspect also applies to long-serving civil servants who, even in retirement, remain dispassionately critical of the governments that they served: three of this cohort have published academic analysis of defence policy management. It is therefore assessed that there is limited risk of sampling bias.

Interviewer bias was addressed using a standardised question list provided in advance based on the same analytical framework applied to the DIS documentation in Chapters 4 and 5 and to the case studies in Chapter 6: example question lists are at Appendix D. Interviewees were also provided with the research background information sheet as submitted for departmental ethical clearance. This same document also proved useful alongside the question list in addressing recall bias. Most interviewees had made notes to assist them during interviews and were not reticent to admit either being unable to remember or that they were not involved in a particular issue at the time. Subsequently, triangulation proved effective during analysis in resolving any distortions or discrepancies. Confirmation bias occurs when sub-consciously placing greater significance on interviewees' comments that support the research hypotheses but is distinct from deliberate deception by the interviewer. To guard against this bias, all interviews were recorded, initially transcribed verbatim before comparison with the original sound recording to produce an intelligent

transcription. Subsequent analysis tested perceived conclusions against textual evidence to identify and eradicate confirmation bias.

DIS as a concept

In meeting the requirements of the extant defence industrial policy, successive editions of DIS have sought to manage the tension between procuring the right military equipment on time at acceptable value for money whilst also seeking to sustain the onshore defence industrial base commensurate with the nation's perceived future needs. The MOD's intent is therefore to describe in a DIS the route towards the creation of a defence market configured to incentivise participating defence firms to bid for contracts, requiring the delivery of equipment on time, within budget and at the selected level of technology. The interviews reveal that there is common ground between government and industry in recognising that, to achieve its objective, a DIS would also need to provide evidence of its ability to implement the strategy in four areas. First, it needs to define those military capabilities that it determines as sovereign such that the relevant intellectual property and it associated manufacturing know-how resides onshore. In parallel, it needs to determine those additional capabilities that contribute to operational independence by permitting the insertion of urgent upgrades or the replenishment of stocks during combat. Secondly, it should provide guidance on the future technologies that it perceives as being core to future capabilities alongside details of how associated research and development is to be funded. Thirdly, for each type of equipment, the strategy should be clear on its preferred routes to contract across the spectrum from open competition on the global market to single-source procurement potentially accompanied by partnering agreements. In so doing, it should explain how the criteria on assessing value for money should be applied. Fourthly, a DIS would need to generate confidence amongst suppliers that MOD's forecasts of future capability and its affordability are robust. The sub-sector strategies for shipbuilding in 2017 and combat air in 2018 have assisted by adding enhanced granularity. This chapter analyses interviewees' perceptions on each of these facets.

In terms of broader DIS characteristics the interviews reveal that, while priorities and emphasis vary between government and industry, there is commonality on the core issues. The most prevalent comment within each cohort concerned the clarity and stability of the MOD's intent but with differing views on the optimum strategic horizon. MOD (officials A, B, C, E, G, J) sees DIS as providing high-level guidance to industry where clarity, transparency and certainty are necessarily constrained by three factors: economic unpredictability; the lack of consensus within Whitehall (not least with the Treasury); and the limitation on political horizons arising out of the electoral cycle. As a former MOD procurement official (E) put it, "So, I think government still shoots itself in

the foot in terms of short-term programmes and a lack of certainty"[5]. Likewise, industry was emphatic (industrialists M, N, O, Q, R, S) on the need for strategic foresight well beyond the normal political horizon to inform business planning but also to ensure that government recognises where critical skills and industrial capacity need to be preserved. Reflecting also the views of industrialist L, industrialist M said:

> It's not unreasonable to look at, for example the *[redacted]* business and say I know what that business is going to be doing in 2050 based on today's perspectives and it gives you a basis for planning. And although in five years' time that might look slightly different, update it in five years' time, but at least give you best view today on something that might be happening in 25 or 30 years' time, given the longevity of the programmes, given the need for the retention of skills and capability to keep those programs alive[6].

That said, there was a majority view in both cohorts, notably reflected by current Industrialist S and current official H that, given the changed global security situation, procurement agility was also increasingly important. In addition, while there was common ground that effective and genuine collaboration with industry was beneficial, neither side underestimated the challenge in putting the initiative into practice. As one former official (C) described:

> I've heard it a thousand times. "We will commit to strengthening partnerships with the industry that's the way forward to do it." People are very happy to write that. But then it's a behavioural thing, isn't it? Are people really going to follow that through? Are they going to be prepared to have the frank conversations rather than the superficial conversations? So, I used to be very frustrated[7].

This aspect suggests the need for deeper investigation into the relevance of DIS to procurement processes, particularly at the contracting interface. A related theme is the degree to which DIS represents a living strategy and penetrates down to the procurement coalface with sufficient authority to influence behaviours and working practices. Expressing frustration on these points, a current official (H) stated that, "These can't be things that get put on the shelf. And that is a classic civil service response. I've written that strategy now it's on the shelf"[8]. While agreeing with this syndrome, former official B pointed to a cultural barrier among some staff of "I know my job, I know

[5] Interview with procurement executive E, 14 May 2024.
[6] Interview with former industrialist M, 8 July 2024.
[7] Interview with former official C 31 Jan 2024.
[8] Interview with current official H, 22 March 2024.

how I do it, I'm going to carry on"[9]. As a result, interview perspectives on the impact of DIS on procurement processes and the penetration of DIS are also examined in this chapter.

Sovereign capability and operational independence

There was a convergence of view among interviewees that the principles behind sovereign capability had been ill-defined until the clarity provided by DSIS 2021. Until that point, officials felt that the concept was too narrowly drawn (A, B, and I) whereas industrialists (L, Q, and R) looked for an approach that provided a direct linkage to procurement actions and to the implications for sustainability of the defence industrial base. SDR 1998 did not address this subject, merely restricting consideration to a single statement on security of supply in the context of the perceived need to restructure the UK defence industry. Under the principle of 'appropriate sovereignty', DIS 2005 recognised the need to distinguish between sovereign capability and operational independence thus reflecting the lessons from the 2003 Iraq War when operational stock levels were not aligned to the planning assumptions on readiness and sustainability (MOD, 2003b, p.6). Thereafter, DIS 2012 took a minimalist approach based on operational advantage and freedom of action but modified by the principle of 'technology advantage', a framework which practitioners found to be over-complex in its application. DSIS 2021 provided a pragmatic determination of sovereign capability as those aspects and associated intellectual property that needs to be retained onshore because of legal constraints on offshore acquisition. It further defined capabilities required for operational independence as those necessary to represent a hedge against political interference from other nations. Despite this progression, there was convergence among interviewees that there remained a failure to recognise the linkage between sovereign capability and its impact on investment. One former official (B) explained that "the Treasury did not recognise the aerospace industry as one that we should be seeking to maintain as a national capability"[10]. Also, in reflecting a common view among industry colleagues, an interviewee pointed to the then Treasury default position that:

> … "we wouldn't want to bias anything towards the UK for anything, because that would skew the open market, which we believe in." Not quite getting the fact that everybody else plays a slightly different game and therefore we are being disadvantaged in the UK.[11]

Instability in the designation and funding of both sovereign and independent capability was also seen by both cohorts as having implications for the effective development of skills and the

[9] Interview with former official B, 8 Jan 2024.
[10] Interview with former official B, 8 Jan 2024.
[11] Interview with current industrialist Q, 7 Jun 2024.

preservation of tacit knowledge involved in high-end engineering. As a former minister (F) explained:

> I saw David Cameron separately, and he told me, "by the way, you were absolutely right about defence skills and technology, I hadn't appreciated it." So, it was not understood. And perhaps the MOD has been bad at telling its story there[12].

In the same vein, a current official (H) who had extensive experience in both government and industry highlighted the critical co-dependency on stewarding the unique skills that exists between the MOD and industry, but which largely goes unrecognised. Yet this industrial know-how is not only critical to indigenous projects but also to those that involve international collaboration where there is a need to bring government technical expertise to the table. Industrialists N, Q and U also advanced a view that a more systematic and transparent approach to requirements for onshore capabilities would assist in the recruiting and retention of young engineers. On the relationship between offshore procurement and operational independence, officials A, I and J saw the clear need for access to the core intellectual property through which to support and upgrade equipment during operations without external support. But access alone was not seen as sufficient: rather, industry needed to be able to manage and sustain such technology and software.[13] While industrialist saw unambiguous signals on operational independence as giving them confidence to invest, they recognised that the MOD had little understanding of the challenge to industry in being asked to surge production with limited notice. Industrialists also drew comparisons with other nations that have similar requirements to those of the UK but where there is more direct collaboration between government and industry. Sweden was cited favourably for its policy of determining its 'Vital National Interests' leading to the indigenous production of fighter aircraft and submarines.[14] Israel was also seen as having a particularly successful model involving light touch government contractual oversight whereby industry develops the capability within a particular equipment to the 80% level followed by co-development up to 90 or 95%: "in UK MOD, that just doesn't happen. It's got to be 100%.[15]

This latter point also arose among industrialists (L, P and Q) in highlighting the slow and bureaucratic procurement processes which led to delays in decisions-making on sovereign capabilities or those designated as being ingredients of operational independence. Citing a future

[12] Interview with former minister F, 27 May 2024
[13] Interview with former official A, 20 March 2024.
[14] Interview with current industrialist T, 4 November 2024
[15] Interview with current industrialist R, 5 July 2024

helicopter requirement, industrialist Q pointed out that the MOD initiated the project in 2021 with an ultimate deadline for responses to the invitation to negotiate of mid-2024. During this period,

> Poland came to us two years after the UK with almost exactly the same requirements set. They did their due diligence, decided to go ahead with the AW149 with roughly the same number, roughly the same money, roughly the same capability. It was on contract within six months. Those aircraft are now on the [Polish] front line[16].

In summary, both cohorts were clear that that the designation of capabilities as sovereign or as contributing operational independence was a key elements of a DIS. This approach was deemed to represent the bedrock of the UK's national resilience when on operations, to contribute to the credibility of conventional deterrence in the eyes of potential adversaries and to set the baseline requirements for a sustainable industrial base. It is thus of importance that both these classes of onshore capability should be accurate, consistent and realistic in their definition. As such, they represent significant indicators to industry on where to invest but also require active management of the required industrial skills. Until DSIS 2021, the MOD approach had lacked precision of analysis and realism in determining the onshore requirement and has been further hampered by its slow and bureaucratic procurement process.

Future core technologies

In terms of the clarity with which DIS had conveyed priorities for future technologies and their funding, there was a consensus that it had been of limited effectiveness. The partial exception was DIS 2005 which was rich in detail but over-ambitious on the number of technologies that it catalogued (and hence their development costs) as representing future requirements. More broadly, industrialists L, O and P were critical of the lack of strategic precision in the treatment of technology in that classifications were largely generic. Also, the ends, ways and means equilibrium was variable in that there were rarely detailed roadmaps to demonstrate how technology would be related to specific capability alongside the level of investment required at each stage. In addition, there was industrial concern (supported by S), that much of the technical and integration risk that ultimately manifests in major projects has its roots in poor early years' analysis of the maturity of technology and the subsequent limitations on investment.[17] In this latter respect there was consensus across both cohorts that there needed to be a more transparent rationale over the way in which the development of nascent technologies is deemed to meet a sovereign requirement. In aerospace, given the level of offshore procurement, "freedom to modify" ought to be the key

[16] Interview with current industrialist Q, 7 June 2024
[17] Interview with former industrialist N, 24 June 2024

criterion over ownership of intellectual property[18], a view strongly supported by official J in reflecting his experience from a secondment to Australia. While the situation improved after 2017 following the introduction of sub-sector strategies and with the publication in 2020 of the MOD Science and Technology Strategy (MOD, 2020d), interviewee I pointed out that there was an overall absence of global technology scanning through which to contextualise the UK approach and to learn from others. A key lesson would have been the value of prototypes and technology demonstrators as the tool by which to pull-through nascent technology to the front-line. As a senior MOD scientist pointed out:

> A lot of the world-class research that occurs in the UK, typically in the academic base: if we're going to stand a chance of pulling that through into product, then we've got to address that kind of middle ground of prototype development activity and get serious about funding[19].

By 'serious', he was referring to stability in MOD funding rather than the current 'kangaroo' approach of stop-start investment and cited the Future Offensive Air System and the Deep and Persistent Offensive Air Capability as examples of research programmes did not realise their full potential. This aspect reflects a continuous debate in MOD over the affordability and balance of investment of scarce resources between basic (or blue skies) research and experimental development. MOD scientists point out that the "capability developments that were in train today could be traced back to pure science that had been studied 20 years ago."[20] There were also comments highlighting differences between government and industry on who should fund product-related research and development. The Gray Review of Acquisition (2009) pointed out that:

> The department recognised that self-financed R&D in the defence sector is currently far less than in the civil sector and the MoD should be looking to industry for more support. It is accepted that industrial investment in defence R&D might be more difficult during the more inventive concept stage, albeit potentially very lucrative, but industry was expected to be more involved with the less risky applied development and demonstration stages (Gray, 2009, p.76).

MOD retain the erroneous view that, in a globalised defence marked, potential demand for a successful product would be sufficient to merit industry investing its shareholders' funds in the

[18] Interview with current industrialist T, 4 November 2024
[19] Interview with current official I, 5 February 2024
[20] Interview with current former official D, 28 February 2024

development of such a project.[21] As an example of the implausibility of this perception, in 2011 the development cost of Eurofighter Typhoon was £6.7 billion (£11.5 billion at 2025 prices) which was twice the original estimate (NAO, 2011c, p.7). Much of this investment was focused on Gray's perceived "less risky applied development and demonstration stages" and which is actually where the significant technological and commercial risk becomes manifest. It is thus inconceivable that shareholders would accept such levels of speculative private venture investment (industrialist N). More broadly, it seems that such spending on future technology was usually afforded low priority in MOD and was unpopular across Whitehall, particularly with the Treasury. A key aim of DIS 2005 was to give industry sufficient information on the MOD's future plans so that they would be more prepared to invest in R&D and infrastructure. But the "Treasury saw that as 'locking-in' the defence plans in a way that they regarded as likely to give them public expenditure problems."[22] As a former minister (F) explained about DIS 2012:

> I think the Treasury's hostility to the MOD was crucial here. I remember particularly that there was an extraordinary counter to defence science spending. There was a real sense that it was a luxury, we could do without, which horrified me.[23]

Offshore firms regarded the UK as a valuable location in which to develop their core intellectual property as described by an industrialist from a major inward investor: "put a UK flag around it, start to develop here, build up a UK team and then we can actually export it"[24], a sentiment also reflected by industrialists S and T. Again, this approach calls for transparency over MOD's plans from which to assess opportunities for co-investment. Over the period of this research, there has been a reduction in the number of core MOD science staff resulting from the privatisation in 2001 of the Defence Evaluation and Research Agency leading to the creation of QinetiQ. in parallel, increased amounts of research were contracted-out to industry and academia from the emergent Defence Science and Technology Laboratory. There has thus been an attempt over the past decade to preserve the MOD's intelligent customer capability rather than maintain deep subject matter expertise across a wide range of disciplines. Expertise as an intelligent customer is important in assessing the merits of collaborative approaches between government and industry on the early technology maturation on major projects. In this respect, the sub-sector strategies were seen as a particular success given that they mostly went into greater detail on the development and funding of key technologies in a way that was relevant to a cluster of projects (officials A, E: industrialists S,

[21] Interview with current official H, 22 March 2024
[22] Interview with former official C, 31 January 2024
[23] Interview with former minister F, 27 May 24
[24] Interview with current industrialist R, 5 July 2024

N). A notable success arising from the *Combat Air Strategy* (MOD, 2018b) was achieved under the Team Tempest arrangements. It proved possible to create the conditions to couple the plans for technology investment of four major defence firms (BAE Systems, Rolls Royce, Leonardo and MBDA) over the following decade to align with MOD's funding based on a set of shared objectives.[25]

Overall, the sustainability of the UK's industrial base with the capacity to produce sovereign capability and operational independence relies on the generation of onshore intellectual property that leads to the creation of battle-winning equipment. The Team Tempest approach is a good example. But the bold ambitions often articulated in a DIS are unmatched by the necessary political will and resources given that systems integration is challenging with the attendant need for risk reduction through technology demonstrators and prototyping.

Routes to contract and partnering

Determining the route to contract is rarely a linear process. Rather, trade-offs between cost, time and capability are usually required to achieve the optimum outcome. MOD also needs to take a long-term view on whether the aggregate volume of onshore equipment contracts over time would be sufficient to sustain the UK defence industrial base. It was notable that there was a strong consensus among interviewees on the theoretical advantages of partnering. But there was also recognition that, in practice, there were barriers to successful implementation which were not addressed in successive editions of DIS beyond vague comments on collaborative behaviours. As a result, this section covers the analysis of the process aspects of partnering while the cultural aspects and their impact on broader procurement follow in a subsequent section.

Sixteen interviewees supported the general view that partnering represented a catalyst for improved procurement performance in that "the closer that industry and MOD are together, the more success we will have" with industrialist Q pointing to the mutual coherence exemplified by the French procurement enterprise.[26] The remaining interviewees expressed some interesting nuances based on specific personal experiences. Industrialist O had been involved in a European collaborative procurement of the A-400M Atlas airlifter where the partnering relationship suffered markedly because of poor industrial project management resulting in excessive delivery delay. However, the subsequent UK arrangement for logistic support "has really come on in terms of the partnering concept at an operational support level and I think that it is very successful within the constraints of the contract"[27]. Official C recognised that success lay in being willing to have difficult

[25] Interview with current official I, 5 February 2024
[26] Interview with current industrialist Q, 7 June 2024
[27] Interview with current industrialist O, 30 April 2024

conversations across the negotiating table while official E pointed to a legacy of mistrust of partnership arrangements created by his predecessor who had occupied the same senior procurement executive role. Industrialist U saw partnerships as being driven more by the need to preserve industrial expertise rather than being aimed at improving relationships. More positively, industrialist N highlighted that partnering had stimulated improved sharing of information such that problems were resolved in discussion rather than by reaching for a copy of the contract. Industrialist R cited the example of the collocation of industry and MOD helicopter teams in the AgustaWestland factory as an effective way of building a shared sense of mission[28]. Industrialists also recognised that greater openness led to an increased willingness to share risk and embed improvements through learning from experience[29]. There were also other comments from both cohorts on overcoming the cultural challenge such as:

> We weren't practiced at being relationship people. And that went for either side. So, a lot of our learning at the start was actually in developing non-transactional ways of doing business, but relational ways of doing business … industry responded with the same behaviour, positive reinforcing behaviour[30].

However, such sentiments on culture were not universal. Given the stovepiped nature of the procurement organisation, there was a recognition that lessons arising from existing partnerships did not permeate across internal boundaries allowing irritants to arise which added to a sense of mistrust[31]. Both industry and MOD were faced with the challenge of adapting to new arrangements in areas such as joint access to intellectual property and increased focus on the robustness of supply chains[32]. Some saw the understanding of partnerships as being slow to build with variation in the expectations of both sides. According to official H who was engaged in surging industrial support for Ukraine, "partnership has not manifested itself in a post-Ukraine world … somehow the partnership is still not right"[33]. A former minister (F) agreed with industrialist N and Q that further barriers arise from delays in MOD decision-making which generate tension in the partnership and leads to increased costs for industry. Budgetary tension was also seen as undermining the stability of MOD's partnerships. Reflecting on the early challenges, an official with much experience in authoring industrial policy considered that, at the outset, the MOD was overly constrained by the current competitive model and that the subsequent lack of continuity of staff hampered progress

[28] Interview with current industrialist R, 5 July 2024
[29] Interview with former industrialist N, 24 June 2024
[30] Interview with current official I, 5 February 2024
[31] Interview with former official C, 31 January 2024
[32] Interview with former official J, 20 March 2024
[33] Interview with current official H, 22 March 2024

in building partnerships. Official B who had also been closely involved with the development of DIS felt that procurement process had been slow to change over the past 20 years:

> " … you would be forgiven for thinking that the world had stopped. There's been a tendency for the political and financial cycle to, as it were, demand results and changes faster than can ever be reasonably delivered[34].

There was recognition (official B and industrialist S) that partnering had become more complicated over the past two decades because of the increased interdependencies between MOD and industry. Reflecting a widely held view in the trade association, industrialist L considered that DIS needs to be more explicit on the conduct of partnerships such that the focus is placed on long-term outcomes and less on immediate contractual benefits. However, interviewees accepted that strong leadership will be required to eradicate the lingering cultural narrative within the MOD that emphasises a combative stance towards industry rather than one of collaboration. Officials (C, D, E and H) reinforced that the Minister Defence Procurement has a pivotal role to play in investing personal time and effort to effect change. Of the 18 incumbents of that ministerial portfolio during the 25-year period of this research, only six spent two years or more in post. As one official lamented:

> They change too quickly … you can't be the Minister of Defence Procurement for a year because if you are, you never get beyond the superficial narrative that says, "we'd like a much stronger partnership with you" because you never do the apprenticeship[35].

In sum, the creation of a partnering agreement required the consolidation of multiple contracts from a range of suppliers into a single document with a prime contractor who was therefore accepting substantial risk transfer. In the case of the original 2006 Tornado Phase 1 partnership with BAE Systems, 70 contracts were consolidated into a single umbrella contract (NAO, 2007a). Whereas partnering is seen to have long-term benefits in terms of improved equipment capability at lower costs, barriers to effective collaboration existed because of commercial complexity and an embedded adversarial culture between MOD and industry generated as the result of a long tradition of competitive procurement, an aspect that is explored in a subsequent section.

[34] Interview with former official B, 8 January 2024
[35] Interview with former official C, 31 January 2024

DIS and the financial control of the equipment budget

In achieving the objectives or 'ends' of a DIS, the elements comprising the 'ways' and 'means' must be plausible in their ability to achieve the effect required of them. Finance is a salient ingredient in both categories. Implementing a DIS itself does not make a significant call on budgetary resources other than perhaps investment in research programmes or skills initiatives. However, a fully funded and stable equipment plan (typically some £305 billion over 10 years (NAO, 2023)) is the key stimulus for the industrial activity that the strategy is seeking to manage. But, as Gray (2009) points out, the creation of the plan "is dominated by a 'bottom up' aggregation process, which makes it hard for 'top down' strategic guidance to control the balance of investment (Gray, 2009. p.6). Nevertheless, the required strategic outcomes are the delivery of sovereign capability, the maintenance of operational independence, the exploitation of technology and the sustainment of the industrial base. The analysis in Chapters 4 and 5 identified that the objectives in successive editions of DIS have not been harmonised effectively with the funding available in the equipment plan. Rather, the strategies have been over-ambitious and thus subject to dilution in the face of budgetary tension, an outcome that undermines the credibility of a DIS and thus adversely affects industry's confidence in the strategy. The analysis of the interviews therefore seeks to determine the initial plausibility of DIS from a financial perspective in building confidence in the MOD's ability to implement the strategy. It also examines the causes of subsequent turbulence in the equipment plan and their impact in frustrating the implementation of DIS. Taken together, these aspects condition industry's assessment of the risks in treating DIS as a guide to their investment or in pursuing a partnering approach with MOD.

In terms of a DIS portraying a pragmatic balance between its aspirations and the required programmatic fuel in the equipment plan, DIS 2005 was criticised for its lack of realism. While appreciated for its attempt at analysis of future capability requirements, it omitted any financial data by which to generate confidence that its objectives were deliverable. A former senior procurement official pointed out that in DIS 2005, "the long-term commitment was never there, and industry then get frustrated with the MOD because there's nothing to sell the shareholders and the investors"[36]. Interviewees (minister F: officials A, B, D, E: and industrialists M, O, Q, T) pointed to inherent Treasury inflexibility and adverse influence in holding-back on DIS financial data that would be useful to industry whether from a doctrinal objection to skewing an open market of from the simple wish to avoid becoming hemmed-in by MOD undertakings to industry. An official involved at the time in the creation of DIS 2005 recalled:

[36] Interview with former senior MOD official, 14 Mar 2024.

> … there was a big debate with the Treasury over how much detail you could go into in presenting a 10-year view of the future equipment plan … the Treasury saw that as locking the defence plans in a way that they regarded as likely to give them public expenditure problems.[37]

A former minister (F) was clear that the same notion applied to later editions of DIS:

> The Treasury said other parts of the government were not allowed to use the word strategy at all … I think the Treasury's hostility to the MOD was crucial here. It had a real, deeply seated and probably well-founded suspicion of what the MOD did, and that was a key aspect[38].

DIS confirmation of a continuous funding stream (or pipeline) for major capabilities is a prime aspect for industry. An industrialist cited airborne radar as an example where there are multiple platform applications with an obvious technological pathway to performance improvements. He therefore placed importance on "having a basis for planning and a basis for understanding how the pipeline will be managed [which] allows you to make the investment decisions - which might also be divestment"[39]. In this case, the lack of confidence generated by DIS meant that rapid divestment of a UK defence electronics capability was the result (industrialist M). Uncertainty over commitment to long-term funding coupled with an MOD culture wedded to the short-term advantages inherent in competitive tendering were seen as having "damaging consequences downstream"[40]. There was also recognition (officials A, B, I: industrialist U) that only DSIS 2021 provided a robust definition of value-for-money. Previous editions of DIS were seen as having left the concept undefined (industrialists N, O, P: minister F) or, as in the case of the narrow definition in DIS 2012, as undermining confidence and proving to be a disincentive to industry to invest.

An important response in DIS 2012 to industry's criticisms over lack of financial granularity was a new initiative to publish the previously confidential annual Defence Equipment Plan. Ministers regarded this as "a significant achievement" (MOD, 2012b, p.6). Issued annually from 2012 (though not in 2023 or 2024 for reasons of internal MOD financial turbulence), the plan was aimed at demonstrating "its affordability and deliverability, and to give the defence industry more information on which to plan for the future" (MOD, 2013a). However, while it describes the funded plan, in any one issue, around 50% of the projects will already be on contract, and the remainder

[37] Interview with former official D, 28 February 2024
[38] Interview with former minister F, 27 May 2024
[39] Interview with former industrialist M, 8 July 2024
[40] Interview with current industrialist Q, 7 June 2024

would be set to change from year-to-year. Hence, publication of the equipment plan does not fulfil the requirements of strategic investment tool for industry: none of the interviewees suggested that it did so.

Implementation of a DIS is also adversely affected by downstream turbulence in the equipment plan which leads to reduced aspirations in individual programmes or sub-sectors. It seemed that officials were inclined to be complacent over the impact on industry's morale and their confidence in MOD's ability to deliver a robust equipment plan. One official (A) who had held extensive financial responsibility subsequently stated that there was a clear need for government to recognise:

> … the vital importance of being stable and reliable and predictable about what the requirement was and the timescales for the requirement, quantities, all that stuff … I only, when I went into the private sector, understood just how damaging it was to find your plans that you'd agreed with the MOD suddenly got changed at short notice. And we never understood or appreciated sufficiently just how much damage and effect that had on industry's performance, let alone the individual morale thing. Its ability to actually absorb it. We always thought they had deeper pockets than me[41].

There was agreement between cohorts that DIS would achieve only limited traction until the causes of the turbulence in the equipment plan were fully addressed. Three elements emerged in the interviews as the core issues: accounting annualarity; immature estimates of cost and time; and optimism bias which is addressed later in this chapter. First, the public accounting conventions of annualarity and minimal year-end capital carry-over meant that in-year budget reprofiling to generate financial headroom was the norm resulting in project delivery delays and hence cost growth (officials B, C, E, H). A senior procurement official likened it to an earlier problem facing Highways England and the road-building programme which was addressed through changes to their financial rules:

> They get basically a moving four-year window which allows some flexibility to roll over cash or overspend in-year if the broader departmental budget allows it. But you can't run a 10-year programme on an annual cycle. Well, you can but it's suboptimal[42]

[41] Interview with former official A, 14 March 2024
[42] Interview with former official E, 14 March 2024

He felt that the solution for MOD lay in similar multi-year funding arrangements such as that applying to Highways England through the five-year 'Road Investment Periods'[43] (DfT, 2020). However, former minister (F) and some officials (A, B, D) doubted that the Treasury could be convinced to provide MOD with such freedom. Secondly, a former minister (F) and officials (D, E, F, H) recognised that the requirement to secure a funding line in the normally overheated and always competitive equipment plan meant that initial estimates of limited validity were entered into the plan which then afforded them an assumed robustness that was not merited. In major projects, this approach led to cost growth and schedule delay as understanding matured and risks materialised[44]. Such outcomes call into question the effectiveness of the Assessment Phase in understanding engineering complexity and integration risk[45]. As a former senior procurement official pointed out when reflecting on his experience of appearing in front of the Public Accounts Committee, such committees rarely understand the uncertainty involved in the integration challenge associated with leading-edge technology. But, he considered, "it seems odd in our system that we ask a project leader to tell us, 'how much and when' with a project that is at a very immature stage." That gives select committees the ammunition to say, "it's all about you and your optimism bias." Whereas there must be a better way of setting the original benchmark because select committees pick the pre-initial gate estimates and then compare them with the main gate figure and draw a damming conclusion. "But the whole point in doing an assessment phase so that you actually know what the cost is going to be." They then lay the challenge that "we should have got the cost right at the beginning of the assessment phase but at that stage I haven't even engaged industry."[46]

Overall, interviewees felt that the norm in DIS (except for some elements of DSIS 2021) was to convey plans that were over-ambitious given the financial context within which they were formulated and implemented. They thus lacked resilience when the financial environment changed. In effect, "You can't have a defence industrial strategy, which says we're going to do everything and be good at everything and have future requirements and capability for everything"[47] This approach generated downstream turbulence in the equipment plan. The credibility of DIS was thus diminished and industry's confidence undermined.

The impact of organisational culture on the implementation of DIS

Beyond the challenge of aligning the prevalent cultures in MOD and industry towards creating successful partnerships, interviewees on both sides pointed to other culturally driven behavioural

[43] Interview with former official E, 14 March 2024.
[44] Interview with current official I, 5 February 2024.
[45] Interview with former industrialist M, 8 July 2024.
[46] Interview with former official E, 14 March 2024.
[47] Interview with current industrialist S, 11 June 2024

aspects that affected a collaborative approach to project delivery. Three aspects were prominent: cognitive biases; inherent mistrust; and acceptance of accountability. On cognitive biases, NAO and select committee criticism in scrutinising MOD's annual equipment plan has long pointed to continuing evidence of optimism bias. In common with the interviewees, the term is used in such reports as a blanket description of the range of biases described in Chapter 3. (Parliament, House of Commons, 2024, p.3).

Optimism bias

The prevalence of optimism bias attracted much comment (officials B C, D, H, J and industrialists L, T, N, Q) and was seen as a key factor in generating turbulence in the equipment plan. Comments from both cohorts were commonplace such as "people overestimate their own capabilities to deal with difficult problems" and "bury their doubts to say that things will be done quicker than they secretly suspect that they will be."[48] But there was also recognition that defence equipment projects are highly complex with multiple dependencies and numerous interfaces which militate against certainty in assessing time and cost in the early stages. Nevertheless, there is seemingly often political pressure:

> "because ministers want to announce that [project] – 'we can't say it won't enter service for another X years, we'll be laughed at…' So, I think there are very strong incentives towards optimism bias in the system and that was always recognised."[49]

Yet a former minister (F) added that "overheating of the programme is ridiculous. Optimism bias leads to this extraordinary overrun of your programmes and is still a real problem"[50]. Across all interviewees, only one official raised the notion of a 'conspiracy of optimism' stating that:

> But then there is the so-called conspiracy of optimism. I'm sure that that is a real thing. That the senior heads of services, senior military officers want to get a particular capability in place. The politicians want to be able to make positive announcements. Industry wants the contracts. So, there's not enough weight on the other side of the scales.[51]

While this may be a pervasive phenomenon, it is doubtful that it represents a true conspiracy. Each of those stakeholders undoubtedly has an individual motivation towards optimism bias but whether this is manifest as an orchestrated collusion is debatable and is not supported by evidence

[48] Interview with former official B, 8 January 2024.
[49] Interview with former official B, 8 January 2024.
[50] Interview with former minister F, 27 May 2024
[51] Interview with former official D, 28 February 2024.

elsewhere in the interviews. However, there was evidence of financial optimism bias cited by an industrialist and supported by others:

> The habit of the financial planners taking P50 estimates [just as likely to cost more as the likelihood of costing less] as something akin to a P90 estimates [near certainty]. I mean it's brutal and it's political. It's the only way to get the money for their project but all they do is create a problem five or ten years down the line where the truth will out.[52]

Industrialist N pointed out that the sophistication of project modelling tools used by defence firms have advanced markedly over recent years but there were still instances of optimism bias over assumption on the performance and capacity of supply chains. Likewise, prime contractors with a portfolio of contracts underway were deemed to exhibit optimism bias over the ease with which they could generate sufficient scarce specialist personnel (such as systems engineers) and move them between projects as needs arise and priorities change.[53] Even if finance were to be available within the overall business plan, successful recruiting from a small pool in a competitive field might not be possible. There was considerable common ground between both cohorts over the complexity of capitalising on leading edge technology in terms of integration risk and the inherent difficulty in forecasting performance and cost. This aspect is rarely given emphasis in a DIS. A striking example on combat aircraft again referred to Team Tempest:

> What do I think it costs to develop a full-up, multifunctional, electronically scanned radar, then integrate that into a signature-controlled asset that's got to fly 8,000 hours then fuse the terabits of data coming off the radar and process it in a way that's meaningful for a single occupant in the front seat. If you haven't done prototype development activity on the complex subsystems and their integration, then you have no reference class for how much that is going to cost. And that's a real problem.[54]

The 'problem' is that optimism bias is dominant in forecasting unrealistic time and cost outcomes driven by the need to secure a funding line in the already overheated equipment programme. Further comments (minister F: industrialists N, O, Q, S, U: officials B, I) pointed to disruption in the affordability of the equipment plan caused by optimism bias and inadequate contract risk management. These aspects divert attention from the strategic to the tactical level given the need to find rapid financial solutions. Equally, sub-optimal procurement process outcomes, particularly

[52] Interview with current industrialist L, 12 February 2024.
[53] Interview with former industrialist N, 24 June 2024.
[54] Interview with current official I, 5 February 2024

in time and cost, were also seen as diverting attention away from placing effort on implementing strategic change.

Inherent mistrust

As for the relationship between MOD and industry, an inherent sense of mistrust of industry was seen as driving the deeply embedded in MOD's preference for competitive processes over partnership or single-source procurement. There was also recognition that the rigorous discipline of competitive procurement militates against attention being afforded to other procurement approaches. As industrialist S put it, supported by comments from industrialists L, N, T, and officials F, H, J, "I think there was a saying which is that they'd rather have a competition than a programme, and that is not an unreasonable analysis of the circumstances."[55] Reflecting the views of other officials (E, I and J), official H saw the adversarial relationship arising out of competitive processes as the key driver of how MOD handle industry.[56] Despite a trend towards partnering, there were a number of views highlighting that mistrust of industry still exists in some parts of the procurement organisation and that, when problems arise, the culture of competition still runs deep (officials E and J; industrialist U). While some interviewees (mostly on the MOD side) felt that partnerships had seen the fostering of positive relationships (industrialist N and officials B, C, F), there was also a prevalent view among industrialists that industry is often not believed:

> I think there is huge mistrust of industry as well in certain quarters, particularly in DE&S. And a desire almost to see it as a competition, "we won, we got one over on you," rather than "how do we jointly get through this?"[57]

In commenting on this intractable nature of MOD culture, official H who had previously been a senior industrialist, corroborated this wider view:

> I think what we've done is we have a generation of officials in acquisition who have been told what good looks like and what good looks like to the department is trading away risk in inverted commas, demonstrating that they've hit industry over the head with a hammer and got a great deal in inverted commas. A real cultural narrative … it's inherent in their belief system that industry cannot be trusted … everything that industry does is to rip

[55] Interview with current industrialist S, 11 June 2024
[56] Interview with current official H, 22 March 2024.
[57] Interview with current industrialist R, 5 July 2024

you off and to do you over, you will see those behaviours manifest themselves as 'why would I not go to competition? … that's my only lever I've got to make them behave'.[58].

The result would be a reversion to a transactional customer-supplier relationship when negotiations became challenging thereby placing commercial interests above true collaboration.[59] By 2005 when DIS saw the launch of the first long-term partnering arrangement, the Levene reforms of 20 years before which introduced mandatory competitive tendering had become deeply embedded in MOD culture. The approach created a combative stance towards industry rather than a sense of collaboration which was hard to shift. There was seemingly a reticence on both sides to have the depth of frank discussion that was vital to achieving a more amenable approach.[60] Despite the recognition and long-term advantages of novel approaches such as partnership, until DSIS 2021, previous strategies remained wedded to competition as the bedrock of procurement. Unsurprisingly, this equivocal policy did little to alter the existing competitive culture in the delivery organisation (officials E, H and industrialist P). On a related point, citing Team Complex Weapons, a former minister underlined the advantages "where there are natural partners, the more collaborative the better."[61]

Commenting on relationship building across the contracting interface, a senior official who was also an accounting officer felt that "we should have been prepared to be much more disciplined with industry." But he also reflected that it was only after joining the private sector that he was able to recognise how little the MOD understood about the way in which the defence industry operated and the importance to industry of MOD's stability of intent.[62] Some felt that these adversarial behaviours were rooted in a lack of confidence amongst procurement staff because of low experience levels resulting in a reversion to the armour represented by process. A former official commenting on the lack of MOD expertise in classes of projects such as complex combat aircraft pointed out that "there are very few people left in UK government service who have done that."[63] Several comments pointed out that, while defence firms generally maintain a stable workforce where individuals build experience over a long career, the MOD suffers considerable personnel turbulence which is particularly apparent both at senior level and in mid-career (industrialists M, N, O, T, U, and officials A, B). There is thus a consequent evaporation of experience on how to tackle complex projects: as a former minister (F) pointed out:

[58] Interview with current official H, 22 March 2024
[59] Interview with current industrialist P, 25 January 2024
[60] Interview with former official C, 31 January 2024
[61] Interview with former minister F, 27 May 2024.
[62] Interview with former official A, 20 March 2024.
[63] Interview with former official J, 20 March 2024

> The lack of continuity of leadership: government, ministers, officials, SROs. There's a lack of stability in the system, which I think really does make things a little difficult … And that lack of continuity makes it easy for manipulative forces to twist things back, to change, or just to forget things, not to know things.[64]

In addition, a current procurement official was clear that, "We are significantly less rich in middle career people who will have cut their teeth on pretty complex stuff. Significantly less"[65]. Both perspectives have implications for nurturing collaborative relationships between MOD and industry based on mutual understanding and trust. This sense of under confidence was also seen as manifest in other cases where MOD appears reactive with a focus on short-term financial outcomes rather than on the long-term horizon inherent in strategic partnerships (officials B, E, H: industrialist Q). There was also the sense among industrialists (M, N, O, R, S) shared by two officials (B, J) that the lack of continuity and hence experience among MOD procurement staff meant that expertise had been replaced by process.

Accountability

There was limited comment from officials on accountability – a telling point - but industrialists raised several perspectives. One (T) felt that, in the mid-seniority levels of MOD, there was a degree of complacency evidenced by a reluctance to take ownership of problems to avoid censure if things were to go wrong: there was also a reluctance to hold major primes to account. The same industrialist contrasted operating in the UK with that in his firm's parent country. There was seemingly a cultural expectation in the UK that initial assessments of costs and timelines were bound to be wrong which acted as a barrier to acceptance of accountability.[66] Another (Q) pointed out that we can build "quite a lot of momentum right up to the point where it's somebody has to commit to something. And then they think, oh, can we get away with not doing this?"[67] Industrials M concurred, pointing out that, more broadly, inadequate project management militated against individuals accepting accountability.[68] The most telling point on the contrast in alignment of authority and accountability between MOD and industry came from a senior official and accounting officer who reflected:

[64] Interview with former minister F, 27 May 2024
[65] Interview with current official I, 5 February 2024.
[66] Interview with current industrialist T, 4 Nov 2024
[67] Interview with current industrialist Q, 7 June 2024
[68] Interview with former industrialist M, 8 July 2024

> I felt that there was a much greater sense of accountability in industry within the organisation. Single point accountability. In the civil service, we always managed to diffuse responsibility, because all sorts of people sat here, nobody quite knew who was really responsible for anything. And the budgets were equally opaque. I found in industry, that was much sharper and clearer. So, accountability is much more important[69].

Overall, interviewees expressed strongly held views on two MOD cultural biases that were considered to impact adversely on the adoption of DIS. Optimism bias was seen as undermining the robustness of project schedules and contributed to inadequate risk assessment which generated financial turbulence in the equipment plan. Secondly, the delivery organisation's cultural adherence to competitive procurement and the transactional mindset resulted in an adversarial relationship with industry which undermined trust and the virtues of collaboration which successive editions of DIS were seeking to promote. In addition, alignment of authority and accountability was tenuous and, at times, completely absent. Taken together, these aspects undermine the effectiveness of DIS implementation and lead to an overriding loss of industry's confidence in DIS as a reliable strategic planning tool.

Other systemic barriers to the adoption of DIS

Interviewees highlighted further issues that represent an unintended barrier to the implementation of DIS. As such, these issues do not represent an orchestrated resistance to DIS: rather, they generate a series of conditions that render implausible the implementation of some ingredients of DIS. For example, there were admissions on both sides over the lack of MOD understanding of how a defence business functions which, at times, was seen further to undermine trust and attenuate collaboration (industrialists M, N, U, and officials G, H, I). Another senior official with previous private sector experience lamented the lack of MOD understanding of the defence industry supply chains. Contrasting the UK's approach with that of France, they pointed out that:

> They have been having that interventionist approach for a lot longer, they have a much better understanding of their industry. So, they have the fidelity of their supply chain data is just streets ahead of where we are.[70]

There was also scepticism among both cohorts (industrialists P, Q: officials C, H) over whether the strategies ever penetrate to the individuals at the coalface of MOD's delivery organisation either because of inadequate initial promulgation or through being crowded out by day-to-day

[69] Interview with former official A, 20 March 2024.
[70] Interview with current official H, 22 March 2024.

procurement process. Some industrialists (L, N, T) pointed out that, at that level, the minutiae of project control and contract management can necessarily be so finely focused and time-consuming that little capacity remains for the adoption of DIS measures that do not seem immediately relevant.

In the same context, there was also comment from industrialists (N and S) that DIS does not absorb the lessons from previous procurement failures and thus undermines its credibility in that, "We have to do things differently to the way we have in the past if we want to make real change and to improve on what we currently do."[71] One official mentioned the difficulty in taking the through-life cost approach to procurement decisions championed by DIS against a tight financial backdrop where enhanced equipment reliability and maintainability usually leads to higher initial costs[72]. Likewise, an element of that tension in the equipment plan results from over-programming the number and cost of projects against the resources available yet DIS traditionally does not seek to address this significant shortcoming.

Finally, industrialists were occasionally concerned over the way in which the presentation of DIS and the structure of the equipment programme was tainted by political initiatives that distorted the relevance of the strategy. On the former, there was considerable variation in DIS on the priority to be given to defence exports where continuity suffered from internal party-political lobbying to restrain exports on ethical grounds (industrialist O). This ambiguity ignored the positive impact of aerospace exports on the broader economy. In addition, throughout the period of this research, industrial policy was aimed at giving increasing prominence to SMEs in manufacturing. This policy was reflected in DIS without contextualising accurately the role of SMEs in the defence supply chains. As such, they sit under a prime contractor who, as the systems integrator, holds all the risk on their behalf, a situation that would not be the norm in other areas of the economy. Referring to these aspects as "fashion statements", a former industrialist said:

> So, in 2012, there's a disproportionate effort in the documents to talk about how the MOD is going to favour SMEs and paid little attention - there's one paragraph - paragraph 203 for specific mention of the importance of prime systems integrators[73].

In summary, while individually these factors might be of limited impact and merely seen as irritants, the cumulative effect on both DIS implementation and MOD-industrial relationships is of

[71] Interview with former industrialist N, 24 June 2024
[72] Interview with former official D, 28 February 2024
[73] Interview with former industrialist M, 8 July 2024

significance. Recognising this danger, industrialists (represented through their trade association by industrialist L) felt that there would be merit in much closer collaboration with industry during the formulation of a DIS so that the risks to implementation could be fully assessed and mitigation measures identified[74]. Such a process that would go beyond the norm of soliciting views ahead of MOD drafting but would bring both sides together over progressive drafts. This approach would serve as a catalyst to a deeper understanding of the way in which unintended consequences of DIS initiatives give rise to barriers to implementation which, in the view of industry, would render a DIS implausible and thus undermine its credibility.

The triangulation of the interview conclusions

Interviewees were united in the view that the primary requirement of a DIS was to convey to industry the nature and extent of the MOD's future equipment and technology requirements. In assessing the potential for a DIS to reach this objective in creating a sustainable defence market configured to incentivise participating firms to invest in the UK and bid for contracts, interviewees sought evidence of implementation confidence in four areas. First, they looked for an accurate and realistic definition of both sovereign capability and aspects deemed pivotal to retaining operational independence. Officials felt that, except for DSIS 2021, previous strategies contained definitions that were too narrowly drawn. Industrialists were critical of the lack of linkage to potential equipment projects and concerned over the lengthy and bureaucratic process involved in subsequently determining that linkage. In addition, the analysis of the component capabilities of operational independence was unrealistically narrow until the publication of DSIS 2021 thus underestimating the extent of the industrial capacity required which, in turn, would generate a high level of cumulative risk should a significant threat materialise. This situation left firms without solid information on which they could align their investment decisions on people, plant and research with MOD's strategic aspirations. Likewise, the analysis in of successive editions of DIS in Chapters 4 and 5 points to similar weaknesses and recognised that approaches to sovereign capability were difficult to determine and complex to apply in practice. The addition of 'technology advantage' in DIS 2012 served to add yet more complexity. The literature on DIS also recognised that the MOD was naïve in its expectations on access to offshore intellectual property, a facet that was also reflected in the interviews. In addition, the literature pointed out that neither DIS 2005 nor DIS 2012 made a rational analysis of the implications of offshore procurement in terms of the potential for external political interference or limitations on priority in meeting urgent UK demands against national priorities. The Protector UAS case study also demonstrated the complexity of gaining access to offshore intellectual property given that the commercially acquired air vehicle with its US

[74] Interview with current industrialist L, 12 February 2024.

government supplied sensors and UK weapons was to be configured as a UK sovereign capability. Taken together, there is strong collective evidence that the UK's approach to sovereign capability and operational independence was sub-optimal until the major policy changes arising from DSIS 2021.

Secondly, on future core technologies, the interviews revealed that there was a lack of strategic precision in identifying the capabilities required and an MOD reluctance to fund the development of those that were selected. In addition, interviewees lamented the lack of roadmaps depicting the development route to combat capability. Some interviewees pointed out the adverse implications of the lack of investment in protypes and technology demonstrators which were deemed vital tools for assessing maturity timelines and managing integration risk. Much of the pressure on resources for the exploitation of science and technology was seemingly Treasury-driven. That said, the MOD-industry co-investment in Team Tempest was cited by some interviewees as a notable success. The analysis of DIS in Chapters 4 and 5 also reveals the MOD's tentative approach to the exploitation of technology. In this respect, SDR 98 set the tone by stating that there was clear government acceptance that multinational operations (probably under US leadership) would require a distinctive, high-quality UK contribution based on high-end but proven technology (MOD, 1998a, Essay 3, para 2). This approach generated a constant tension between the cost of delivering combat edge through exquisite technology against retaining a viable combat mass through the procurement of larger numbers of less capable equipment. In the event, continuous pressure on the defence budget has seen the UK forced down a middle road which has been sub-optimal in both respects. The Defence Select Committee raised this as a growing problem given the shrinkage in the number of UK combat aircraft (Parliament, House of Commons, 2023b, paras. 13-18). DIS 2012 was particularly tentative about providing guidance to industry on technology priorities reflecting in stronger terms the earlier DIS warnings on obsolescence. However, there was common ground in the analysis of DSIS 2021 and the interviewees on the need for increased agility in the light of emerging threats by adopt fast-changing off-the-shelf technologies. Of note, as a particularly troublesome project, the Crowsnest case study revealed a high degree of unwarranted MOD risk aversion in the selection of radar technology which points either to a lack of specialist knowledge in assessing integration risk or a cultural barrier to novel technology, or probably both.

On the third criterion concerning routes to contract, there was strong support among interviewees for the concept of long-term strategic partnerships with industry. However, there was much comment on the barriers that seemingly persist between MOD and industry in terms of both the unavoidable complexity of contracting given the array of activity involved and the often adversarial relationships between the parties. Interviewees felt that the latter arose as a cultural legacy of

many years of competitive tendering being the default route to contract. Both officials and industrialists recognised that the persistence of this adverse culture was not helped by the stovepiped nature of the procurement organisation making the sharing of best practice difficult. The MOD's reluctance to accept a realistic definition of value for money until DSIS 2021 added to the complexity of assessing the advantages of a partnership approach. The early steps in SDR 98 and DIS 2005 were recognised by interviewees as having increasingly encouraged the partnership approach, particularly in aerospace. The Team Complex Weapons model was also strongly supported but DIS 2012 was criticised for its lack of acknowledgment of the advantages of partnerships leading some interviewees to suggest that an optimum DIS should contain a more detailed framework for partnering with particular emphasis on the required cultural relationships. The Wildcat case study (with which three of the interviewees had direct involvement) showed the value of a partnership agreement in sustaining onshore capability despite the adverse budgetary conditions prevailing at the time.

The interview responses on the relationship between each DIS and the budgetary context within which it was to be implemented was the fourth criterion which revealed two weaknesses. Successive editions of DIS were seen as being over-ambitious in the light of the known costs of the current equipment plan. Secondly, DIS implementation suffered adversely from the subsequent lack of stability in the equipment plan although the prospect of downstream turbulence was obvious at the time of publication. Interviewees also felt that the Treasury was averse to the publication of DIS given that that it might be interpreted as their acceptance of the financial implications. This lack of coherence with the prevailing financial climate rapidly diluted the credibility of the strategy and undermined confidence amongst both project teams and suppliers. The same conclusions were drawn from the analysis in Chapters 4 and 5 in that it is the funding in the equipment plan that fuels the activity in the industrial ecosystem at which a DIS is aimed. Although the tension in procurement budgets was evident to MOD planners, successive editions of DIS were not synchronised with the available funding. DIS 2005 was particularly unrealistic and made no attempt to apply financial metrics to the strategy's objectives thus undermining the 'ends, ways and means' equilibrium. In addition, the procurement performance in all three case studies was adversely affected by turbulence in the equipment plan which overshadowed the potential influence of DIS. Taken together, there is compelling evidence to support the views of interviewees that inadequate financial management of the equipment plan rapidly undermines the plausibility of DIS.

The interviews also identified two further cultural barriers to the implementation of DIS: optimism bias and the delivery organisation's innate preference for competitive procurement. Comments on

optimism bias described a range of cognitive biases which were seen as significant in generating turbulence in the equipment plan. While the complexity of defence procurement was acknowledged, the key drivers were cited as the need to secure a funding line against competition for scarce financial resources and political pressure to announce equipment enhancements at a stage of relative immaturity. In addition, Defence Select Committee evidence cited in Chapters 4 and 5 was clear on the adverse effects of optimism bias on project delivery and budgetary stability. However, although DIS 2012 acknowledged the existence of optimism bias in the equipment plan inherited from the previous government, the strategy took no steps either to identify its extent or to mandate systemic change towards eradicating it. Furthermore, all three case studies indicate that optimism bias (and strategic misrepresentation) contributed to capability shortfalls and poor project performance in terms of time and cost. As for competitive procurement, interviewees saw this cultural preference as being at the root of adversarial relationships between MOD and industry which undermined the collaborative approach required for successful partnerships. This cultural mindset was reinforced by the transactional approach in 2012 DIS which determined the default procurement option of open competition on the global market alongside a very narrow definition of value for money. Risk aversion as exemplified in the Crowsnest case study partially resulted from the constraining tone of DIS 2012.

Overall, in considering the four hypotheses, there was positive correlation between the analysis of the published editions of DIS, the interview comments and the case study outcomes is assessing the successful implementation of such strategies. First, long-term strategic partnerships are deemed to have merit in promoting collaborative behaviour between MOD and industry which leads to reduced cost and increased equipment availability. Secondly, the concepts of sovereign capability and operational independence need further development. In the latter case, the strategic pathway to unfettered information access, security of supply and avoidance of political interference from other nations has yet to be defined. Thirdly, there is an overriding need to eradicate optimism bias from procurement processes by applying best practice in forecasting techniques drawn from other areas of complex project management. Fourthly, successive editions of DIS have been over-ambitious in their objectives and were not coherent with the prevailing financial context. Implementation has therefore been derailed by uncertain affordability at the outset and subsequent turbulence in the equipment plan. Because of the annualarity requirement, project teams are required to take extensive tactical actions by to constrain overspends which deflects attention away from DIS implementation. The next chapter assesses the validity of the concepts of partnering, sovereign capability and operational independence on which DIS is founded and proposes how barriers to implementation might be overcome. It also assesses how the procurement processes related to inadequate project forecasting and incompatible financial

control need to be amended to increase the traction achieved by DIS across the defence ecosystem. The analysis will identify those areas where organisational culture serves to frustrate improved project outcomes and broader acceptance of DIS.

Chapter 8 –Exploring the hypotheses

> *The Procurement Executive's processes remain rigid and bureaucratic... and time has moved on; new management tools, used by industry to great effect, have yet to filter through to the MoD ... Whatever some may wish, this is not a return to the cosy relationships which were common before Peter Levene's intervention. But neither is it the somewhat sterile confrontation which has marked the relationship between government and industry in recent years, with each side hiding behind their contracts in a trench war.* (Lord Robertson, Secretary of State for Defence, 1998).

Part 1-The hypotheses forming the conceptual theme - partnering

(1) Hypothesis One - Defence industrial strategies that focus their ambition on high-level, long-term partnering relationships with industry are more likely to yield improved project outcomes than those that seek solely to define transactional processes.

(2) Hypothesis Two - Defence industrial strategies that seek to develop soft partnerships based on framework agreements with potential suppliers are likely to be more effective in achieving operational independence and in enhancing the sustainability of the defence industrial base than relying on the uncertain outcomes of competitive contracts.

The context of part one

Part one of this chapter is concerned with the two conceptual hypotheses. On the first hypothesis, it asks whether the design of successive editions of DIS (until DSIS 2021) have been at fault though an innately cautious approach to loosening the strictures of competitive procurement. It suggests that the alternative of taking a strategic approach aimed at creating high-level, long-term partnering relationships with industry, would result in improved project outcomes. Evidence is drawn from the progressive success of partnering in complex integrated support contracts and from the resilience that partnering brings to first production orders. As the elite interviews have shown, focusing solely on the tautness of the contract as the overriding consideration acts as a catalyst for adversarial relationships at the customer-supplier interface leading, on occasion, to the 'trench warfare' suggested by Robertson. Analysis of the second hypothesis requires an assessment of the plausibility of maintaining operational independence in an era of an increased threat and reduced warning time of state-on-state conflict. This outcome could be achieved by applying a partnering approach coupled with an enlarged framework contracting regime to the range of capability requirements associated with operational independence. Much of the Private Sector Support to DE&S is delivered through framework contracts as is a significant drone capability. This MOD experience would assist in creating a commercial structure through which to maintain a high

readiness procurement plan of trusted and pre-approved suppliers. It would also add robustness to the sustainability of the defence industrial base.

The legacy of competition

Across the period of this research, two editions of Defence Industrial Policy, three issues of Defence Industrial Strategy (DIS) and ten further procurement reform initiatives have not yielded sustained improvement in procurement performance (Brooke-Holland, 2019). However, although successive editions of DIS have continued to advance the case for competitive procurement, its role as the preferred route to contract has declined in the face of greater use of single-source procurement sometimes accompanied by a strategic partnership with a supplier. In the years since the 1961 Gibb-Zuckerman report, few of the following nine defence procurement reform initiatives have had the same impact on both MOD processes and its culture as that resulting from the 1985 Levene reforms. With the widespread introduction of competitive tendering and fixed-price contracts alongside the transfer of risk to industry, the MOD predicted potential savings of £1 billion per year in the equipment plan (NAO, 1994, p.3, para.11). Yet by 1991, it was clear that significant cost growth of more than 15% continued to arise in some 20% of major projects (NAO, 1994, p.3. para.16). This trend continued with the 1997 Major Projects Report recording an annual cost increase for the 25 major projects under consideration of 9.1% with an average delivery delay of 37 months (NAO, 1998, paras. 1.8 and 1.12). As a result, Michael Bell, a former senior civil servant and Deputy Chief of Defence Procurement (Support), asserted that the Levene savings had thus proven illusory (Bell, 2000, p.31). Predictably, once published, this assertion yielded an allergic reaction from the now Lord Levene (Levene, 2000, pp. vii-viii). In (partial) support, the then NAO Comptroller and Auditor General did not seek to quibble with the financial data but emphasised the validity of the initiatives. In particular, he opined that they "were the right approach at the right time" (Bourne, 2000, p.8). He continued that "the Levene initiatives were not implemented sufficiently rigorously in practice", particularly on the avoidance of specification changes and inadequate investment in the Assessment Phase through which to judge accurately time, cost and technical risk (Bourn, 2000, p.8). In the same correspondence, commenting on the validity of the £1 billion figure, Kirkpatrick (2000) added that "In future, at least until MOD can present adequate justification, it should appear only between inverted commas and chaperoned by appropriate caveats" (Kirkpatrick, 2000, p.9). Schofield (1995) subsequently conducted a major project-by-project study of the outcome of the Levene reforms, concluding that:

> it appears that the MoD has balanced its books more by traditional tactics of cancellation, reduced orders, stretched production schedules and delays to contracts than by savings

> arising from competitive tendering and reforms in procurement practice (Schofield, 1995, p. 158).

While MOD made no attempt to conduct a subsequent evaluation of the policy, industry pointed out that, "Transferring the risk to industry does not make that risk disappear. In fact, the competitive process on major procurements may have increased the risk of failure on contract performance" (Bell, 2000, p.33). In a speech to the CBI setting the scene for the 1998 Strategic Defence Review, the then Secretary of State for Defence emphasised that, because of the Levene reforms, "The spur of competition sharpened industry's act and produced better value for MOD … but unfortunately Sir Peter [Levene] had less impact on the MOD itself" (Bell, 2000, p.33). The Secretary of State pointed to three possible causes within MOD: a rigid and bureaucratic procurement organisation; a failure to keep abreast of industry in modernising its modelling tools; and the unintended consequence of a competitive contract becoming the scenario for "trench war" (Bell, 2000, p.33). The elite interviews supporting this research indicate that while the "trench war" might have subsided, there remains a post-Levene cultural legacy in terms of an inherent MOD mistrust of industry at the contractual coalface which undermines attempts to take a more collaborative approach. That said, although DIS 2012 sought to reinvigorate the default policy of open competition and off-the-shelf capability, by 2017, 51% of the MOD's contracts by number were let non-competitively (NAO, 2017c, p.4). The NAO report continued, "The Department is committed to using competition wherever possible, but it cannot show currently that it is doing so in a systematic way" (NAO, 2017c, p.8, para.8). A subsequent NAO study examined 20 major procurement projects and determined that 11 were contracted non-competitively and three partly non-competitively but, only four of this group of 14 contracts met the constraint of sovereignty requirements (NAO, 2021a, p.30, para.3.2). It therefore appears that, despite the extant MOD policy on competition, a different more flexible orthodoxy had emerged.

Integrated operational support and partnering

There are four classes of contract where non-competitive procurement is unavoidable: sovereign requirements; urgent capability requirements for combat operations; access to unique intellectual property; and "securing long-term partnerships with industry, where the benefits of not opening contracts to competition outweigh the cost" (NAO, 2017c, p.13, para. 1.3). The latter two aspects are particularly germane to the through-life support of defence equipment for which the 2024-25 budget was £5.8 billion. By way of comparison, the armed forces' personnel costs for the same period stood at £11 billion (MOD, 2024c, p.9). Of note, the Equipment Support Budget is not subject to the same independent scrutiny as the MOD's capital investment programme represented by the annual Equipment Plan. The development of a partnership approach with industry was seen as a

necessary enabler in the original 1997 Smart Procurement Initiative (relaunched in 2000 as Smart Acquisition) which was reflected in SDR 1998 but was subsequently given substance in DIS 2005. In the latter case, the initiative was applied to the support of in-use helicopter fleets starting in 2005 with the 80-strong Sea King fleet. The contract was enlarged in 2007 to include aircraft availability targets to run until 2017, subject to five-year repricing intervals. The cost for the first five years was £700 million with a ten-year savings target compared with an in-house service set at £90 million (Ainsworth, 2007, 41WS). A similar approach to Merlin helicopter support was instigated in 2006 with a 25-year contract which has since been renewed at every five-year pricing point: forecast annual savings were set at £12 million (Luff, 2011, 28 WS). Both arrangements were subsequently absorbed into a Strategic Partnering Arrangement (SPA) between MOD and AgustaWestland. The SPA also covered the DIS 2005 initiative for the first production order for the Wildcat helicopter and the subsequent integrated support and training contract (MOD, 2005a, p.9). By 2015, the Apache (with AgustaWestland) and Chinook (with Boeing) had similar support arrangements bringing the total value of the then active helicopter support contracts to £4.6 billion (MOD, 2015b, para.2). By that stage, all these single-source contracts were subject to SSRO validation on value for money so, while there is no open-source information by which to judge success in reaching savings targets, the willingness to renew contracts at the 5-year pricing points indicates both the MOD's and the SSROS's confidence in supplier performance. DIS 2012 was silent on the significance of these contracting arrangements and made no reference to future development.

Other aerospace capabilities also adopted the integrated support model underpinned by partnering arrangements. In 2006, BAE Systems instigated the 10-year, £947 million Tornado ATTAC availability contract with the aim of saving £510 million in support and upgrade costs. NAO analysis of an earlier version of the arrangement identified achieved savings of £1.3 billion in the first five years from 2002 (NAO, 2007a, p.6). This approach was further developed for Typhoon in the 2016 TyTAN availability contract. At a cost of £2.1 billion over 10 years, by 2020, MOD's confidence in the savings arising from the arrangement had allowed some £500 million to be re-invested in Typhoon capability, particularly in the AESA radar (Goldie, 2020, UIN HL329). Similarly, launched in 2021, the £236 million Poseidon P-8A maritime patrol aircraft is supported by a partnering arrangement with Boeing valued at £234 million for the fleet's nine aircraft over five years (Boeing, 2021, para. 3). Whereas Hartley considers that, "Defence markets lack the incentive and penalty structure of private markets" (Hartley, 2011, p.8), these long-term partnering arrangements do provide suppliers with the incentive to participate through the predictable multi-year cashflows that result: there are also penalties for under-performance. In the latter respect, suppliers add resilience to their performance through investment in spares inventory based on identifying pinch-points through the application of modern management information systems. More broadly, the

robustness of this approach to supplier provision of support adds credibility to the UK's military capability and is also positive in sustaining the UK defence industrial base.

Strategic Partnering Agreements

By the publication of DSIS 2021, five major UK-based defence companies had entered into legally binding strategic partnering agreements with MOD, namely BAE Systems, Leonardo, MBDA, QinetiQ, and Babcock. This position is reflected in DSIS 2021 which made important strides in the understanding of both sovereign capability and operational independence. The strategy accepted that "global competition at the prime level may be ineffective or incompatible with our national security requirements" and thus favoured long-term strategic partnerships (HMG, 2021a, p.6). Commenting on the period since the end of the Cold War, DSIS 2021 also stressed that "the importance of operational independence was reflected in the previously developed strategies and partnerships for combat air, maritime, complex weapons and general munitions" (HMG, 2021a, p.22). It added that "the implications for operational independence of decisions which affect industrial capabilities will be explicitly evaluated in acquisition-related decisions: (HMG, 2021a, p.22). This represents a profound departure from previous editions of DIS which seemingly left to chance the capability requirements of operational independence. For example, the last major UK deployment of a divisional-sized force with the full spectrum of enablers amounting to 43,000 personnel was for Operation TELIC in Iraq in 2003. Preparation for, and the conduct of, the short warfighting phase of that operation required the procurement of 194 Urgent Operational Requirements (UORs) at a cost of £510 million (NAO, 2003, p.10, para.2.6). For large-scale operations, procurement of UORs (now termed Urgent Capability Requirements) is funded through the Treasury reserve: where an existing programme is accelerated, MOD subsequently reimburses the Treasury. Support funding from the Treasury for each UOR is limited to 12 months. Thereafter, the cost of supporting a UOR that is eventually absorbed into the force structure falls to the MOD. About 30% of the TELIC UORs represented the acceleration of capability that was already funded in the programme, and a similar proportion were recognised as unfunded gaps in the equipment plan (NAO, 2004d, p.12, para. 1.14). The remainder were for theatre-specific requirements such as communications equipment and additional stockpiles. As the NAO report on Operation TELIC explained:

> In an unpredictable security environment with constrained resources, planning is complex and involves a high degree of operational judgement. … It is inevitable that the Department has to make difficult decisions about which capability requirements should be included in its procurement plans (NAO, 2004d, p.12, paras.1.12-1.13).

The MOD's initial analysis on UOR provision for Operation TELIC contained the statement that:

> The very considerable success in delivering equipment against very demanding time and performance criteria owed much to the excellent contribution of contractors in the face of relatively late changes to the force composition and constraints on early consultation with industry. It may be necessary to review the constraints on earlier industrial engagement to minimise procurement delays in future (MOD, 2003b, p.6 para.2.6).

There is no evidence of a subsequent concerted change to defence industrial policy: the 2002 version remained extant until 2018 but DIS 2005 did point to the need for operational independence in some areas. It also promoted the initial moves towards strategic partnering for both production (Wildcat) and support (helicopters and fast jets). DIS 2012 referred to the requirement for freedom of action but only "where essential for national security" with additional explanation that "we must be able to operate, maintain, and refresh certain capabilities effectively, without being dependent on others" (MOD, 2012b, p.12&14). However, there was no detail on how this was to be achieved against the strategy's overriding tenet that "we will seek to fulfil the UK's defence and security requirements through open competition in the domestic and global market, buying off-the-shelf where appropriate" (MOD, 2012b, p.8). In addition, the strategy did not comment on the development of partnerships with industry. Rather, it was explicit that "The MOD has a number of long-standing arrangements for working with industry, but the relationship needs re-balancing" (MOD, 2012b, p50).

Twenty years on from the war in Iraq, the likelihood of state-on-state conflict at short notice has grown markedly thus increasing the risk resulting from capability gaps in the equipment plan. DSIS 2021 ultimately moved away from competition by default and redefined the relationship between operational independence and how the associated capabilities would be procured. It confirmed that "the importance of operational independence was reflected in the previously developed strategies and partnerships for combat air, maritime, complex weapons and general munitions" (HMG, 2021a, p.22). In so doing, it sought a closer and more strategic partnership between government and industry" (HMG, 2021a, p.14) and referred to the 2018 creation of the MOD Strategic Partnering Programme (SPP) with 19 of its key suppliers[75] (NAO, 2021a, p. 42). This initiative was intended to enable greater collaboration with industry "to unlock mutual benefit, improve value to UK society, and underpin long term economic prosperity" (HMG, 2021a, p.29). Earlier NAO analysis on the SPP reported that BAE Systems had made most progress and, working

[75] Airbus, Babcock, BAE Systems, Boeing, Capita, DXC, KBR, Leidos, Leonardo, Lockheed Martin, MBDA, QinetiQ, Raytheon, Rolls-Royce, Serco, Thales, and Ultra

with MOD, had "jointly identified shared shortcomings in programme scheduling, pace of delivery and approval timescales, and in aligning objectives and incentives" (NAO, 2021a, p.42). Details of the 18 associated workstreams were not published but the modest savings target of £18 million over ten years suggests an attempt to enhance relationships rather than process transformation. The SPP surfaced again in 2022 as part of the Defence SME action plan where the objective was stated as "to influence behaviours [so as] to improve the global competitiveness of the supply-chain by encouraging wider diversity, innovation and sustainability at all tiers of the defence supply chain" (MOD, 2022i, para. 4.1). In evidence to the PAC on the initiative, the MOD's Chief Commercial Officer pointed out that:

> Although it uses the word "partnership", this isn't soft; this is about trying to have a single consistent point of contact with our biggest suppliers, because of course, our big suppliers have multiple contracts and multiple touchpoints. This is about trying to get a consistent view of performance and trying to understand, if performance isn't good, what the reasons behind that are, and whether there are any issues we could look at across the whole portfolio and across the relationship, and then setting up interventions—workstreams, we call them—and projects to try to fix those (Parliament, House of Commons, 2021c, Q,73).

This rather tentative statement seems to suggest just improved liaison and seemingly ignores the positive contractual progress that had been made in delivering both platforms and support solutions since the partnering approach was advocated in DIS 2005. As such, it seems culturally defensive and worried about transmitting any notion that competitive procurement was being diluted. In that respect, it aligns with the statement about DIS 2005 made in Parliament by the then Secretary of State for Defence:

> Competition will remain a major element of that, but it will not be used when other tools, such as partnering, would deliver a better outcome, or where it would impinge on our operational sovereignty. The defence industrial strategy does not signal a move in the direction of protectionism (Reid, 2005, 440, col. 1466).

Evidence on partnerships from the case studies and interviews

The Wildcat case study describes a helicopter first production order and through-life integrated support contract conducted under a strategic partnering agreement. Despite an 8-month hiatus in the production phase (accompanied by the prospect of cancellation) while MOD reassessed the affordability of its equipment plan, the collaborative relationships forged within the partnership

allowed both sides to weather this disruption. In this respect the collocation of the MOD project team within the AgustaWestland factory had established an ethos of trust and joint working (Interview with current industrialist R, 5 July 2024). The MOD committed to the partnering agreement because of the need to maintain end-to-end onshore helicopter production and support capability, and the systems engineering expertise on which they rest. In this respect but not without some turbulence, the partnering approach proved successful. The Protector UAS case study also revealed an affordability hiatus causing a delivery delay of two years. The hybrid single-source contract with both the US government and General Atomics Aeronautical Systems (GA-ASI) allowed for the UK to ensure sovereign control over the weapon system, software and sensors. There had been a long-standing relationship between the MOD and GA-ASI based on collaborative operation of Predator (Protector's predecessor) in Afghanistan which saw UK personnel embedded with their US military and industry counterparts. While the Protector build contract was not subject to a partnering arrangement, the MOD was transparent in its intent to operate the aircraft under an integrated operational support contract with GA-ASI. This led to the creation of the 2025 UK Protector Availability and Support Solution (UK PASS) (General Atomics, 2025, para. 1). Development and flight testing was also conducted in the US on a collaborative basis. Again, the ability to absorb a two-year contract delay without acrimony rested on the positive, long-term relationship between the UK MOD and GA-ASI (MOD, 2019b, para.11).

The interviews revealed that both officials and industrialists saw advantages to a partnering approach but recognised the complexity in creating the associated commercial agreements. But there was also realism about the challenges represented by the MOD's embedded processes and in overcoming the cultural inhibitors, not least a long tradition of competitive procurement. In this latter case, interviewees were quick to cite the adversarial culture that had resulted. In addition, it was pointed out that delayed decision-making arising from budgetary tension had the potential to undermine the partnership ethos. Industrialists felt that successive editions of DIS had not been sufficiently explicit on how partnerships should be created and managed. Of most significance was a comment from a current senior official accountable for surging industrial support for Ukraine who stated that, "partnership has not manifested itself in a post-Ukraine world … somehow the partnership is still not right" (Interview with current official H, 22 March 2024). They were referring to the unwillingness of industry to invest in increased production levels (in some cases requiring new plant) without the comfort of an impending contract: they lamented the lack of risk-taking and wondered whether partnering had led to a lack of commercial hunger. This is a significant view given that they had spent the previous decade as a senior industrialist in a major company. Their key point was that "long-term relationships would look very different if you were saying this is about always warm and less about the exquisite" (Interview with current official H, 22 March 2024). In

other words, in an era of operational independence and reduced warning time of conflict, industrial capacity (an always warm production line) was more important than solely relying on the most advanced technology. She also added that stockpiles had been sacrificed because of the perceived need to make short-term affordability decisions. This is relevant to the second hypothesis on the role of partnerships in supporting operational independence.

Conclusion on hypothesis one

> Defence industrial strategies that focus their ambition on high-level, long-term partnering relationships with industry are more likely to yield improved project outcomes than those that seek solely to define transactional processes.

High-level long-term partnerships have proved effective in providing value for money, particularly through integrated support, and in sustaining elements of the UK industrial base. The positive outcomes also enhance the credibility of the nation's military capability. However, successive editions of DIS (except DSIS 2021) have been tentative in embracing the approach wholeheartedly as a strategic imperative. Rather, the primacy attached to competition has undermined the effectiveness of the procurement enterprise through the adversarial relationship that it has fostered between MOD and industry. To be effective in embedding partnership, a DIS of the future needs to be more ambitious and more explicit on the required commercial and behavioural characteristics that are deemed to result in an effective partnership. However, across the period of this research, there are potentially both institutional impediments at play and a propensity to focus on the tactical significance of the contract to the detriment of broader more strategic performance improvement. On the former, the conceptual framework for this research in Chapter 3 recognises that, as a machine bureaucracy, the MOD is ill-suited to implementing change to its fundamental strategy (Mintzberg, 1989). On the latter, external audit and assurance requirements might prove to be a barrier as the metrics within a contract on cost, time and performance form the basis against which the Treasury, the Infrastructure Projects Authority and parliamentary select committees make their assessments of MOD's project management acumen and the effectiveness of its financial stewardship. These aspects are reinforced by the NAO Major Projects Reports which aggregate the individual annual project outcomes from the bottom-up to draw conclusions on the procurement organisation's expertise. In addition, given the standardisation of process within a machine bureaucracy, those involved in procurement are immersed in the detail of their individual project delivery which, as Mintzberg suggests, represents a significant bureaucratic momentum militating against the ability to adopt strategic change (Mintzberg, 1989). These factors reinforce the need for DIS to be much more emphatic on the importance of partnering to the effective provision of defence capability.

Conclusion on hypothesis two

> Defence industrial strategies that seek to develop soft partnerships based on framework agreements with potential suppliers are likely to be more effective in achieving operational independence and in enhancing the sustainability of the defence industrial base than relying on the uncertain outcomes of competitive contracts.

Delivering operational independence

Three considerations apply to assurance on operational independence. First, there is the need to assess the robustness of the continuing relationship with the supplier of an offshore procurement. Secondly, it is highly likely that, even for an onshore procurement, elements of the supply chain will be offshore and could represent critical pinch-points if politics or industrial failure occur. Thirdly, recognised but unfunded gaps in the equipment plan caused by affordability priorities might need to be filled at short notice. Whereas the determination of sovereign capability has been a characteristic of successive editions of DIS, the challenge of maintaining the related requirement of operational independence was not laid out in detail until DSIS 2021. Earlier editions accepted that, while the UK could not maintain the full range of industrial capabilities onshore, there was an assumption that traditional alliances and collaborations would fill any gaps (MOD, 1998a, Essay 2, para. 33; MOD, 2005a, pp.2,7; MOD 2012a, pp.6,19,42). None of these versions of DIS detailed how security of supply and access to both the industrial knowledge and intellectual property required for sustainment and operational upgrades would be procured. Conversely, DSIS 2021 covered this ground in a 26-page annex having first pointed out that:

> Since the end of the Cold War, the UK has not sought to maintain a full spectrum of industrial capability onshore, and has increasingly partnered or imported, from the US in particular, where that had cost advantages and/or secured access to technology that was not available domestically (HMG, 2021a, p.21).

In considering combat air, the strategy points out that previous approaches to operational independence associated with offshore procurements such as the F-35 have involved significant programme investment by the UK. As the sole 'Tier One' partner among a cohort on nine nations at lower tiers, the UK invested $2 billion in the aircraft's development (NAO, 2017b, para.17). In addition to the positive impact of onshore industrialisation amounting to 15% of the value of the

entire programme (Dunne, 2013), this was also deemed to result in the sustainment of indigenous industrial capability in "systems integration, upgrades and manufacture of the most critical components" (HMG, 2021a, p.21). Attributing this type of arrangement to 'past governments', the strategy stated that, "Under the DSIS, the implications for operational independence of decisions which affect industrial capabilities will be explicitly evaluated in acquisition-related decisions" (HMG, 2021a, p.21). It seems, therefore that, DSIS 2021 did not have full confidence that US co-operation through which these advantages flow could be guaranteed. For example, the mission reprogramming facility which is required to create bespoke data for national missions is shared with Australia and Canada but is located in Florida on a US Air Force base (NAO, 2025, p.29). But given that F-35 has the advantage that it is a major programme with the UK's closest military ally resting on a contractual arrangement, these misgivings must be more prominent in other offshore procurements which are not founded on such solidity. Likewise, the same situation might arise in UK industry's offshore supply chains. There is thus a need to consider how a form of partnership could be enacted to reduce the risk to operational independence. The same approach might also be valid in planning contingency arrangements to fill gaps in the equipment plan if future conflict is assessed as imminent. In this case, such an approach would accelerate procurement through the existing UOR system. The same approach might also be used to pump-prime low-rate production of ammunition and other defence materiel to provide the 'always on' (or warm production line) capability to meet an increased stockpiling requirement.

Framework contracts

The use of framework contracts is commonplace in UK public sector procurement (CCS, 2021a) and MOD has recent experience of the process (MOD, 2022j). The Public Contract Regulations 2015 allow arrangement whereby firms can qualify as a pre-approved supplier by signing up to previously agreed terms and conditions. The contacting department conducts due diligence ahead of signature to ensure that the firm concerned can provide the goods or services that might subsequently be required under a call-off contract (CCS, 2021a). Taken together, these aspects truncate the tender process when a requirement arises but continue to allow negotiation of either a competitive or a single source contract. Two recent developments make this approach more attractive for defence procurement as a tool by which to reduce the risk associated with operational independence. First, the Procurement Act 2023 (HMG, 2022) has introduced the option of a closed framework. This configuration means that once the initial competition for firms to join the framework has been completed, no new suppliers can join thus giving greater control to the MOD on the selection of a fixed cohort. The Procurement Act 2023 allows for exclusion of cohort members should geopolitical shifts generate threats to national security from suppliers based in potentially hostile states (Cabinet Office, 2025b. paras.33-86). For defence, such frameworks last for eight years but can be

extended further in the light of compelling justification (CCS, 2021b, Glossary, sect. C). Private Sector Support is already provided through framework contracts with that for engineering services being of particular significance as a blueprint for an approach to operational independence through partnering. The Aurora Engineering Partnership involves QinetiQ, AtkinsRéalis and BMT, supported by its network of specialist providers. It was created in 2019 as a 10-year open framework with a value of £2.5 billion. (MOD, 2022j, line 4). A further closed framework created in 2019 with a 6-monthly value of £95 million covers the development of uncrewed autonomous heavy lift air vehicles (drones), principally for maritime operations (MOD, 2022j, line 6). Both frameworks could be surged if necessary to provide increased capability: they also provide the seed corn knowledge for wider use of frameworks.

The second development centres on the codification of ownership and access to intellectual property between MOD and its contractors. Access to intellectual property is essential for both parties when maintenance and upgrade to military equipment is conducted by a contractor (MOD, 2025d, para.9). Over the last two decades, the increased use of outsourced support contracts for mature equipment where the original equipment manufacturer had either ceased trading or been subject to a merger or takeover created doubt over the rights of use of third-party intellectual property. The situation was further confused by loose terms and conditions in historic production contracts and poor record keeping by all parties such that ownership of the associated intellectual property was in doubt (MOD, 2025d, para.43). To avoid protracted commercial disputes in the future, the MOD negotiated an intellectual property protocol with industry (brokered by the UK Confederation of British Industry) to codify how technical information belonging to the Design Rights Owner can be made available to third parties to enable a competitive approach to outsourcing support activity. It also clarifies the policy on the handling of intellectual property generated during the development phase (often fully funded by MOD) where the subsequent production phase is to be competed (MOD, 2025d, para.47).

Partnering agreements and partnering arrangements have proved necessary in optimising both production and support of defence equipment but they are not sufficient to meet the full challenge of operational independence within affordability constraints. In addition, given the extent of the UK's reliance on the globalised defence industry, there is inherent risk in maintaining guaranteed access in the light of political or national security barriers arising. While it might be preferable to bring onshore as much of the industrial capacity as possible required in support of operational independence, such expansion would be infeasible in the near term. As a result, soft partnerships based on framework contracts offer a method by which to reduce (but not obviate) the risk of interruptions in offshore supply. They also provide a tool by which to increase industrial

participation of onshore firms with consequent value to the broader economy and to the sustainability of the defence industrial base. The disadvantage of this approach is that it invokes a management overhead in creating and monitoring what are essentially dormant contracts. However, it represents a pragmatic risk premium for adding speed of response and greater certainty of supply when short-notice, high-priority requirements occur. In this sense, given that defence procurement operates in an imperfect market, the application of the economic theory of 'second best' applies in recognition that it is not possible to optimise all the components of an imperfect market (Gansler, 1987). Industrial intervention by government therefore needs to recognise where to focus effort to achieve the most effective configuration (Lipsey and Lancaster, 1956; Warwick, 2013).

Part 2– The hypotheses forming the process theme – optimism bias and financial alignment

(3) **Hypothesis Three** - Improvements to individual project outcomes are more likely to result from defence industrial strategies that require procurement process to take a systematic approach to the identification and eradication of optimism bias.

(4) **Hypothesis Four**- Improvements to overall procurement outcomes are unlikely to arise unless the ambition in defence industrial strategies is more tightly aligned with the resources likely to be available in the forward defence budget.

The context of part two

Despite the attempts at reform, major procurement projects have continued to be blighted by overruns in cost and time. As a result, the MOD continued to attract strident criticism from the NAO and parliamentary select committees. One recurring aspect was the accusation that the MOD's procurement system was riven with optimism bias which, in turn, meant that the financial profiling at the outset of a project was frequently implausible. The internal impact of this syndrome on MOD was the continuous need to reprofile elements of the defence equipment plan and reprioritise the projects within it. However, the related is criticism is rarely accompanied by accurate recognition of the complexity and risk associated with manufacturing defence equipment. Financial management in these circumstances has been made more challenging by the convention of annualarity in public sector accounting. Changes in the project management structure were introduced in the Smart Acquisition initiative. Prominent among them was the introduction of Integrated Project Teams (now termed Delivery Teams) for the full equipment lifecycle (MOD, 2002b, p.6). The teams consisted of representatives from the principal stakeholders (including industry in the post-competitive stage) and the main functional specialists. This project-based approach was regarded as the then best practice in the automotive and aerospace industries, and in the US Pentagon (MOD, 1998a, Essay 10, para.14). While there have minor adjustments over subsequent years, these organisational changes remain the bedrock of current MOD project management. While there were clear advantages in applying a multi-disciplinary approach, there would still be occasions when human interaction and culture rub up against the rules of process. For example, generating a consensus on technological and financial risk among the different specialists is not straightforward. Equally, portraying unity of purpose to address the adversarial relationships with industry arising from the earlier Levene reforms (identified in Chapter One) also represents a significant challenge for the team leader.

Smart acquisition processes

With its roots in a procurement mantra of 'faster-cheaper-better', Smart Acquisition introduced a streamlined approval and oversight mechanism on the route to meeting a capability requirement. It relied on an Initial Gate by which to gain agreement on commencing the Assessment Phase. The latter's aim was to identify potential solutions, assess the associated levels of technological and manufacturing risks, and determine the cost and timescale to delivery (MOD, 2002b, p.5). This was to be followed by the Main Gate to confirm the full investment for the demonstration and manufacture phases (MOD, 2002b, p.5). This process was modified in 2020 to a three-gate process to align with the standardised 2018 cross-government process consisting (in order of progression) of a Strategic Outline Case (to establish the need for change), an Outline Business Case (broadly replacing the Initial Gate) and a Full Business Case (equivalent to Main Gate) (HMT, 2018). The Treasury process was further refined in 2022 and 2024 (HMT, 2024). Smart Acquisition also recognised that the Assessment Phase of the procurement cycle should pay greater attention to risk reduction analysis to ensure delivery in accordance with the project definition. The related guidance was that 15% of the design, demonstration and manufacturing budget should be invested in risk reduction ahead of the Main Gate decision to proceed to full investment (MOD, 1998a, Essay 10, para.15). Again, this approach was based on best practice in the US Pentagon and in industry. At that stage, the investment norm stood at 11% which was deemed insufficient to achieve a refined understanding of all the facets of risk and take early mitigation measures (MOD,1998b). A subsequent 2003 review assessed the figure at just 7% with a 2009 study determining that the result for 44 projects between 1997 and 2007 "was only c.5% of total forecast spending" (Gray, 2009, p.122).

A further consideration is that the traditional generation of P50 forecasts on project time and schedule means that there is just a 50% probability of the forecasts being correct. However, in accordance with the Treasury Green Book, the MOD now requires Full Business Cases to present assessments at P10, P50 and P90: recent guidance now makes P70 the norm for schedule forecasting (Parliament House of Commons, 2023e, p.4). On cost forecasting, MOD has applied a P70 requirement against the most complex programmes such as Dreadnought submarines and nuclear infrastructure: in other cases, SROs may propose with evidence the use of other than P50 (Parliament House of Commons, 2023e, p.4). Contingency funding held at portfolio and departmental level is calibrated against the prospect of excursions from the forecast probability of outcome. (Parliament House of Commons, 2023e, p.4). As a result, it is emphasised that adoption of higher levels of forecasting probability does not drive performance improvement: rather, it alters the calibration of the risk contingency (Parliament House of Commons, 2023e, p.4). In evidence to the Defence Select Committee, the MOD pointed out that the "44 largest completed acquisition

programmes which achieved an In-Service Date since 2017, 73% of them met their P50 estimate on cost, whilst only 52% met their P50 estimate regarding schedule" (Parliament House of Commons, 2023a, p.27). However, projects that overrun invariably also lead to increased costs elsewhere in MOD's budget.

Hypothesis three – eradicating optimism bias

The policy documents of the period between the Levene initiatives of 1985 and the publication of the SDR in 1998 made few inroads into the analysis and eradication of risk in procurement. Bold decisions on transferring risk to industry through prime contracting did not reduce risk to project outcomes on time and cost: progress was slow on understanding the extent of the risk premium being changed by industry (NAO, 1994, p.5). SDR 1998 identified the related problem that it was not always possible for contractors to absorb the levels of commercial and technical risk being transferred to them (MOD, 1998a, para. 154). Optimism bias was mentioned only once in the entire SDR 1998 documentation appearing in the supporting essay on industry where it was noted that "MOD predictions on the cost of technical risk were subject to an inherent optimism" (MOD, 1998a, Essay 2, para. 14). Even the wise initiative to invest up-front in risk reduction early in the project life cycle had not taken root when reviewed in 2007 (Gray, 2009, p.122).

The systematic process for handling risk management and optimism bias in investment appraisals and business cases was laid out in 2014 in a Joint Service Publication (JSP) consisting of mandatory policy direction and process guidance. (MOD, 2014b). Yet by 2022, in its own evidence on defence inflation submitted to the PAC, the MOD still attributed procurement cost growth to optimism bias and a poor understanding of risk and assumptions (MOD, 2022c). It further recommended the adoption of reference class forecasting as described in Chapter 3 of this research. The MOD's risk management and optimism bias processes in JSP 507 align with those mandated by the Treasury in 'The Green Book' (HMT, 2022). However, the latter document is inconsistent on the issue. It first states that "Optimism bias is a form of reference class forecasting which predicts future outcomes based on the outcomes for a group of similar past projects (HMT, 2022, p.48, para 5.6) which is patently incorrect. It latter states more accurately that "Optimism bias estimates are a form of reference class forecasting, which predicts future outcomes based on the outcomes for a group of similar past projects (HMT, 2022, p.104, para. A5-4). A second anomaly relates to the assertion on the nature of the reference class as consisting of similar projects. The source of this statement is some earlier 'Supplementary Guidance' (HMT, 2013) which is based on a 2002 civil engineering consultancy study which no longer represents best evidence on the performance of projects given the passage of two decades and provides little insight into complex defence equipment projects. Meanwhile, the Infrastructure Projects Authority is clear that, "Estimates for costs, benefits,

schedule and resources should be justifiable through evidence or experience such as reference class forecasting, benchmarking, data analytics, probabilistic simulation, consensus or experience from previous work" (IPA, 2021, p. 27). While this statement might be seen as allowing some latitude in approach, the IPA document entitled *Project Delivery. Continuous improvement assessment framework* is more prescriptive. In segmenting process and performance as 'good-better-best' under the heading of decision-making, it applies the 'best' rating when decisions are based on actual outcomes in a reference class of similar decisions to that being addressed" (IPA, 2021b, pp. 12 and 24). The MOD's use of theoretical examples based on historical data would not match-up to this standard.

The adverse impact of optimism bias on project performance on time and cost has been a constant comment by the NAO and the PAC. Of note was the latter's strident criticism of the MOD's Equipment Plan 2023-33 which showed a deficit of £16.9 billion.

> This is the largest funding deficit in any of the 12 Plans the MoD has published since 2012. It is also a marked deterioration in the reported financial position since last year's Plan, which the MoD judged to be affordable, but this Committee concluded was not and that it is characterised by optimism bias (Parliament, House of Commons, 2024, p3).

Apart from affordability and financial profiling issues arising from cost growth, delivery delays also have additional budgetary implications. The harmonisation of equipment delivery with other Lines of Development such as the provision of trained personnel and operational infrastructure, which together combine to form military capability, is key in avoiding nugatory expenditure. Equally, the need to run-on progressively unreliable and obsolescent equipment beyond its funded out-of-service date also incurs additional cost.

Evidence of Optimism Bias from elsewhere in this research

The case studies demonstrate the practical impact of optimism bias. All three were complex aerospace projects with significant systems integration challenges and important dependencies on other projects and lines of development. Although Wildcat production proved straightforward after an initial hiatus, weapon integration was problematic due both to optimistic forecasts over interface compatibility and to delays in weapon delivery caused by mis-placed optimism over design and development, particularly for the Anglo-French Sea Venom. Likewise, Crowsnest suffered from excessive optimism during the development phase over the ease with which old radar and processor technology could be integrated into a modern digital aircraft, leading to excessive delivery delays and sub-optimal initial performance. Of note, at the time of letting the

contract, MOD assessed that there was “a very high risk that industry would be unable to deliver the initial capability” because of the compressed timescale (NAO, 2020b, p.24). However, in the MOD’s report to the IPA on the project, it was assessed as Amber (successful delivery appears feasible but significant issues exist and require management action) (NAO, 2020b, p.26, fig.7). As for Protector, apart from resolving some initial software integration issues, the project was delayed by affordability problems in the broader equipment plan representing inaccurate initial project costings in other projects. Contracting delays, inadequate preparation of infrastructure, slow provision of trained personnel and the insertion of a two-year affordability hiatus resulted in an aggregate delivery delay of seven years and ultimate cost-growth of 57% (MOD, 2024e, cell P-87). This poor project performance represents the cumulative impact of incremental elements of optimism bias in different facets of the project. Among the interviewees, two issues were paramount. First, both cohorts were clear that the complexity of assessing time and cost outcomes in advanced defence equipment is not sufficiently well understood by those outside the direct procurement enterprise. As the case studies demonstrate, both officials and industrialists pointed to the multiple dependencies and interfaces within a project that militate against certainty in initial forecasts. Secondly, optimism bias was deemed to be the root cause of individuals demonstrating over-confidence in their personal ability to assess risk and a propensity to bury their doubts. These two aspects were seen as the prime factors in generating turbulence and over-heating in the equipment plan which yields two effects: MOD management attention is diverted way from strategic issues to tactical financial firefighting of an overheated programme; and it promotes perverse behaviour from project sponsors whose inaccurate forecasts are used in seeking to secure funding against competition for scarce financial resources.

Addressing optimism bias through DIS

The MOD’s approach to optimism bias contained in JSP 507 suffers from two significant defects. First, there is no attempt to refine the components of behavioural bias as identified by Flyvbjerg (2021) between, strategic misrepresentation, (true) optimism bias, planning fallacy and overconfidence bias. Secondly, the guidance in JSP 507 takes a broad-brush approach and identifies eight contributory factors to procurement bias (MOD, 2014b, p.117). The statistical framework is acknowledged as arising from the same 2002 study by Mott McDonald on 50 large UK public procurement construction projects referenced in Treasury guidance, involving buildings and civil engineering works (MOD, 2014b, p.95 and fn.11). Of these, seven are drawn from the MOD of which four are classic infrastructure construction projects, one is a Private Finance Initiative for maintenance of the defence estate, and one is a fixed telephony system. All six have a direct read across to other public sector infrastructure such as prisons and hospitals which also feature in the list. In terms of complexity, they are also representative of the characteristics of commercial

projects. They therefore represent a valid dataset to support reference class forecasting for those types of projects and provide valid data on the bias increments that should be embraced in business cases. The project type 'Equipment/Development' project was defined as:

> Projects that are concerned with the provision of equipment and/or development of software and systems (i.e. manufactured equipment, Information and Communication Technology (ICT) development projects) or leading- edge projects (Mott MacDonald, 2002, p8).

However, the sole project considered in this category was MOD's Faslane Shiplift which combines a vast, covered dry-dock with a gigantic crane required to lift a 25,000 submarine or ship, the mechanical system of which requires the synchronisation of 100 winches. Completed in 1993 at a final cost of £314 million, the project was £167 million over budget and 3 years late (Navy Lookout, 2025, paras. 7-8.) Whilst this was undoubtedly a complex project, it is not representative of the integration challenge inherent in fighting equipment where a systems of systems of leading-edge technology, often involving lethal weapons, has to be developed where solutions are limited by constraints of weight, volume and safety. It is arguable that the shiplift's characteristics were at variance with the Mott MacDonald definition of an Equipment/Development' project. Such complexity is rarely experienced in commercial projects nor in the 50 public sector projects under review. Two points emerge. First, as an outlier among the 50 projects under review in terms of capital overspend and schedule delay, the associated upper bound bias increments for the sole 'Equipment/Development' project compared to those associated with the other classes of projects were broadly double the mean for schedule and quadruple for cost (data at Appendix E). Secondly, to comply with Treasury requirements on forecasting, the MOD procurement process was saddled with the need to adopt an inappropriate reference class.

In terms of application of the Treasury-mandated methodology for reference class forecasting and using 'Equipment/Development' as a project example, in total, the contributory factors represent a 200% upper bound bias increment on capital spend and a figure of 54% for duration (MOD, 2014b, pp.95 & 116 for detailed figurework)). Of the eight contributory factors, complexity of the contract structure, the degree of innovation, inadequacy of the business case, and technological uncertainty together represent 70% of the bias increment for cost and 72% for time translating to 140% in cost and 39% in duration (data and process schematic at Appendix E).

In creating the MOD procurement business case, each of these contributions to bias can be reduced:

> Optimism bias may be reduced in proportion to the amount that each factor has been mitigated. Evidence to support any mitigation claimed (e.g. from past projects) must be documented and must be independently endorsed (e.g. by CAAS[76], Defence Economics or relevant TLB[77] Appraisal and Evaluation team) (MOD, 2014b, p.98, para. 22).

However, the evidence does not arise from a statistically robust methodology such as that involved in reference class forecasting which takes an 'outside view'. In this case, the outside view (the shiplift) is both outdated and unrepresentative of the technological content and integration complexity of defence equipment. Thereafter, JSP 507 encourages the use of an 'inside view' by drawing evidence from past MOD projects (MOD, 2014b, Part 2, p.98) which are necessarily drawn from a restricted envelope given the limited array of projects by which to assemble an evidence base. As Kahneman and Tversky (1977) point out, many of the components of bias that lead to weak judgements are generated solely from internal perspectives (or an 'inside view') which are insulated from the reality of outcomes in similar projects elsewhere. In evidence to the PAC, the MOD recognised the NAO 2013 analysis that "weaknesses in the quality and appropriateness of data and modelling techniques distorts the information on which projects are approved and masks the risks" (MOD, 2022c, p.13, Fig. 4). The document cites four further process issues that lead to bias in project management. First, the need to secure a funding line in the equipment plan sees competition between the armed forces leading to bids at unrealistically low cost delivering over optimistic benefits. Secondly, accountability is weak because of the churn of both military and civilian staff in that the original decision-makers are rarely confronted by their forecasting errors (MOD, 2022c, p. 12). A RAND study, *Persistent Challenges in UK Defence Equipment Acquisition* also points to the "lack of institutional memory hampering learning from the past" (Retter et al, 2021, p.15). Thirdly, as capability sponsor, the front-line customer is under significant budgetary pressure which makes it difficult for delivery teams to push back against unrealistic expectations on cost and time. Finally, the MOD points to the moral hazard arising from the incentive on contractors to underestimate costs in the knowledge that, once launched, political pressure and the sunk cost fallacy make cancellation unlikely (MOD, 2022c, p. 12).

[76] MOD's independent Cost Assurance and Analysis Service
[77] Top Level Budget: for equipment procurement, generally the relevant front-line command budget.

The assessment of bias in an MOD business case is a Treasury requirement and works alongside the risk management process. However, the MOD's guidance admits that "the requirement to address optimism bias does not easily sit with the MOD's approach to estimating uncertainty, and there is a risk of double counting" (MOD, 2024e, sect. 2, line 2). Forecasting in defence acquisition involves three steps: costing; risk and uncertainty management; and adjustment for optimum bias. The NAO has noted in the past that "good practice in costing techniques is inconsistent across project teams and we remain concerned that the Department may be inadequately incorporating risk and uncertainty in its project costs" (NAO, 2014, p.11). The technique involves the requirement to use a three-point assessment embracing the P10, P50 and P90 forecasts on cost followed by the application of Monte Carlo modelling to assess the impact of the identified risks and uncertainty (MOD, 2007, para. 3.2). The optimism bias assessment figure is then applied to the deterministic result of cost with no allowance for risk and uncertainty. If the outcome is close to the 50% confidence figure (equal probability of costing more as less), then the final costing is deemed to be robust: if not, the uncertainty and bias assessment process are reviewed and revised (MOD, 2024f, sect. 4; Appendix E). The issue remains that NAO audits find that there is variability across projects in the robust application of costing techniques and inconsistency in the treatment of risk between delivery teams. Given also, that the evidence base for optimism bias assessments is frail, then the nexus of these aspects points to significant potential inaccuracy in the costing figures that form the budget bid. The weakest link in this process is the way in which the theory of optimism bias is applied. This weakness could be eradicated over time by creating a reference class dataset from current projects in MOD and across the broader economy (including with international partners) broken down by individual systems and sub-systems that can permit a granular and incremental statistical analysis that can be applied to future business cases. For MOD, this might usefully be embraced in the current 'Learning from Experience' (LFE) process which is aimed at anticipating issues and risks but which is currently more qualitative that quantitative (MOD, 2025e).

Hypothesis four - aligning DIS with the forward defence budget

A defence industrial strategy should seek to balance the triad of ends, ways and means within which coherence with the extant equipment plan is a key factor. The ends are defined in defence industrial policy as providing the Armed Forces with high quality equipment at best value for money whilst also promoting a thriving and competitive defence industry (MOD, 2002b; MOD 2017b and MOD 2021). Such policy statements also accept the inherent tension between generating effective military capability and the strategic imperative to maintain an appropriate industrial base. The former suggests a preference for competitive procurement on the global market whereas the latter requires a more nuanced approach.

Evidence on financial management from elsewhere in this research

The analysis of successive issues of DIS, the case studies and the interviews point towards a chain of problems that undermine the credibility of DIS and erode the MOD's reputation as a procurement organisation. In terms of delivering a strategy, DIS fails to create an equilibrium between ends, ways and means in that it adopts over-ambitious objectives which cannot be achieved by the amount of onshore industrial activity funded in the extant equipment plan. But the equipment plan is overheated and, as the previous analysis of Hypothesis Three shows, is under constant pressure because of the degree of optimism bias attaching to project forecasts of time and costs. This syndrome adds more turbulence to the plan and further disrupts the associated industrial activity: it was clearly apparent in the production hiatus for Wildcat and the delivery delay for Protector. Also, both Protector and Crowsnest were procured against the backdrop of four years of an unaffordable equipment plan (NAO, 2021b, p. 4). Protector was particularly badly placed because of the extent of the unfunded equipment enhancements in SDSR 2015 adding further tension to the plan. Interviewees all recognised the problem: most wished to see greater Treasury flexibility and looked for increased use of portfolio funding to allow a more top-down control of finance. A common view was that stable and predictable funding was in everyone's interest but recognised the core issues as accounting annualarity, minimal carry-over between years and immature estimates of cost and time. The use of reference class forecasting was not mentioned. Managing complex, multi-year projects on an annual basis was deemed to be almost impossible. Those interviewees with most experience of high-level financial management saw the need to adjust the early stages of the procurement cycle such that the project funding lines in the equipment plan were not inserted until the end of a strengthened Assessment Phase which would provide higher fidelity forecasts of time and costs. They suggested that the wider use of portfolio funding management would allow a range of costs to be entered into the plan with the ability to veer and haul between individual projects within the portfolio as assumptions hardened. That said, a former senior procurement official pointed out that, of late, costing accuracy has improved but schedule forecasting has remained weak. In summary, evidence points to the priority need to introduce a financial management system that produces a stable and predictable equipment plan to which the aspirations in DIS could be matched.

Addressing over-ambition in DIS

In the UK, greater complexity arises from two factors which limit the 'means' available to a DIS in terms of the size and stability of the defence equipment budget. The first factor recognises that a DIS that seeks to determine the retention of a range of onshore capabilities must be matched by firm requirements for the associated industrial output in the funded equipment plan. For example, while DIS 2005 was forensic in its analysis of an 'ideal' onshore industrial capability based on a

perceived array of requirements to meet future threats, it was unrealistic in its ambition that the funding would be available in the subsequent decade. At the time of publication, the Equipment Plan was running at 11% over budget with the delay to 19 major projects at an aggregate of 433 months (NAO 2006a). Eurofighter Typhoon and the Queen Elizabeth carriers were each subject to unspecified delay and each showing cost growth of more than £1billion. This situation caused the MOD to conduct a major budgetary review in 2008 entitled the 'Equipment Examination'. This process saw an eight-month contract hiatus on the Wildcat helicopter, one of the flagship projects in DIS 2005. Subsequently, by 2010 the effect of the 2007-08 global financial crisis coupled with the UK's increased commitments in Iraq and Afghanistan had generated a £38 billion black hole in the defence budget. In effect, the implausible ambition on the 'ends' available to support the implementation of the strategy rendered It undeliverable. It is therefore arguable that a DIS needs to be less focussed on the manufacturing footprint and detailed output of individual firms (as was DIS 2005) which creates unrealistic expectations. Rather, DIS should be more engaged in creating a strategic relationship with a market-driven, onshore defence industrial base which includes inward investors based on certainty of funded requirements.

Annualarity in public sector finance

The second factor is focused on the more tactical level of the contractual interface and the application of the Treasury-defined process of annualarity as a crucial tool of financial control (HMT, 2025). Introduced in 1862, annualarity has its roots in departmental accountability to parliament in that Ministers require annual parliamentary authority to use public funds ahead of committing expenditure. This authority which is time-limited is achieved through the departmental presentation to parliament of the annual 'Estimates' of the following year's expenditure which is then approved by vote under the Supply and Appropriations Act. This process cements the notion that the required funding is within the government's expenditure plans and that the departmental accounting officer (routinely the permanent under-secretary) is responsible to Parliament through the PAC for the stewardship of the funds delegated by the Treasury. To allow forward planning, such delegation is achieved through multi-year budgets agreed across the Cabinet at periodic spending reviews. A disadvantage of the annualarity approach is that it can lead to perverse spending decisions towards the end of the financial year to address the 'use it or lose it' notion of an impending underspend thus placing value for money at risk (HMT, 2025). The Treasury's treatment of budgetary underspends has become more stringent across the period of this research.

The historical approach to annualarity was overhauled with the introduction in the UK of the New Public Management initiatives of the Thatcher and Blair governments in the 1980s and 1990s. This period saw an increased rate of privatisation and outsourcing aimed at opting for a more

commercial approach to the provision of public services. These changes also saw a move to decentralisation in government which was accompanied by greater freedoms in the control of budgetary systems. By 1998, the rule of annualarity had been set aside in favour of multi-year settlements arising from the periodic spending reviews. This approach created end-year flexibility by allowing departments to carry forward any underspends against departmental control totals subject to Treasury approval (Hyndman et al, 2007). The period of austerity following the global financial crisis caused the then Coalition government of 2010 to reintroduce stringent financial controls given that the target for government debt was now set against the fixed timescale of a full parliament (2010-15) rather than over the economic cycle. Judgements on progress would be made by the newly instigated Office of Budget Responsibility. The Treasury directed that there would be no freedom to carry forward underspends that were not forecast in advance in the Supplementary Estimate (a January course correction of the main Estimate). At that stage and with Treasury agreement, under the 'Budget Exchange Process', the MOD would have been able to carry forward 1.5% of its Capital Departmental Expenditure Limit but the amount would be netted off in the receiving year's budget (HMT, 2012). However, the MOD spend on some individual projects is also ring-fenced by the Treasury.

With a £53.9 billion budget in 2023-24 (near-cash in resource accounting terms), MOD runs the UK's fifth largest departmental budget but has the largest capital spend (MOD, 2024c). Of the MOD's capital funding allocation of £19.2 billion, £12.1 billion was allocated to the MOD's equipment delivery organisation, DE&S. Including in-year support activity, the DE&S managed 615 projects embracing 2,648 contracts (MOD, 2024g). By the end of 2022, the in-year cost of the 19 major projects had increased by £647 million with a cumulative delivery delay of 21 years (Parliament, House of Commons, 2024). Despite this legacy, DE&S closed the 2023-24 accounts with a 3% underspend on the equipment budget of some £12 billion: the preceding three years provided much the same result with a range of underspends between 1.7% and 3.7% but with increasing delivery delays (MOD, 2024b, p.20). Apart from admiring the financial dexterity involved, three points arise about annualarity. First, incremental underspends from individual projects can only be carried forward if the project's overall delivery timescale is unchanged, otherwise they must be surrendered to the Treasury. Secondly, constraining capital expenditure below the control total requires considerable dexterity in manipulating individual project spend profiles. Control can be applied by measured decisions on deferring delivery dates but unpredictability also arises from schedule delays in contract activity arising from manufacturing problems or from the impact of embedded optimism bias. Thirdly, MOD is subject to a project delegation threshold of £1 billion such that, for projects above that value, the Treasury rather than MOD acts as the approving authority. Such projects are subject to ring-fenced funding with Treasury approval required for any

additions to cost which further reduces profiling flexibility. Category A projects are those costing more than £400 million where the MOD is the approving authority but with a requirement for Treasury agreement. All major MOD projects and any that are deemed high risk or novel and contentious become elements of the Government Major Projects Portfolio are thus subject to scrutiny by the Infrastructure Projects Authority: 45 such projects were included in the 2024-25 report (IPA, 2023). Managing the cumulative cost growth across this portfolio is highly complex but is also one of the major drivers of project delay. Based on the MOD's evidence to a 2023 enquiry, the Defence Select Committee reported that:

> Of DE&S' 44 largest completed acquisition programmes which achieved an In-Service Date since 2017, 73% of them met their P50 estimate on cost [just as likely to cost more as cost less], whilst only 52% met their P50 estimate regarding schedule (Parliament, House of Commons, 2024).

It is therefore arguable that, given the volume and complexity of DE&S activity, the notion of annualarity in defence procurement needs to be revisited but there are also countervailing arguments. Experience of the pre-2012 regime where departments had considerable freedom within their multi-year settlements led to ambiguity over definitions of expenditure between the Treasury control mechanism, the parliamentary Estimates and departmental accounts. The ambiguity arose because differing international standards were applied to each category. As a result, the creation of 'the Clear Line of Sight Project' aimed to reduce this ambiguity, strengthen the management of expenditure and standardise the presentation of data (HMT, 2009, p.3). Consequently, parliamentary controls were aligned with those of the Treasury and the perimeter of the Estimate was also enlarged such that data in Estimates are consistent with Treasury budgetary controls (HMT, 2011, p.3). Given the resulting hard-won improvements, any proposed MOD exemption from this regime would have to be compelling to be agreed by the centre of government.

Pan-departmental portfolio approach

An alternative and potentially more acceptable approach might be found in an extension of the hierarchy of portfolio management within MOD. The NAO pointed out in a 2021 report that, "The Department's short-term approach to the financial management of its equipment portfolio has affected suppliers' ability to deliver contracts effectively" (NAO, 2021a, p.7). The management of this extensive portfolio is segmented into sub-portfolios delegated to the customer Top Level Budget holders in the front-line commands, with management of the most complex or strategic programmes retained at MOD Head Office level. There is one notable variation on these

hierarchical arrangements in which the combination of a portfolio approach coupled with an agreed funding pipeline has proved successful. Conceived in DIS 2005 as the solution to managing the industrial over-capacity in the UK's guided weapons sector, Team Complex weapons instigated a portfolio approach to a discrete area of acquisition. It initially brought together as sovereign capability a range of weapons with inter-dependent technologies, but which were at different stages of maturity and had varying future delivery dates. Subject to a legally binding Portfolio Management Agreement, it provided the participating companies with a long-term pipeline of requirements but with built-in flexibility for the MOD to change priorities on capability and delivery dates (MBDA, 2015). It also provided an agile framework within which resources could be matched to changing priorities. The Portfolio Management Agreement was renewed in 2024 with 10-year future pipeline funding of £6.5 billion having scored savings of £2.6 billion in the preceding 14 years. During the same period, as lead partner, MBDA invested £550 million in UK manufacturing facilities with an undertaking to invest a further £500 million in the decade ahead (MOD, 2024h). In addition to the advantages of long-term collaboration arising from MOD-industry partnering, savings also arose from: commonality and re-use of systems modules; enhanced stockpile management by maintaining 'hot' production lines embracing continuous product improvement thus eradicating obsolescence; and economies of scale in support costs by bundling together a family of weapons. Although the current internal matrix organisation of DE&S in undergoing change, the engine-room of the organisation will remain the four procurement pillars of ships, land, air and strategic enablers. Within these pillars, it should be possible to identify clusters of activity equivalent to that in Team Complex Weapons where a portfolio approach with pipeline funding would allow greater financial agility.

Concluding comment on the hypotheses

The four hypotheses were selected to expose the most significant shortcoming in the deployment of DIS and propose solutions. They represent four interlocking problems that together undermine both the credibility of the strategies and limit their acceptance across the procurement enterprise. In each case the tools already exist to resolve the problem but their use has been suppressed because of the existence of organisational, cultural or process barriers. As a highly standardised machine bureaucracy with a strong technostructure, the MOD's procurement organisation is not amenable to change (Mintzberg, 1989). Culturally, the enterprise has been driven for four decades by the need to see competitive procurement as the optimum route to contract and accept as normal the adversarial relationship with industry that results. In addition, procurement performance is undermined by erratic financial management caused by imperfect forecasting of cost and time, mainly through the prevalence of optimism bias. Financial control is further weakened by public accounting constraints generated by annualarity and the need to adhere to

departmental control totals. The interaction of these aspect means that the delivery of the objectives of a DIS is attenuated. Budgetary limitations and turbulence associated with the equipment plan do not permit the degree of onshore industrial activity required by the strategy. Hence the role of DIS in meeting the requirements of defence industrial policy in terms of providing optimum equipment capability at acceptable value for money whist sustaining the UK industrial base is eroded.

Strategic partnering agreements have proved successful in delivering the required capability in limited areas whist yielding savings without reverting to 'cosy' (or better, 'comfortable') MOD-industry relationship that was the major catalyst for the Levene reforms. Yet behavioural change is slow to take root because of the fear that MOD's interests would suffer without the competitive approach to procurement. This facet was reinforced in successive editions of DIS until DSIS 2021 whilst the advantages of strategic partnering was underplayed. Likewise, the reality of how operational independence was to be delivered was absent from the same editions of DIS yet the tools by which to build a network of pre-qualified preferred suppliers already existed through the creation of framework contracts. With the advent in 2016 of the Infrastructure Projects Authority (IPA), much progress has been made on the eradication of optimism bias in major public sector projects through their detailed guidance on best practice and training though the Major Projects Leadership Academy (IPA, 2021b). In this respect, the IPA regards reference class forecasting as a primary tool by which to eradicate optimism bias, yet the MOD gives the technique minimal prominence and is concerned about distortions to its own internal methodology (MOD, 2024f, sect. 2, line 2). There is thus a risk that inaccurate forecasting of cost and time will persist which would continue to undermine budgetary control to the detriment of MOD's reputation for sound financial stewardship. Consistent improvement in these areas would be a pre-requisite for the Treasury to allow greater MOD flexibility in annualarity, carry-over and portfolio management with pipeline funding. The following concluding chapter will address how the content and approach to a future DIS should be altered to embrace both the analysis of these hypotheses and the other shortcomings identified in this research.

Chapter 9 – Conclusion

> *Behaviour matters more than process. There are common traits that can lead to the wrong behaviours and decisions on major projects. These are not easily countered even with clear accountabilities and structural checks and balances. They need to be searched for, recognised when they exhibit, and actively countered through calm and objective assessment of the evidence and by instilling the right behaviours within and between organisations* (DfT & IPA, 2019, p.6.).

The research question

This thesis has attempted to answer the question:

> ***Why have the three versions of the MOD's Defence Industrial Strategy produced in the period 1998-2023 not yielded greater improvement in the delivery of UK defence aerospace projects to time, and cost, and what has been their impact on the sustainability of the defence industrial base? What changes need to be made to the formulation and deployment of defence industrial strategies to generate improved outcomes?***

This final chapter will therefore lay out the shortcomings in the formulation of DIS and assess the implications of those shortcomings for aerospace project performance and for the sustainability of the UK industrial base. But it is also necessary to consider the deployment of DIS within the procurement ecosystem to assess whether barriers to acceptance exist. Such barriers arise from organisational structure, culturally embedded resistance and the strategic implausibility of implementation arising from a lack of equilibrium between the 'ends', 'ways' and 'means' articulated in DIS. The chapter then recommends that a future DIS should be wider in scope and be subject to greater cross-government endorsement if it is to be more effective in enhancing the credibility aspect of UK deterrence.

Findings on the formulation of DIS

This research reveals shortcomings in the formulation to DIS in the areas of the identification of sovereign capability and the creation of operational independence, the treatment of future technology requirements and the optimisation of the routes to contract. Problems also arose because DIS objectives were not coherent with the financial resources available in the equipment plan which served to inhibit implementation and undermine industry's confidence in the strategy. On sovereign capability, the selection was too narrowly drawn and DIS did not show how the individual capabilities concerned were related to procurement action. Where criteria were listed,

they proved difficult to apply in practice, particularly the notion of 'technology advantage' in DIS 2012. Except for DIS 2021, the creation of operational independence was not treated in sufficient depth to give confidence of a reliable outcome to meet rapid changes in the prevailing threat. Rather, it is seemingly left to chance that the equipment plan would deliver the requirement as a matter of business as usual. There was also evidence of naivety on the likely unfettered access to intellectual property and industrial know-how related to offshore procurements. As for future technology requirements, the strategies were inconsistent in approach and incomplete on exploitation routes. DIS 2005 was ambitious over the array of technologies relevant to future defence capability but did not provide roadmaps showing funding requirements for exploitation. DIS 2012 was explicit in its intention not to stipulate requirements for technology or procurement programmes thus providing minimal advice to industry with which to assist their investment planning. On routes to contract, although industrial partnering had been a continuous theme since the 1997 Smart Procurement Initiative, its treatment was variable. While DIS 2005 was very positive in seeing partnering as a vital tool for the onshore sustainability of capabilities in complex weapons and helicopters, it was largely ignored by DIS 2012. DSIS 2021 was more realistic in its approach but, throughout the period of this research, there seemed to be varying levels of reluctance over undermining the use of traditional competitive procurement. Taken together, until DSIS 2021, successive editions of the strategy have been unsuccessful in setting optimum "market conditions in which investment and production occur" which is the most important element of a DIS (Jacobs et al, 2017, p.2).

Aerospace project performance

There is little evidence in the analysis of successive editions of DIS at Chapters 4 and 5, the case studies at Chapter 6, and the interviews at Chapter 7 that the successive editions of DIS have enhanced aerospace project management performance. On schedule adherence, there is evidence of interrelated shortcomings in project management and in broader financial control of the equipment plan. Within the former, schedule delay resulted from slow progress towards contract agreement, inadequate supplier performance and external affordability constraints requiring a deferral to delivery. On occasion, such aspects were compounded by inadequate forecasting at the outset of a project, largely due to optimism bias. Turning to the components of delay, progress towards contract agreement was influenced by three factors: the availability of accurate data which had been agreed by both sides; a common view of technical risk; and a positive relationship between the MOD and the potential supplier. The Crowsnest case study demonstrated the adverse implications for subsequent schedule adherence within a fixed-price contract when neither the MOD nor industry understood the complexity of the systems integration challenge involved (NAO, 2021a, p.39, para.3.7). The subsequent supplier under-performance largely resulted from

inadequate oversight of the supply chain by the prime and because the lead sub-contractor under-resourced the project with sufficient people of the right calibre. Normal contractual penalties could be applied in the event of under-performance. Also, in its explanation of assessing value for money, DIS 2012 stated that "non-quantifiable factors may be relevant to value for money assessments, such as a supplier's track record and financial robustness" (MOD, 2012b, p.12, fn.6). However, the Procurement Act 2023 now allows firms exhibiting poor performance in public sector contracts to be excluded from future competitions: there is yet no evidence of such exclusions in defence procurement. External affordability constraints have also impacted on an individual project's schedule when reprofiling of the equipment plan is required to address overspends on other projects. For example, the two-year delay to Protector described in the case study resulted in additional costs of £356.2 million (MOD, 2019b, para 3). More broadly, cost-growth will often result from schedule delay. Overall, there is no compelling evidence in this research that DIS has served to enhance project schedule performance.

Turning to cost-growth arising from within aerospace projects, optimism bias and lack of awareness of technical complexity again led to inaccurate forecasting. Setting aside the impact of defence inflation and foreign exchange fluctuations, pre-contract cost growth was more common than that occurring post contract signature. A contributory factor highlighted in the interviews at Chapter 7 was that project Assessment Phases were often subject to delay (and hence cost increases) because of the complexity of the competitive process. Three factors were deemed to have assisted in enhancing recent post-contract performance (Parliament House of Commons, 2023a, p.27): improved project management skills at DE&S; the increased use of firm-fixed price contracts; and the higher degree of cost certainty that results from the interaction with industry during the contracting process (NAO, 2021a, p.27, para.2). However, two problems remain. Inaccurate cost forecasts (even at this improved level of performance) have injected turbulence into the equipment programme because the multi-year project funding stream has been incorrectly profiled. This, in turn, requires near constant budgetary adjustment to meet annualarity requirements and to stay within the departmental control total. Secondly, in some cases, cost growth has been controlled by reducing the number of platforms in the original requirement. For example, in the Wildcat case study, a reduction in aircraft numbers of 23% (from 80 to 62 initially) yielded a saving of just 12%. More broadly, across the twelve 'classic' aerospace procurements outlined in Appendix A to Chapter 1, six were subject to platform number reductions (Typhoon from 232 to160; Nimrod 21-9; A-400M 25-22; Wildcat, 80-66; Poseidon, 12-9; Wedgetail AWACS, 5-3). While the operational risk arising from these reductions in capability must be mitigated by doctrinal changes in tactical employment, there are also implications for value for money assessments. The root of these problems centres on the MOD's lack of an agreed definition of value for money. NAO sees value for

money as “getting as close as possible to achieving the optimum balance between cost, schedule and performance” but pointed out that MOD business cases “did not always set out a clear definition of VFM against which progress could be measured (NAO, 2021a, p.51, para.5.3). The interviews also pointed to the haphazard approach in successive edition of DIS (until DSIS 2021) in providing precision in defining value for money. DIS 2005 mentioned the term 98 times without providing a definition other than it was a long-term target (MOD, 2005a, p.48). Interviewees were particularly scathing about the approach in DIS 2012 which was seen as undermining industry’s confidence and acted as a disincentive to invest. It is also striking that the accounting officer’s report to the PAC when Protector exceeded its business case funding allocation stated that the value for money case remained robust despite the two-year delay resulting in additional costs of £356.2 million (MOD, 2019b, para 8). In the case of a non-competitive contract (such as Protector), MOD seeks to use value for-money benchmarks but, as the NAO confirms “this is not an exact science” (NAO, 2021, p.51. para.5.6). Overall, although cost forecasting has improved of late, there has been no parallel progress in defining value for money in a way that allows comparative project performance to be assessed based on the return on investment. Rather, as demonstrated in the interviews, there appears to be a lingering nervousness in MOD to deviate from the competitive approach to procurement with the result that value for money assessment is made on a case-by-case basis and is targeted at achieving the lowest price. Again, there is little evidence that that DIS implementation has had more than a marginal impact on improving project cost performance beyond the wider use of firm-fixed price contracts.

Sustainability of the defence industrial base

A significant aspect in the credibility element of the deterrence equation rests on the capability and resilience of the defence industrial base. Successive editions of DIS have recognised that the UK domestic defence equipment market is too small to sustain a full range of onshore capabilities in the defence industrial base (MOD, 1998a, Essay 2, para. 33; MOD, 2005a, pp.2,7; MOD 2012b, pp.6,19,42). The designation of sovereign capabilities that must be retained onshore, traditionally including just nuclear weapons, nuclear propulsion, cryptography and high-grade cyber security, is clearly insufficient to sustain the broader industrial base through which operational independence could be guaranteed. In this respect, Hartley (2020) and Taylor (2021) are correct to point out that it is the MOD’s spending choices that determine the configuration and characteristics of the UK defence industrial base. This calls for such choices to reflect the implications on sustaining the defence industrial base to avoid a cumulative erosion of sustainability.

As a result, three further considerations arise from the perspective of industry which largely go unrecognised in DIS but serve to undermine industry confidence. First, onshore defence firms crave stability of intent from their domestic customer, yet the UK MOD's procurement track record is tenuous in terms of solidity of funding and timely decision-making. The propensity towards short-termism and to control cost growth in the equipment plan by reducing the numbers of platforms required during production is problematic. It presents firms with workforce and supply chain sustainability problems, reduces future support revenues and weakens export potential. Collectively, such decisions also reduce combat mass thus undermining the capability element of deterrence. Secondly, the complex technology embedded in defence equipment calls for high-grade systems engineering expertise in industry which can be applied to future design and development. This type of noble work generates both intellectual property and tacit knowledge within a firm and thereby enhances both its sustainability and its competitiveness. 'Building to print' under an industrialisation licence from an offshore supplier does not generate the same core expertise. It is these competencies that must be applied to sustaining capability during tension and operations through increased support for high rates of usage, capability upgrade and safety management: together, they represent the foundations of operational independence. Thirdly, DIS analysis on operational independence pays little attention to the configuration and geographical location of supply chains. Firms face a dilemma over ensuring what might be an effective and efficient supply chain during geopolitical calm could cease to be so when threats change. Successive editions of DIS profess support for the onshore defence industry but only DSIS 2021 conveyed a pragmatic understanding of the broader need for an onshore industrial footprint capable of providing key elements of operational independence.

The recognition that traditional DIS approach to industrial sustainability of 'one size fits all' was sub-optimal led to MOD's post-2017 publication of bespoke sub-sector strategies. Of note, the National Shipbuilding Strategy (MOD, 2017c) and the Combat Air Strategy (MOD, 2018b) made significant contributions to future onshore sustainability. In recognising the long-term nature of large system design and manufacture, each set out a pathway of development opportunities and procurement decisions that should be addressed through the perspective of continued UK onshore industrial activity. However, there has been no UK industrial capacity for the end-to-end production of large aircraft (civil or military) since 2001. It is therefore unsurprising that, of the twelve classic procurements described in Chapter 1, six of the seven large aircraft were procured offshore, four from the US and two from Airbus Europe. The seventh was the Nimrod project which was cancelled in 2010 after a nine-year schedule delay. However, of the two combat air projects, Typhoon was a European collaboration and F-35 was an offshore collaboration with the US where the UK was the

sole junior partner for the development phase. While F-35 yielded 15% of the project value as revenues to onshore UK firms, there was little noble work involved which risked a post-Typhoon atrophy of fast-jet design and development engineering skills. However, the Combat Air Strategy created Team Tempest with a £2 billion initial investment which is focused on the design and development of a sixth-generation combat aircraft thereby enhancing sector sustainability.

SDR 1998 and subsequent editions of DIS included statements stressing the value of the defence industry to the broader economy, the high-grade skills concerned, and the number of jobs involved (MOD, 1998a, para. 162; MOD, 2005a, p.55, para. A9.2; MOD, 2012b, p.6; HMG, 2021a, p.2). On the latter aspect, SDR 1998 quoted 400,000 direct and indirect jobs, DIS 2012 reported 300,000 and DSIS 2021 estimated 200,000. Despite the increased automation introduced in advanced manufacturing throughout this period, the figures indicate the degree of consolidation that has taken place. In addition, the interviews point to a strong Treasury aversion to DIS regardless of the incumbent government. The publication of long-term undertakings to onshore firms whether UK owned or not was not encouraged. In considering this type of Treasury orthodoxy, Wilkes et al (2024) caution:

> Scepticism is a vital characteristic of any finance ministry but can lead to good policies being rejected, especially when combined with the Treasury's power, the lack of counterbalance from other parts of government, and the inexperience of its spending officials (Wilkes et al, 2024, p.5).

In terms of the political tone of successive editions of DIS, there has been little inconsistency between the parties save potentially in one detail. Having lauded the UK defence industry's global performance, DIS 2012 under the Coalition government introduced a paradox within the strategy's very narrow definition of value for money in stating that "the MOD does not consider wider employment, industrial, or economic factors in its value-for money assessments" (MOD, 2012b, p.12 fn.6). It seems unlikely that, despite the austere economic conditions of the time, Labour would have wished to have been so explicit. Otherwise, there is little to choose between governments on the quality of their implementation of DIS. In every case, the strategic objectives have been undermined by financial considerations emanating from an unaffordable equipment plan. That said, the sub-sector strategies have made some headway in charting a route to improved industrial sustainability and gained a consensus of approval in the interviews as the preferred tool for managing the sustainability of individual segments of industrial capacity.

Optimising the effectiveness of DIS

This research demonstrates that there are three challenges in optimising the effectiveness of a DIS which are inexorably interlinked. First, the formulation must be comprehensive from end-to-end to create a coherent framework covering all aspects of the acquisition life cycle from concept design and requirement capture to industrial production and through-life support. Secondly, effective implementation will be thwarted unless there is a stable and affordable equipment budget to fund the required industrial activity: this is a compelling requirement without which effort expended on DIS design would be rendered nugatory. Thirdly, the culture across the entire enterprise must be attuned to working effectively and harmoniously towards the common purpose of equipping the armed forces with the right equipment on time at acceptable value for money. Across the period of this research these aspects of the 'ways' and 'means' by which to attain the strategic 'ends' have been in constant tension to the detriment of achieving the objectives of a DIS. Success rests on solving all three of these problems but there are no quick solutions. This situation calls for long-term transformation with the need to prioritise. The most urgent priority for DIS to address is MOD's management of the equipment programme which, in turn, would not only enhance the wider implementation of DIS but would also address the strident and valid criticism from the PAC and defence select committee described in Chapter 1.

Addressing financial management

In terms of this primary concern over financial management, two aspects are germane. First, the envelope of funding must be realistic and affordable within the wider defence budget to meet the cost of the force structure. But it must also be stable if it is to provide the meaningful level of resources against which to formulate a DIS. Of note, none of the pre-2021 reviews resulted in a fully funded force structure, requiring MOD to manage the financial gap on an annual basis (Jessett et al, 2020, p. viii). In addition, financial instability in a procurement environment is problematic, particularly in cases where advanced technology is involved. Turbulence on cost and time (which also articulates as cost) also arises through other risks such as foreign exchange fluctuations, unexpected spikes in inflation and friction in supply chains. Beyond the obvious need to retain headroom against such contingencies, interviewees were clear that long-term stability would only result by making the equipment resource envelope more elastic. Three options are available and are likely to be required in combination. First, MOD should be allowed greater freedom in the defence budget to extend the use of portfolio funding which applies a constraint on a group of projects rather than just on a single project. Secondly, Treasury annualarity rules should be amended to allow a greater degree of year-end carry-over in the defence budget. Thirdly, MOD's capital expenditure programme should be configured around multi-year funding arrangements such as that applying to Highways England through the five-year 'Road Investment Periods' (DfT,

2020). The future provision of these additional freedoms would need the MOD to build greater confidence within the Treasury and the centre of government over its effective stewardship of public money.

Confidence in MOD's procurement expertise will need to be demonstrated though enhanced project management performance and especially the cost and schedule control of individual projects. Improvements in this area would clearly alleviate the cumulative effect of cost and time overruns which cause the equipment plan to overheat. It would also eradicate the damaging syndrome of controlling costs by reducing platform numbers thus failing to meet the original project requirement. The first step in solving this problem would be to add greater certainty to the initial forecasts of cost and time by addressing optimism bias which, according to the interviews, is endemic in the procurement enterprise. While this research shows that several cognitive biases are at play, optimism bias is used as a generic term in MOD, but true optimism bias is indeed the most prevalent. The solution would be to reconfigure MOD's procurement practices to align with best practice in high-risk project management by applying reference class forecasting techniques to the initial assessment of time and cost before they are entered into the equipment plan and become set in stone. This level of assurance, coupled with the more elastic funding envelope, would eradicate the current perception among the equipment customer community that bidding low stands more chance of achieving scarce funding in an already overheated equipment plan. Taken together, these initiatives should allow more realistic formulation of a DIS and increase confidence in its content thus enhancing its deployment.

Formulating an optimum DIS

Returning to the formulation of a DIS, past editions have suffered by addressing only part of the procurement enterprise so that it was left to periodic bottom-up change programmes to introduce adjustments in procurement process. This approach was deemed to be ineffective by interviewees in that strategy and process were not harmonised within a coherent framework. Rather, it encouraged a case-by-case approach to equipment procurement which could undermine strategic aims on operational independence and the sustainability of the industrial base. This shortcoming needs to be addressed by taking an end-to-end approach covering several elements. First, given the advantages of long-term partnering with industry exposed in Chapter 8, the strategy should explain how this route to contract for both equipment and its support is to be optimised to meet the requirements of sovereign capability and operational independence. The latter represents a wide agenda so a DIS should also address the need for agility across a broad range of industrial capacity through framework agreements as outlined in Chapter 8. In the same vein, the strategy should contextualise the future role for competitive procurement to remove any lingering doubts

that it is no longer the default option. DSIS 2021 was effective in articulating this changed policy (HMG, 2021a, p.6) which recognises the increasing use of single-source contracts to meet sovereign requirements and those associated with operational independence. These amounted to 44% by value (£16.4 billion) in 2023/24, a 5% increase over the previous financial year. As the interviews point out, defence contract negotiations are necessarily complex and, given the levels of cost involved, negotiations can become fractious and sometimes overly adversarial. Addressing this issue requires the formulation of a code of conduct and a compact on behaviours between MOD and its suppliers as an addendum to both a (legally binding) partnering arrangement and a (non-binding) partnering agreement.

Thereafter, a 'defence equipment investment plan' needs to be included which outlines future equipment requirements and indicative funding. Previously, some (but not all) of this data has been included in the annual equipment plan which has become less granular since its initial introduction after DIS 2012. More recently, a *Defence Capability Framework* has been published for the first time with the aim of providing "a longer-term demand signal to industry" (MOD, 2022k, p. 3). It states at number seven among its nine *Guiding Principles for Capability Development*, "Maintaining a balanced and affordable Defence Programme" (MOD, 2022k, p. 3). The stand-alone annex (MOD, 2022l) gives broad-brush detail on forthcoming major procurements with indicative costs and timeframes for investment: with the inclusion of more granular data, this would be an appropriate element of a DIS. But there also needs to be clarity on how value for money is to be assessed to allow effective benchmarking and thus add to a future reference class forecasting database. Such an approach fulfils one of the primary aims of a DIS to inform industry on future requirements so that firms can adjust their investment accordingly. This is particularly the case for industry's research into emergent technologies where a DIS needs to convey priorities, explain exploitation routes and funding strategy. Opportunities for co-investment leading to technology demonstrators or prototypes need to be explained as these are especially appealing to industry as they are symbolic of the MOD's intent to pull-through technology into front-line equipment. Recent successful examples are the technology demonstrator for counter-drone directed energy weapons (MOD, 2024i, paras.1-2) and the development of the prototype Tempest sixth generation fighter which is due to fly in 2027 (MOD, 2022f, para.1).

One of the salient 'ways' in achieving the 'ends' of a DIS is the effectiveness of the associated procurement processes as they apply to both MOD and industry. Here, the strategy should expose recognised weaknesses and mandate remedial action. Current topics in this category would be the weakness in project forecasting caused by extensive optimism bias among stakeholders. The remedy would be to stipulate the use of reference class forecasting. In this respect a well-

functioning relationship between MOD and industry will be important in generating acceptance of the need for change. The interviews suggest that the MOD's procurement personnel would find this difficult because of their concern over jeopardising their commercial neutrality. However, in formulating a DIS of the type recommended here, close consultation with industry will be required. Successive editions of DIS have been preceded by a consultation phase with a wider audience than just industry but, normally, based on respondents answering a range of set questions. This sterile approach rarely provides the optimum input from industry. Whilst this process might usefully lead to an initial draft of a DIS, thereafter industry (through the trade association and the MOD co-chaired Defence Suppliers' Forum) should be involved in refining drafts and providing statements on the impact on industry of proposed DIS measures to ensure that the strategy is deliverable. This will be important in creating the strategy's action plan and performance metrics, aspects that have been absent from previous editions of DIS. In this respect MOD should provide annual performance reports to parliament alongside an update to the strategy's defence investment plan.

Taken together, a DIS of this nature should be more effective in informing industry of future requirements and in incentivising participation in the UK market. A DIS in this format could be expected to convey more gravitas given that it represents a response to an increasingly dangerous world where the credibility of deterrence is of growing importance. To that end, DIS should continue to be laid before Parliament as a Command Paper conveying that it is "by Command of His Majesty" under the royal prerogative (Parliament, 2025). In addition, it should be a government sponsored strategy (as was DSIS 2021) rather than an MOD departmentally sponsored paper as were DIS 2005 and DIS 2012. This would address the weaknesses identified in the literature review about the lack of cross government buy-in of industrial strategy which has been a past barrier to implementation. For a DIS, with MOD as the sponsor and in consultation with the Department of Business and Trade, it should be a pivotal requirement to secure National Security Council (NSC) endorsement. Such an approach would lock-in Number 10, the Cabinet Office, the Treasury, the Home Office and the Foreign, Commonwealth and Development Office. En route, the DIS should be agreed by the two sub-committees, the NSC (Nuclear) and the NSC (Resilience) thereby involving the Department for Energy Security and the Department for Net Zero and Science, Innovation and Technology. The NSC should also delegate DIS implementation monitoring to an ad hoc sub-committee.

Culture Rather Than Contracts

Provided that a DIS is plausible in the way in which it harmonises its ambitions with the prevailing financial environment, its successful deployment and acceptance across MOD and industry depends on the prevailing culture. In this respect, culture arises from the two ingredients of

tradition and organisational structure. While they overlap, their roots are different. Nevertheless, an effective DIS needs to address both. On tradition, the cultural impact of the 1985 Levene review's introduction of competitive contracting placed MOD firmly in the driving seat of culture. The impact was characterised in the introduction to this research (Chapter 1) by terms such as mutual suspicion, creative tension, confrontational style and outright hostility. Ahead of SDR 1998, Lord Robertson described the culture as 'trench warfare'. Despite the reduction in competitive contracts since 1985, the interviews (Chapter 7) added further texture with a recognition that the culture of competition still runs deep with a resulting adversarial relationship between MOD and industry serving to limit the effectiveness of partnering. Contrasting these research findings with a 2005 report by the NAO suggests that change has been slow to take root:

> Successful working relationships are characterised by soft factors such as team working, trust and honesty. When the Department and its industry partners on a project display these behaviours, they are more likely to develop a common understanding of the task, the progress being made and give early warning of problems (NAO, 2005b, p.7, para1.1).

DIS 2005 was bold in seeking to address the problem of culture through a defined set of 'Defence Values for Acquisition' including: recognition and respect for the contribution made by industry; openness and transparency; a through-life culture in in all planning and decision-making; attaching value to objectivity; and recognising that success and failure matter (MOD, 2005a, p.132). In so doing, the strategy pointed out that relationships that "are purely transactional and conducted at arms-length will struggle to meet these challenges. Increasingly they demand the use of a different style of relationship" (MOD, 2005a, p.133). In addition, it was clear that the goal was to create a relationship that was "less adversarial in style, based on a mutual understanding of where the motivations and interests of each party lie, acknowledging and managing the areas of difference and tension" (MOD, 2005a, p.133). However, there was also recognition that these ambitions, which would be firmly rooted in project performance, would be challenging to deliver and would place greater demands on industry. Furthermore, competition remained the bedrock of procurement but with limited recognition that it might not always present the right answer. In essence, a forward-leaning set of values seemed to be in danger of being reined-back by the those who felt that competition was the primary lever by which to regulate industry.

This same notion was even more prevalent in DIS 2012 which pointed out that, while the MOD had some long-standing arrangements with industry, the relationship needed to be rebalanced (MOD, 2012b, p.50). Culture and values were not mentioned with the result that much of the positive industrial sentiment that had been generated by DIS 2005 was reversed. By the time of publication

of DSIS 2021, partnerships were very much back in vogue, accompanied by an MOD undertaking to be "as transparent and inclusive as possible about our future plans and priorities" (HMG, 2021a, p.6). The strategy was clear on the need for a deeper and more sophisticated strategic MOD-industry relationship, which was more direct, trusted, committed and transparent (HMG, 2021a, p.79). Overall, as confirmed by the interviews, across the period of this research, until DIS 2021, a succession of industrial strategies has been unable to release the shackles of competition sufficiently to remove the grounds for trench warfare. A shortcoming of all versions of DIS in this respect was that, while they identified the 'what?' and 'why?' over the need for cultural change, they were deficient in articulating the 'how?'. Some of the frictions would be eased if initiatives to improve project management (particularly on forecasting) and the harmonisation of DIS with the prevailing financial climate were to take root. But a future DIS optimised for deployment needs to instigate a top-down programme of cultural change related to interaction with suppliers across MOD, backed-up by appropriate HR strategies and performance reporting. The DE&S annual report for 2023-24 refers extensively to internal culture in terms of professional excellence and staff diversity emphasising that "Creating a culture and environment where individuals can bring their true selves to work is important to DE&S" (MOD, 2024b, p.11). Elsewhere, the report paraphrases the 2023 Defence Command Paper Refresh which states:

> However, we need to further transform our relationship with industry – forging a new alliance – to create an environment that generates a shared sense of national endeavour Industry is, and must feel, part of the Defence Enterprise. This must also be visible: being in perfect lockstep with a resilient industrial base will underpin our credibility as a fighting force, demonstrate our dependability as an ally, and deter our adversaries. (MOD, 2023e, p.30).

Beyond citing the role of the MOD's Head Office Strategic Partnering Programme, there is no mention in the DE&S report on how this important directive is to be delivered. It could thus be deduced that, despite the strong views articulated by the interviewees in this research, the MOD's delivery organisation does not regard relationships with industry as a problem.

In the end, it is this cultural gap that is the real problem that only an external intervention can resolve. Reverting to Mintzberg's theories, the barrier to effective deployment of a DIS arises from organisational structure. Focusing on the DE&S as the MOD's primary delivery organisation, it was deemed to represent a machine bureaucracy with a strong technostructure. Given its direct interface with industry, the DE&S is an important agent in the acceptance, deployment and implementation of a DIS to the extent that the strategy should be 'visible' in its contractual dealings

with industry. But, according to the interviewees – both officials and industrialists - this is not the case. In practical terms, it might be that the organisation has been subject to near continuous bottom-up acquisition reform initiatives which compete for attention and relevance with the top-down strategic imperatives arising from a DIS. As such, those at the contracting interface are focused on delivering their individual projects which, according to Mintzberg, generates a significant bureaucratic momentum that crowds-out the ability for a DIS to become embedded. However, in a study of a range of machine bureaucracies Mintzberg recognised that machine bureaucracies are ill-suited to strategic change and concluded, as does this research that:

> We emerge from this discussion with two conclusions. First, strategies must be formulated outside the machine bureaucratic structure if they are to be realistic. Second, the dichotomy between formulation and implementation ceases to have relevance in times of unpredictable change. Together these conclusions tell us that Machine Bureaucracies are fundamentally nonadaptive structures, ill-suited to changing their strategies (Mintzberg, 1979, p.319).

Appendices

Appendix A (Chapter 1) - Aerospace Project Performance 1998 - 2023

Project/Prime	Route to contract	Initial Gate	Main Gate	Approved Cost (£B)	Actual Cost (£B)	Cost Overrun %	Planned Delivery	Actual Delivery	Overrun (Months)	Approved Number	Final Number
Typhoon BAE Systems	Single source Collaboration (4)	Jul 85	Nov 87	15.173	17.453	**15.0**	Dec-98	Jun-03	**54**	**232**	**160**
C-130J Lockheed Martin	Competition (FMS) Off the shelf	Jul 93	Jan 95	1.045	1.042	**-0.3**	Jul-98	Jun-00	**23**	**25**	**25**
Nimrod MRA4 BAE Systems	Competition (Cancelled)	Nov 92	Jul 96	2.813	3.602	**28.0**	Apr-03	Oct-12	**114**	**21**	**9**
A-400M Airbus Military	Single source Collaboration (7)	Jul 97	May 00	2.238	2.752	**23.0**	Dec-09	Sep-15	**70**	**25**	**22**
Hawk 128 (28) BAE Systems	Directed single-source	Dec-02	Dec-04	0.471	0.445	**-5.5**	May-09	Feb-10	**9**	**28**	**28**
F-35 Lockheed Martin	Single source (FMS) Collaboration (2)	Nov 96	Dec 06	5.622	5.036	**-10.4**	Dec-18	Dec-18	**0**	**48**	**48**
Voyager (14) Airbus	PFI (includes support)	Dec-00	May 07	12,307	12,266	**-0.3.**	May-14	May-14	**0**	**14**	**14**
Lynx Wildcat (Land & Maritime) AgustaWestland	Single Source Development	Dec 01 & Sep 02	Jun 06 & Dec 08	1.803	1.663	**-7.8**	Jan 14 & Jan 15	Aug 14 & Jan 15	**7/0**	**80**	**66**

Project/Prime	Route to contract	Initial Gate	Main Gate	Approved Cost (£B)	Actual Cost (£B)	Cost Overrun %	Planned Delivery	Actual Delivery	Overrun (Months)	Approved Number	Final Number
Air Seeker (3) L-3 Communications	Single Source (FMS) Development	Aug 03	Mar 10	0.633	0.634	**0**	Nov 13	Nov-13	**0**	**3**	**3**
Poseidon P-8A (9) Boeing	Single Source (FMS) Off the shelf	Nov 15	Jan 16	2.392	2.207	**-11.0**	Apr-20	Apr-20	**0**	**12**	**9**
Protector (16) GA-ASI	Single source (FMS-hybrid)	Dec 09	Jun 16	0.929	1.463	**57.3**	Nov 18	Nov 24	**72**	**16**	**16**
Wedgetail (6-3) Boeing	Single Source (FMS) Development	Oct 18	Feb 19	2.084	2.156	**3.5**	Dec 23	2026	**24**	**5**	**3**

Table A-1 - Aerospace Project Performance 1998 – 2023

Sources: NAO Major Project Reviews 1996-2015; IPA MOD inputs 2016-2023; NAO, 2011, Management of the Typhoon Project (HC 755); NAO, 2025, The UK's F-35 Capability (HC 989)

Appendix B (Chapter 1) - Abbreviations and Glossary of Terms

Source: MOD and NAO documents unless otherwise cited.

AEW – Airborne Early Warning: usually provided by an aircraft or helicopter equipped with a powerful radar to provide a recognised air picture for cooperating forces.

ALARM – Air Launched Anti-Radiation Missile: a complex weapon used to attack an adversary's ground radar installations.

ALARP – As Low AS Reasonably Practicable: a term used in risk management referring to regulate the residual risk in safety-critical systems.

ASW – Anti Submarine Warfare

CBRN - Chemical Biological Radiological and Nuclear: capabilities which together or individually represent weapons of mass effect.

CEPP – Carriera Enabled Power Projection: a UK capability consisting of the integration of aircraft carriers, F-35 combat aircraft, surveillance and offensive helicopters, escort warships and logistic support shipping.

Cognitive bias in defence procurement includes ambiguity aversion (the tendency to favour known risks over unknown risks); availability bias (the use of readily available information rather than the most representative information); and framing bias (where the way data is presented can affect decision making).

Cost escalation is the change in the price of goods and services over time. In defence it is primarily caused by the need to match adversaries' technological developments. It thus consists of two components: intergenerational cost escalation (the change in cost between one platform and the next generation of a similar platform); and defence inflation.

Cost growth is traditionally understood as the difference between actual and estimated costs (Arena 2008). This is different from 'cost escalation', which is the change in the price of a specific good/service over time; it can be measured as percentage change in cost between time periods

(Arena 2008). In MOD, **cost growth** is the difference between estimates and actual cost. In defence procurement, it consists of three components: optimism bias; poor understanding of risk and assumptions; and workforce challenges (slow supplier build-up and MOD skill shortages).

DE&S – Defence Equipment and Support is the delivery organisation within MOD for the procurement and support of military equipment except for submarines, nuclear aspects and information systems.

Defence Inflation is defined by the MOD as the average change in both pay and the prices of goods and services that make up the defence budget, adjusted for quality and volume (MOD, 2017b*).* Consequently, defence inflation contributes to cost escalation by affecting the price at which inputs of an equipment project are bought. Defence inflation data has not been published externally since 2015/16 (MOD, 2015c).

DIP – Defence Industrial Policy is a refined subset of the generic definition of industrial policy of any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention. (Warwick, 2013, p. 16). In defence, DIP is concerned with balancing equipment capability, value-for-money and the sustainability of the defence industrial base.

DIS – Defence Industrial Strategy is a rented subset of the generic definition of industrial strategy of the purpose-driven coordination by the state of its supply-side economic policies that relate to the productive capacity of the economy, and the market conditions in which investment and production occur (Jacobs et al, 2017, p.2). DIS is particularly concerned with creating appropriate conditions by which to motivate firms to participate in the UK defence market.

FCAS - Future Combat Air System: a UK capability development programme leading to the creation of a sixth-generation combat aircraft (both manned and unmanned) supported by a suite of collaborating drones.

FDI – Foreign Direct Investment

GA-ASI - General Atomics Aeronautical Systems Inc: a US defence manufacturer of drones and other high-tech systems including the UK's Predator and Protector drones.

Green Book contains the Treasury's guidance on the conduct of appraisal and evaluation of procurement business cases.

FMS – Foreign Military Sales is the US export arrangement for government-to-government sales of defence equipment to other nations.

FOC – Full Operating Capability is the level of military capability which is intended for a particular programme.

HCDC – House of Commons Defence Committee

IAC- Investment Approvals Committee: the senior MOD body responsible for the investment decisions on major projects on behalf of the Defence Board.

IED – improvised Explosive Device: an explosive device normally using low technology materials, frequently detonated remotely and often employed by asymmetric enemies.

Industrial policy is any type of selective government intervention or policy that attempts to alter the structure of production in favour of sectors that are expected to offer better prospects for economic growth in a way that would not occur in the absence of such intervention in the market equilibrium. (Source: Pack, H. and Saggi, K. (2006)

IOC –Initial Operating Capability is the minimum level at which the capability or service is usefully deployable

IPA - Infrastructure Projects Authority is the government's centre of expertise for infrastructure and major projects which reports to the Cabinet Office and the Treasury. The IPA provides an annual assessment of the deliverability of projects (including MOD equipment procurement) based on submissions from project Senior Responsible Owners (SRO). From April 2005, now known as the National Infrastructure and Service Transformation Authority (NISTA) having been combined with the former National Infrastructure Commission.

IP & IPR – **Intellectual Property and Intellectual Property Rights** is a created by the human mind and leads to an invention, design or specific process and thus covers copyright, trademarks, patents and systems' design. The **rights** are owned by the creator or by a third party through acquisition or licensing.

ISC – Industrial Strategy Council was an independent body tasked to provide impartial and expert evaluation on the implementation of the government's 2017 industrial strategy: it was controversially disbanded in 2021 to be replaced in 2024 by the Industrial Strategy Advisory Council.

ISD - In-service Date is the date on which a programme enters service.

ISTAR – Intelligence, Surveillance, Target Acquisition and Reconnaissance is the capability resulting from a range of sensors and other inputs to provide situational awareness.

ITAR – International Traffic in Arms Regulations: the US regulatory arms control process for the export of defence equipment, technology and services

KUR – Key User Requirements define the specified equipment performance in about ten high level requirements in suitably broad-brush terms to be meaningful to parliament and other government departments without breaching security classification requirements. Prior to 2016, the MOD published KUR performance associated with each project. Subsequently, KUR's have been reported only by exception in MOD's annual reports to the Infrastructure Projects Authority (IPA).

MAA – Military Aviation Authority is responsible for the regulation, assurance and enforcement of defence air operations and associated technical aspects.

MOD – Ministry of Defence is the generic term for the Ministerial department which is supported by 25 agencies and public bodies charged with working for a secure and prosperous United Kingdom and with the protection of overseas territories. This research uses the term to cover the collective do the MOD Head Office, the front-line commands and the procurement delivery organisation DE&S.

NAPNOC – No Acceptable Price, No Contract is a term related to the 1985 Levine procurement review to account for cases where running a completion was implausible. In these circumstances three contracting principles applied: pricing at the outset; benchmarking against a 'should cost' market price; and the ability for a firm to improve profitability through innovation.

Optimism bias is defined in the Treasury's 2020 Green Book as the proven tendency for appraisers to be optimistically biased about key project parameters, including capital costs and operating costs, project duration, and resulting benefits delivery (HMT, 2020b). It is not unique to defence.

Organisational Structure refers to the formal configuration between individuals and groups regarding the allocation of tasks, responsibilities, and authority within the organisation (Galbraith, 1967)

PAC – Public Accounts Committee

PSS - Private Sector Support is the term used by DE&S for commercial consultancy support in areas such as engineering design and contingent labour.

R&D – Research and Development is a government or firm's systematic activity aimed to create novel technology or products. The term is subject very loose usage in public life. In defence procurement, its usage is determined through the OECD-endorsed Frascati principles which define the three R&D activities of (and boundaries between) basic research, applied research and experimental development.

Redetermination - a term used in fixed-price contracts to describe the risk mitigation measure for both buyer and seller allowing adjustments to be made under specific circumstances such as cost overruns or changes in the baseline profit rate (MOD, 2014a, Single Source Contract Regulations 2014, Annex A).

Risk:

- **Technical risk** is the exposure to the chance that development of critical technologies does not meet programme objectives within the delivery envelope (cost, schedule, performance).

- **Design risk** is the exposure to the chance that the weapon system's design will not result in effective operation or be easy to produce. (System) integration risk is the exposure to the chance that new and existing technologies employed in the weapon system do not work together and/or interact with operators and maintainers in way that enables effective programme delivery on schedule and on budget**.**
- **Business risk** is the exposure to the chance that the overall acquisition strategy and decisions about the process to select the winning bidder, standards to which the system is required to be built and schedules for design and build do not lead to effective programme delivery on budget, on schedule and meeting the performance requirements (Murphy & Birkler 2009).

RPAS – Remotely Piloted Air System such as Predator and Protector where there is a human in the operating loop.

RtL – Risk to Life in military aviation is regulated through the MAA the MAA's Regulatory Article 1210 which in essence requires **Risk to Life** to be **As Low AS Reasonably Practicable (ALARP).**

SRD - System Requirement Document is the detailed specification required at the end of the Assessment Phase required to justify the investment for demonstration and manufacture outlined in the Full Business Case.

SPA – Strategic Partnering Agreement is a legally binding contractual arrangement between MOD and a firm, which is normally long-term and incentive based, for the delivery of logistic support and, occasionally, for initial manufacture.

Single Source Procurement involves contracting with a single firm when running a competition is not feasible because of sovereign capability requirements, the existence of a sole supplier in the market, the nature of the technology involved or for security reasons.

SSRO – Single Source Regulations Office is a statutory executive non-departmental body, sponsored by the MOD, to operate a regulatory framework for single source contracts through pricing control.

SRO - Senior Responsible Owner who is accountable to the MOD Permanent Under Secretary and to Parliament for the delivery of the project.

TLCM Through-Life Capability Management is a support and upgrade arrangement, normally associated with a Strategic Partnering agreement to fuse routine servicing with incremental capability upgrade as technology matures or the requirement changes because of a changed treat without entering into costly equipment mid-life upgrades.

UOR – Urgent Operational Requirement relates to the need to upgrade equipment or generate greater numbers in the face of an immediate threat during operations using a streamlined procurement process. The term has since been replaced by **Urgent Capability Requirement (UCR).**

URD – User Requirement Document is the first step in project definition through which to define the operational need for a new capability, the military effect that is to be achieved, the quantity required and the timescale. It is used in the Outline Business Case to support investment in the Assessment Phase.

Appendix C (Chapter 6) – UK Defence Equipment Procurement Process

UK procurement context

Procurement projects frequently adopt new and untried technology with development stretching over many years during which time much can change in terms of technological advances, budgetary limitations and the fine detail of the requirement itself. While adjustments to the procurement process have been made during the period of this research, the broad principles have remained the same. Across this period, the UK's defence procurement enterprise has been characterised by late delivery and excessive cost growth. In attempts to address these failings, there have been several process and organisational reviews but the core DNA of the mechanics of procurement rests on the introduction in 2000 of 'Smart Acquisition' which itself had its roots in the 1998 Strategic Defence Review's Smart Procurement Initiative (Gray, 2009). It was aimed at delivering on the Review's procurement mantra of 'faster, cheaper, better' based on the incremental and progressive procurement of defence capability at lower risk and by optimising the trade-offs between performance, time and cost. It was also to be configured to speed-up the integration of new technologies to enhance front-line military capabilities.

In defence policy planning, there is a constant need to analyse the likely threats facing the nation's security over an extended timescale. Designing, demonstrating and manufacturing major defence platforms is necessarily lengthy so it can take more than a decade for new equipment to reach the front-line user. Long-term concept studies are therefore initiated on a continuous basis to determine the types of capability required to address future potential threats. Decisions over procurement timing can also be complex given the range of potential catalysts. Existing equipment might have reached the end of its useful or cost-effective life and needs to be replaced. A change in threat might have arisen, or be predicted to arise, over the next decade or so requiring an entirely new capability aligned to the policy response. Technological advances might indicate a new way of addressing an existing or predicted threat with greater certainty. Lessons may have been learned from recent combat operations that result in the need to introduce new equipment. Within this process known as Force Development, these catalysts are rarely neatly bounded. Rather, requirements arise from a combination of all these factors. There are thus early judgements to be made over the timescale of the resulting procurement and its affordability. Operational risk from delay and the financial risk arising from necessarily loose initial cost estimates are also factors. This research describes the procurement process through two lenses. The first, which is covered in detail in this appendix, sees a systematic, mechanistic process consisting of many streams of activity that are

assumed to be perfectly synchronised. The second, which is covered in the main body of the research, recognises the role of people within that process. A report by an independent King's Counsel into the major procurement failure for a complex armoured vehicle cited a lesson from the Infrastructure and Projects Authority (IPA):

> Behaviour matters more than process. There are common traits that can lead to the wrong behaviours and decisions on major projects. These are not easily countered even with clear accountabilities and structural checks and balances. They need to be searched for, recognised when they exhibit, and actively countered through calm and objective assessment of the evidence and by instilling the right behaviours within and between organisations (DfT & IPA, 2019, p.6).

Project initiation

The first step in procurement is to create a User Requirement Document (URD) through which to define the operational need by defining the effect that is to be achieved, the level of certainty required in achieving that effect, the quantity needed and the timescale. The URD also provides the discipline of bounding the recognised capability gap that is to be filled. In addition, the URD ultimately leads to the creation of a Systems Requirement Document (SRD) which defines the acquisition solution in technical terms that are later articulated as a specification. But defence capability does not consist solely of a platform and its weapons such as an aircraft a ship or a tank. Rather, it relies on the convergence of what are termed in UK doctrine as Defence Lines of Development consisting of training, equipment, personnel, Information, doctrine, organisation, infrastructure and logistics. The term 'acquisition' refers to the through-life provision of all the Lines of Development whereas 'procurement' is the transaction that provides the platform, and its weapons. Increasingly, this initial stage procurement will additionally include the through-life support solution and training simulators. Successful project delivery also relies on the effective integration with dependencies in terms of capabilities provided from elsewhere in the equipment plan.

The MOD refers to the project life cycle as the CADMID Cycle consisting of consecutive phases of Concept, Assessment, Demonstration, Manufacture, In-service and Disposal (MOD, 2018d). Procurement is focused on the first four phases. Until 2019, the MOD applied a two-gate principle to approvals each of which triggers subsequent activity and investment. These were known as the Initial Gate Business Case and the Main Gate Business Case: this process applies to all the case studies in this research. From 2020, the government introduced a standardised

three-gate process across all procurement projects, but which does not apply retrospectively to live MOD projects (Taylor, 2020). The Initial Gate Business Case launches the Assessment Phase activity. The preceding Concept Phase represents project initiation which, until the Levene Reforms of 2011 was led by the central MOD Capability Staff (MOD, 2011). The implementation of the Levene report saw the MOD Head Office reverting to a more strategic role in terms of financial oversight and investment approval. Delegation of the mechanics of most procurement projects including budgetary control was passed to the front-line commands (Navy, Army, Air or Strategic Command) with IT and nuclear-related acquisition handled by specialist bodies. In effect, the capability staff involved merely moved location in 2011 retaining broadly the same types of personnel with the same level of expertise. However, they were placed under military command in an organisation with a different culture which was more readily aligned with the front-line of the armed forces.

The Concept phase is conducted by a Delivery Team within the front-line command's equipment capability staff under the leadership of a Senior Responsible Owner (SRO). The SRO is personally accountable under a letter of appointment to the Permanent Under Secretary and to Parliament for the delivery of the project. Regardless of the location of the Delivery Team, such concept studies are a collaborative effort between the front-line staff, the MOD central staff, the Defence Intelligence Staff and the Defence Scientific Staff. There is also the also need to consult industry over technology maturity and integration risk. Their collective role is to create the URD, identify potential solutions for in-depth study in the Assessment Phase and obtain the necessary funding for those studies. This activity culminates in the production of the outline business case which rests heavily on the URD by which to gain Initial Gate investment approval. The MOD's Investment Approvals Committee considers the highest value and most contentious projects but can delegate approval to the front-line commands for projects below £400 million. Projects valued at over £600 million must receive Treasury approval. Lower value investment in selected areas such as IT or the appointment of external consultants also requires Cabinet Office approval.

The Assessment Phase leads to the second gate known as Main Gate which relies on a Full Business Case based on an SRD that meets the users' needs by defining the most cost-effective procurement and technology solution (MOD, 2023b). This requires trade-offs between time, cost and performance to meet affordability criteria. It also requires risk reduction analysis to ensure project delivery within the tightly defined cost, time and performance criteria. Smart Acquisition guidance is that 15% of the total procurement budget should be invested in

achieving the associated refinements and in early risk mitigation. There is also a requirement to develop elements of the Through Life Management Plan and to define the project milestones. These include: the In-service Date (ISD - the point at which the project enters service); the Initial Operating Capability (IOC - the minimum level at which the capability or is usefully deployable); and the Full Operating Capability (FOC – the project's target level of military capability). Once endorsed for Main Gate investment, responsibility for tendering and contract negotiations passes to the Project Delivery Team at the Defence Equipment and Support organisation (DE&S) which also manages the Demonstration and Manufacture phases. A former Executive Agency, DE&S became an arms-length body of the MOD in 2014 as a bespoke trading entity responsible for the procurement of military equipment and its support.

Governance and oversight

Scrutiny teams in the headquarters of the front-line commands and the MOD Head Office provide assurance on the commercial and financial aspects of business cases. Oversight of the outputs of both the customer's Delivery Team and the DE&S Project Team is provided by an inter-disciplinary Project Board chaired by the SRO. However, the overarching principle contained in the Acquisition System Handbook is that "Issues should be resolved at the lowest possible level" (MOD, 2018d, p. 4.2.15) thus encouraging problem solving through working-level activity. In addition, after Main Gate approval, significant changes in time, cost or performance must be notified to the relevant investment approval authority. Where such issues are likely to attract media or parliamentary attention or are deemed novel and contentious, Ministers will be informed. In parallel, since 2016, external independent assurance reviews of major defence projects have been provided by the Infrastructure and Projects Authority (IPA) alongside other projects in the Government Major Projects Portfolio. In 2022, the portfolio consisted of 235 projects with a total whole life cost of £678 billion of which 45 were defence equipment projects totalling £174 billion. Of these, the average whole life cost was £3.9 billion with an average project length of 19.94 years, a figure twice that civil infrastructure and construction projects. The IPA reports to the Cabinet Office and the Treasury.

Certification, airworthiness and safety

Military aircraft are not subject to the same airworthiness regime as are civil aircraft. Rather, military aircraft operation is regulated by the Military Aviation Authority (MAA) which has enforcement powers delegated by the Secretary of State for Defence. As such, the Ministry of Defence "could be liable under common law if it were to operate aircraft negligently thus causing injury to persons or damage to property or the environment" (MAA-01, 2022, p.7). The

MAA therefore assures the safety and the delivery of military aviation capability based on through-life airworthiness resting on an explicit Safety Case. The Safety Case is configured to assess the cumulative and interrelated risks based on a body of evidence acquired during design, testing and evaluation and includes the validation of software. Expert independent engineering advice might also be incorporated. The resulting Risk to Life (RtL) must be deemed to be acceptably safe. Hence, the Safety Case requires risks to be mitigated such that they are 'As Low As Reasonably Practicable' (ALARP) but the residual risk must also be 'Tolerable'. The Safety Case needs to be considered early in the procurement process when modification is cheaper and less disruptive. It is ultimately signed off during the Demonstration and Manufacture phase of the CADMID cycle by the manufacturer and the SRO. Subsequently, the Aviation Duty Holder applies the Safety Case as a primary tool in discharging their legal accountability for the safe operation, continuing airworthiness and maintenance of those air systems in their area of responsibility. The notion of Duty Holding which sits outside the chain of command and goes beyond the standard Duty of Care, applies to military aviation because "there is credible and reasonably foreseeable Risk to Life" (MOD, 2024j, Table 1, p.9). The significance of aircraft Safety Cases and the need for a Duty Holder regime were brought into prominence by the Haddon Cave Report into the loss of a Nimrod and its crew of 14 over Afghanistan in 2006 (Parliament, House of Commons, 2009b). The accident inquiry also led to the creation of the MAA in 2010.

Performance outcomes

The 2021-22 IPA Annual Report listed 45 defence equipment projects with a total value of £174 billion. Ten of the defence projects were aerospace platforms or sensors. Each project is given a Delivery Confidence Assessment (DCA) defined as "an assessment of the likelihood of a project delivering its aims and objectives and doing so on time and on budget" (IPA, 2022, Annex, p. 42). Of the ten aerospace projects, two were assessed as Red (Crowsnest and the F35 Lightning fighter): the rest, which included Protector, were deemed to be Amber. The Wildcat helicopter project preceded the creation of IPA evaluation process. The definition of a Red DCA is:

> Successful delivery of the project appears to be unachievable. There are major issues with project definition, schedule, budget, quality and/or benefits delivery, which at this stage do not appear to be manageable or resolvable. The project may need re-scoping and/or its overall viability reassessed (IPA, 2022, Annex, p. 42).

Whereas Amber is defined as:

> Successful delivery appears feasible but significant issues already exist, requiring management attention. These appear resolvable at this stage and, if addressed promptly, should not present a cost/ schedule overrun (IPA, 2022, Annex, p. 42).

UK Defence procurement is a large and complex enterprise with some 11,000 people and additional contractor support working in the DE&S. Including IT and nuclear procurement, the MOD let 2,225 new contracts in 2021/22 with a collective value of £18.5 billion (MOD, 2023f). Given the precisely defined and highly systematic procurement process described above, it is perhaps surprising that performance in the project delivery of major defence equipment has attracted both NAO and Public Accounts Committee (PAC) criticism over an extended period. The PAC 2021 inquiry into defence contracting concluded:

> The Ministry of Defence (the Department) has been managing suppliers and delivering military equipment programmes critical to our national security for decades. There have been numerous reviews of defence procurement over the past 35 years, which have provided the Department with opportunities to take stock and learn from experience. We are therefore extremely disappointed and frustrated by the continued poor track record of the Department and its suppliers - including significant net delays of 21 years across the programmes most recently examined by the National Audit Office - and by wastage of taxpayers' money running into the billions. The Department is in a disadvantageous position because it relies on a limited specialist supplier base to meet its needs and at times lacks the skilled personnel to effectively manage the performance of these suppliers. Overall, we are very concerned that the Department—and ultimately the taxpayer—bears too much of the financial risks for failure. …… We were therefore shocked to learn that the Department had only established a central register of learning from experience (LFE) in December 2020 (Parliament, House of Commons, 2021c, p.6, para.4).

The human interaction with risk

Project schedules in terms of cost, time and performance need to be accurately defined at the outset so that they can be robustly monitored and remedial action taken throughout the life of the project. The required judgements on these definitions are not straightforward, particularly in aerospace projects. Inevitably, the technology involved is not mature. Also, a modern combat aircraft is a system of systems requiring huge computing power to allow the

fusion of sensor data to operate the aircraft safely and effectively while providing the crew with unambiguous situational awareness. For example, the F35 Lightning has some 25 million lines of code all of which must be certified for functionality and safety. Such aircraft systems also place high demands on electrical power and cooling. The move in aerospace towards open systems architecture allows greater economy in software computation and is thus seeing a reduction in lines of operating code. Nevertheless, challenges will remain over integration through the interfaces between the backbone architecture and the various mission modules and sensors that represent the capability of a combat aircraft. Interfaces must provide a frictionless pipeline for data in terms of volume, speed and robust stability. Problems can arise over the design conventions of the equipment on either side of the interface. This aspect can be exacerbated where the manufacturers involved are reluctant to release the intellectual property embedded in the design which is frequently a matter of competitive advantage. Similar problems arise in support aircraft. For example, the engine control system alone of A400M transport aircraft is driven by 275,000 lines of code, four times more complex than that for a large civil airliner (Hepher & Doerr, 2008). These aspects bear on the robustness of initial project definition and the potential technical difficulties to be encountered along the way.

The human judgements made against this backdrop of imperfect information are also influenced by context and culture: “project evaluation is often the focus of special pleading, myths and emotion” (Hartley, 2020, p.13). The imperfect alignment between authority and accountability inherent in the procurement process allows game-playing by the tribes involved and presents a variety of different incentives. The miliary customer’s Delivery Team will normally be sensitive to any externally mandated budget reductions or even cancellation. They will therefore be inclined to burnish the reputation of their project and will thus wish to exhibit optimism over schedule performance. They are incentivised by supporting the legitimate interests of their own arm of the Services by delivering on the needs of the front line by winning the competition for scarce resources (Gray, 2009). By contrast, the DE&S Project Team is professionally focused on the project management, commercial and engineering challenges of ensuring that contractor performance meets the schedule requirements and the project always remains within budget. But, in some cases, Project Teams lack both the depth and extent of the skills required and are thus badly placed to validate information provided by the contractor. While they are motivated towards supporting the front-line, they are forensically focused on delivery according to the contract. Yet they are insufficiently skilled to “flush out at an early stage the real costs of the

equipment" (Gray 2009, p.6). Industry is similarly segmented with the risk averse commercial cohort needing to rein-in the technically optimistic engineering community who see mastering novel technology as a legitimate professional challenge without paying too much attention of the ultimate project price in doing so. In these circumstances, the realistic costing of a bid and robust assessment of the inherent risk to delivery is at the core of successful project delivery. Yet 'must win' circumstances sometimes arise which distort the cold logic of both these factors. Bidding at a low price will impact the amount of human resource applied to the contract further down the line immediately building-in risk to delivery gates and minimising resilience when things go wrong.

This main body of this research focuses on the role of cognitive biases in adverse procurement project performance. Government procurement guidance identifies optimism bias as being the most prevalent, using the term as a generic category for a range of cognitive biases. The UK Government's Green Book on investment appraisal identifies optimism bias as "the proven tendency for appraisers to be optimistically biased about key project parameters, including capital costs and operating costs, project duration, and resulting benefits delivery" (HMT, 2022, para. 13.1). Despite guidance on taking proportionate account of risks, the NAO is clear that:

> The Department's approach to risk analysis means that its central cost forecast may exclude risks that it cannot calculate precisely, and strategic risks not tied to any specific project, regardless of their likelihood (NAO, 2021a, p.23).

More broadly, as the IPA and the Department of Transport point out in their analysis of procurement failures and this research confirms, "Behaviour matters more than process" DfT & IPA, 2019, p.6.).

Appendix D (Chapter 7) - Interview Guide – Questions for Discussion

Context

1. What is your current role? What experience have you had during your career at the customer-supplier interface in defence aerospace procurement and over what period?

Defence Industrial Strategy (DIS)

There have been four issues of a DIS since Options for change in 1991: a partial version in 1998, then 2005, 2012 and 2021.

1. Which of these stick in in your mind as being the most significant? Why was that?

2. To what extent did any of these editions of DIS represent an incentive to industry? What form did that take?

3. How did any of these editions of DIS cause you to alter your posture as a customer or supplier? How permanent were those changes?

4. a. (Supplier). To what extent did you take account of the prevailing DIS in making investment decisions over R&D or capital expenditure on plant or people?

   b. (Customer). What were your expectations as to how industry would change or adapt with each issue of the DIS?

5. Does the framework of the prevailing DIS figure in your day-to-day decision-making? If so, how?

Partnering

***There are common threads in each of the editions of DIS reflecting the adoption of Smart Acquisition in 1998 (replaced in name as the Acquisition and Approvals Transformation Portfolio* (AATP) in 2020), among which is the notion of partnering between the MOD and industry.**

6. How would you characterise the relationship between the MOD and the defence industry? How has that changed over the years?

7. What experience have you had of introducing a partnered approach to defence acquisition? What was the catalyst for that?

8. How successful do you consider partnering has been? In what circumstances did it work well (or otherwise)?

9. What changes in customer and supplier behaviours did you see? Did it undermine the perceived advantages of competition?

Operational Sovereignty

Different requirements over operational sovereignty arise in each issue of DIS but all have the underlying characteristics of being able to maintain the edge over potential adversaries and guaranteeing security of supply.

1. How should operational sovereignty be factored into DIS? What are the implications for value-for-money and broader UK prosperity?

2. a. (Supplier). What impact does MOD policy on operations sovereignty have on your investment decisions and your choice over whether to bid for a contract? How do you cope with successive variations in policy?

   b. (Customer). How does the policy on operational sovereignty feed through to procurement decisions? How do you cope with successive variations in policy?

3. What do you see as the broader implications of policy on operational sovereignty in terms of the UK science and technology ecosystem, the national skill base and in export performance?

Procurement Processes

Risk Reduction – Smart acquisition and broader best practice in project management calls for investment of about 15% of the procurement budget in de-risking activity ahead of making a development and production decision.

15. What is your experience on this aspect of defence aerospace procurement? What good examples are there (and otherwise)?

Conspiracy of Optimism – Previous reviews of defence acquisition point to the existence of a conspiracy of optimism over risk, cost, time and performance.

16. What is your understanding of this term and how is it manifest? What are the drivers?

Social Value – Following changes to the Government's Green Book[78], DSIS 2021 introduced the notion of 'social value' to defence procurement "to promote economic growth that is distributed more equitably across the UK".

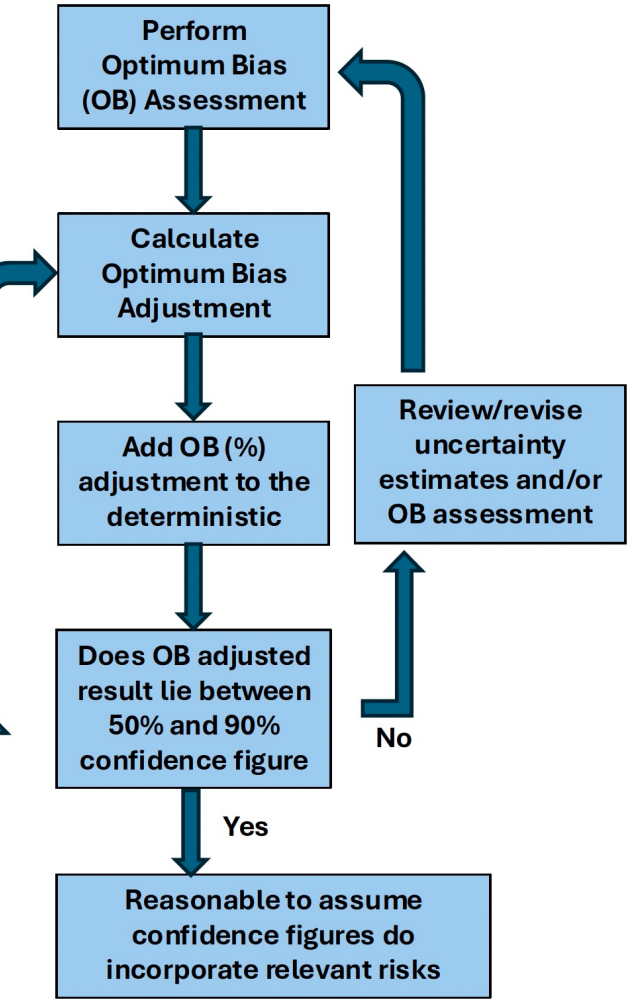
17. What are your expectations of this change? Have you yet seen it emerge in the assessment of defence procurement bids?

[78] The Green Book is guidance issued by HM Treasury on how to appraise policies, programmes and projects. It also provides guidance on the design and use of monitoring and evaluation before, during and after implementation.

Appendix E (Chapter 8) – Reference Class Forecasting - Computing the Optimism Bias Factor

Project Type (indicative starting values) Based on a sample of 50 but with just one* (MOD) Equipment / Development project	Upper Bound (%)	
	Time	CAPEX
Non-standard Buildings	39	41
Standard Buildings	4	24
Non-standard Civil Engineering	25	66
Standard Civil Engineering	20	44
Equipment / Development	54	200
Outsourcing (Operating Expenditure only)	41	

Contributory Factors to Upper Bound	(%)	
	Time	CAPEX
Procurement – Complexity of contract structure	13	7
Project – Degree of innovation	20	17
Project – Design complexity	-	10
Client – Inadequacy of business case	20	18
External influence - Technology	19	18
Total Contribution (%)	72	70
Adjusted upper bound (%)	72x54 = 39%	70x200 = 140%



* Faslane ship lift

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