



EUROPE



Persistent Challenges in UK Defence Equipment Acquisition

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Cover image: UK F-35 Lightning jets onboard Britain's next generation aircraft carrier, HMS Queen Elizabeth for the first time (UK Ministry of Defence 2020)

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Preface

Equipping the armed forces to deliver their outputs is one of the most important, challenging and complex tasks faced by the UK government. There are few, if any, public sector investment programmes that involve such levels of uncertainty, complexity, technical risk and expenditure. Often, acquisition programmes experience one or more of the challenges associated with such large investments: cost growth, schedule slippage and performance shortfall. This affects value-for-money, as well as the overall ability of the Ministry of Defence (MOD) and armed forces to deliver the defence contribution to achieving the UK's National Security Objectives (NSOs) – meaning that the UK's security, prosperity and influence suffers as a result.

For decades, the National Audit Office (NAO) has been monitoring and evaluating the performance of defence acquisition programmes. The NAO's reports and analyses, such as the Major Projects Review and Equipment Plan as well as focused studies, are publicly available.¹ Over the years, the NAO has examined both individual equipment programmes and the overall acquisition system. It has identified many of the reasons behind poor programme performance and provided both general principles and specific recommendations that will allow the MOD to improve programme delivery.

In January 2021, the NAO commissioned RAND Europe to prepare a short discussion paper to help shed light on the underlying causes of equipment procurement problems and the reasons why they persist despite repeated efforts to learn from the past.² Part of the global RAND Corporation, RAND Europe is a not-for-profit research institute whose mission is to help improve policy and decision making through objective research and analysis. This short paper draws on decades' worth of public and non-public RAND analyses of US, UK and European defence acquisition programmes and input from senior subject matter experts (SMEs). It is intended to provide food for thought for further initiatives within the NAO.

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1 For example: NAO (2004); NAO (2005); NAO (2021).

2 For example: Gray (2009); Levene (2011)

Underlying causes of equipment procurement problems

Background and scope of this discussion paper

Defence acquisition is complex, uncertain and constantly exposed to the chance of failure, requiring sound risk management

Development, acquisition and through-life support of military capabilities are inherently challenging. Since these capabilities are often bespoke and differ greatly from their predecessors, this process involves substantial and sometimes unavoidable risks, some of which are generic to large, capital-intensive programmes in other sectors, but many of which reflect the unique operating context of defence. Understanding the acquisition process itself (from concept to capability), the approach to individual projects, and the wider defence environment demonstrates why this is the case. Selecting and developing particular cutting-edge technologies, embedding these within platforms and system designs, and producing complex systems that are novel and integrating them within existing infrastructure, personnel and other aspects of capability management³ generate inherent risk at each step of the acquisition process. Further challenges are presented by uncertainty around the capabilities and intent of potential adversaries as well as those of some of our allies with whom we will seek to

be interoperable militarily but in competition commercially. These are the unique dynamics of the defence industrial base and markets, economic pressures, and resource constraints as Defence competes for an adequate proportion of the budget pie with other Government departments.

In many respects, large defence acquisition projects share characteristics with large civil capital investment projects; by their nature, these projects are often pioneering and bespoke, they are long in duration and complex in terms of design, production, business arrangements, technology and integration. As a result, there are likely to be many changes to project scope, budget and benefits as well as staff turnover and corporate memory. These complexities often make it difficult to have a solid understanding of cost, especially at the project inception, since parametric estimates rely on historic data and do not necessarily extrapolate into the future and bottom-up costs are difficult to estimate given the novelty of the programme in the first place. This is arguably the most important stage in the project's lifecycle.⁴ Just as it is the case with large civil projects, defence acquisition programmes are prone to strong optimism bias, which will be explored later in this paper. Finally, both sets of projects tend to

3 These include the Defence Lines of Development (DLODs), namely: training, equipment, personnel, information, concepts and doctrine, organisation, infrastructure and logistics.

4 For example: NAO (2005); NAO (2020e).



BOXER ambulance vehicle crossing a temporary bridge formed by several UK and German M3 Amphibious Rigs in Minden, during a joint UK/German Bridging Operation

be 'easy to start but too difficult to stop',⁵ with sunk costs or certain design or commercial choices made in initial phases often creating a situation in which programmes are locked into a trajectory, despite early signs of potentially non-recoverable poor performance. Political pressure and the risk of embarrassment may also add to the reduced ability to cancel poorly performing projects.

Finally, it is important to remember that many defence acquisition programmes are run in a unique market set-up where incentive structures for both customer and supplier are shaped by a monopoly-monopsony relationship. The unique capability requirements on the side of the MOD customer often result in a reduced ability to buy off-the-shelf equipment, foregoing potential benefits of competitive

pressure in terms of reducing the profit margin and driving production efficiencies. Further market distortions are created by security and classification requirements, export controls (US' ITAR in particular), restricting access to the defence market to suppliers with insufficient resources to handle and navigate all these specificities.

Given these unique characteristics, it is perhaps unsurprising that many complex, large acquisition programmes experience at least some cost growth,⁶ schedule slippage or performance shortfall – or all of the above – in the course of their lifecycle. A wide range of factors contribute to historically substandard performance of large acquisition programmes; these are examined in detail in the following sections.

5 Flyvbjerg (2003; 2014).

6 '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).

This paper discusses four broad drivers of cost, schedule or other performance problems often encountered in defence programmes

Numerous RAND, NAO and other reports identify underlying causes of problems in defence equipment programmes, including MOD’s industrial policy and strategy, commercial strategies adopted for individual programmes, poor supplier management, supply chain issues and requirements management. The scope of this discussion paper does not allow for covering all of them, though the bibliography provides further readings. Rather, this paper highlights three types of factors specifically requested by the NAO, namely:

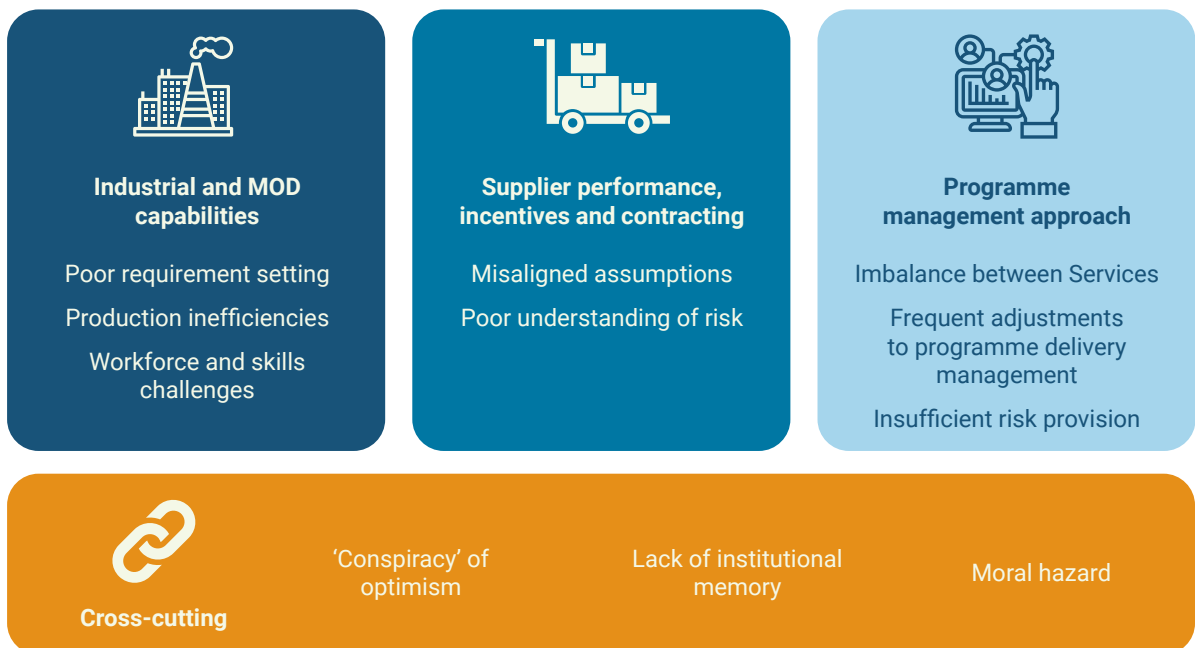
- Industrial and MOD skills and capabilities
- Supplier performance, incentives and contracting
- Programme management, budgeting and delivery.

Under each of these headings, RAND has identified from the literature and consultation with subject matter experts a number of specific factors which are examined briefly in the following sections of this short paper. In addition to these, the discussion also captures some overarching, cross-cutting factors. All factors are summarised in Figure 1.

Industrial and MOD capabilities

The complexity and long duration of many defence acquisition programmes demand that both industry and the MOD have appropriate capabilities in place at the project initiation stage. At the minimum, they should have a robust plan on how these capabilities will be secured and varied over time, as the demand for particular skills changes, to ensure timely and cost-effective delivery. The principal capabilities relevant here include a sufficient quantity of suitably qualified and experienced

Figure 1. Overview of underlying reasons for defence equipment procurement problems



Source: RAND Europe analysis.

personnel (SQEP) and appropriate design and production systems, processes, tools, materials and facilities. In the area of industrial and MOD capabilities, two main issues have emerged most prominently from past RAND analyses and the limited expert consultation conducted for this project: poor requirement setting, production inefficiencies and challenges related to workforce and skills.

Overly prescriptive or overly ambitious capability requirements can set the scene for poor performance delivery down the track

As noted earlier, defence capability development takes place in a highly uncertain environment with many unknowns and the need to make assumptions about factors such as the future operating environment, future competition, technologies, as well as MOD and industrial capacity and capability. Past RAND and NAO reports noted that the MOD response to these uncertainties has often been in the form of prescriptive requirements that solicited an ambitious, 'gold-plated' proposal from industry in response. Where technical specifications are set out in too much detail (instead of, for example, setting out the broad military requirements and use cases), industry has little manoeuvre in defining how the requirement could be delivered in a most efficient and effective way in terms of the key criteria: performance, cost and schedule. In these circumstances, programmes basically start off trying to deliver an end product that may not be the best solution from a capability perspective in the first place and is likely to end up being more costly than necessary due to the ambitious nature of the design. Based on RAND literature and SME input, there

has also been insufficient focus on iterative development of capability, which can reduce risk and cost of the overall programme due to interim steps in maturing capabilities.

In defence, production efficiencies are hard to achieve, hampering industry's ability to drive learning economies and maximise return on investment

Several RAND reports highlight the significant impact of production inefficiencies on the ability of a given programme to deliver within its defined performance, cost and schedule envelope. Long gone are days when most defence manufacturers benefited from economies of scale, driving down unit production cost through mass manufacturing. In fact, many large equipment programmes have relatively short production runs, with only limited number of units produced (e.g. ships, submarines, combat aircraft, helicopters) and there is a wider trend in recent decades towards ever more complex, expensive and 'exquisite' designs and a decades-long acquisition cycle. This means that each unit could almost be its own prototype and there are only limited opportunities for economies of scale, reducing the productivity benefits to be derived from learning or use of new technology over the lifetime of a production run.⁷ Perhaps the most notable recent exception here is the multinational but US-led Joint Strike Fighter (JSF) programme, which has started seeing declining manufacturing costs due to increasing number of units being produced as successful exports have secured international customers in addition to the extensive orders placed by the US armed services' joint procurement.⁸ While unit production costs generally decrease following the initial start

7 Arena et al. (2008); Rich et al. (1986); Schank et al. (2011; 2014).

8 Powers et al. (2018).



RAF A400M Atlas transport aircraft carrying out a series of test landings and take offs on a beach in South Wales.

of production, the kind of production at scale currently witnessed with the JSF is relatively unique among Western democratic nations.

At least since the end of the Cold War, flexible production facilities have been needed both to maintain high utilisation rates and keep overhead rates low. Flexible, agile and increasingly digitalised production facilities can more easily adjust to a new production rate and more cheaply adapt to design changes. These are the norm in the civil or commercial sector (e.g. commercial shipbuilding) but are not always present in defence suppliers at the programme initiation stage. RAND's work on productivity challenges in UK defence supply chains has also highlighted the lag with which defence equipment manufacturers are adopting new and digital manufacturing technologies and processes relative to other sectors (e.g. automotive), which prevents savings and efficiencies. When there is an effort to innovate in manufacturing, it tends to coincide with the start of production, adding costs.⁹

Additional costs and schedule delays may be caused by changes to the production drumbeat. This can happen for a range of reasons: some being the responsibility of MOD (e.g. due to re-profiling to ensure in-year affordability) and some due to commercial decisions by industry (e.g. the desire to align production with other orders for MOD or other customers, to smooth resourcing and minimise steep ramp-up curves for labour). Whenever production rates drop, per unit prices invariably increase and vice versa as facility and overhead cost for total production are amortised in the unit production costs. Past RAND analysis also finds that decreases in production rates hurt more than increases help.¹⁰ In other words, the impact of decreasing production rates is greater in terms of additional cost and schedule delay than production ramp-up is in cutting cost and compressing the schedule. The physical constraints of facilities and the challenges of adequately resourcing any significant workforce ramp-up (as witnessed

9 Muravska et al. (2020).

10 Rich et al. (1986).

in past shipbuilding programmes in particular) mean that there are always greater limits on the ability to ramp up production drumbeat than on the ability to slow it down.

Workforce and skills constitute critical enablers for effective programme delivery and conversely, insufficient SQEP can undermine effective delivery

Closely linked to production inefficiencies and similarly responsible for a large portion of overall cost growth and schedule slippage on defence equipment programmes are workforce and skills challenges. Both industry and MOD experience challenges in relation to the quantity and quality of their respective workforces across all levels.¹¹ Further challenges experienced by large acquisition programmes in the past have been created by rapid workforce ramp-up for production. Past naval and submarine programmes demonstrate the difficulties and delays that can arise from too rapid a build-up of the workforce and use of inexperienced workers.¹² Some of these include costly re-work due to poor quality assurance and failure to realise planned production efficiencies due to lower-than-planned workforce productivity or problems with the recruitment, training and security clearance pipeline. Both re-work and lower-than-assumed productivity naturally have an impact on programme cost and schedule.

RAND's frequently cited and critically acclaimed analysis of lessons learned from past US, UK and Australian submarine acquisition programmes clearly shows that long gaps between the design stages of successive programmes can have an

especially detrimental effect on the ability of industry and MOD to deliver the next programme efficiently.¹³ Defence is a niche business where skills are critical and costly to rebuild, particularly in areas where unique skillsets require years of experience and may only reside in a relatively small number (even single digits) of key individuals. Once the appropriately qualified and experienced workforce is diminished – whether due to demographic changes such as retirement, departure of employees to other industries, or a lack of sufficient demand to justify the expense of new recruitment – it can be prohibitively costly in both time and financial terms to train up the SQEP from a low or zero base.

Similarly, long gaps between programmes mean that critical skills, particularly in the design and development stages of the equipment lifecycle, are not sufficiently exercised and tend to atrophy. RAND's analyses of the UK combat air industrial base have raised these concerns time and time again.¹⁴ As Figure 2 shows, in the past, aircraft design engineers would work on one or two programmes at a time, with much greater frequency of starting new programmes. More recently, there has been a 15-year gap between the design phase of Typhoon (beginning 1985) and the UK involvement in JSF design (about 2000). Between 2000 and the early work on the Tempest, almost twenty years have passed since design engineers had to exercise their skills on a full programme.

Rebuilding, retraining, recruiting or sourcing these skills from sources external to the programme (or seeking to bring in external subcontractors or partners to fill known

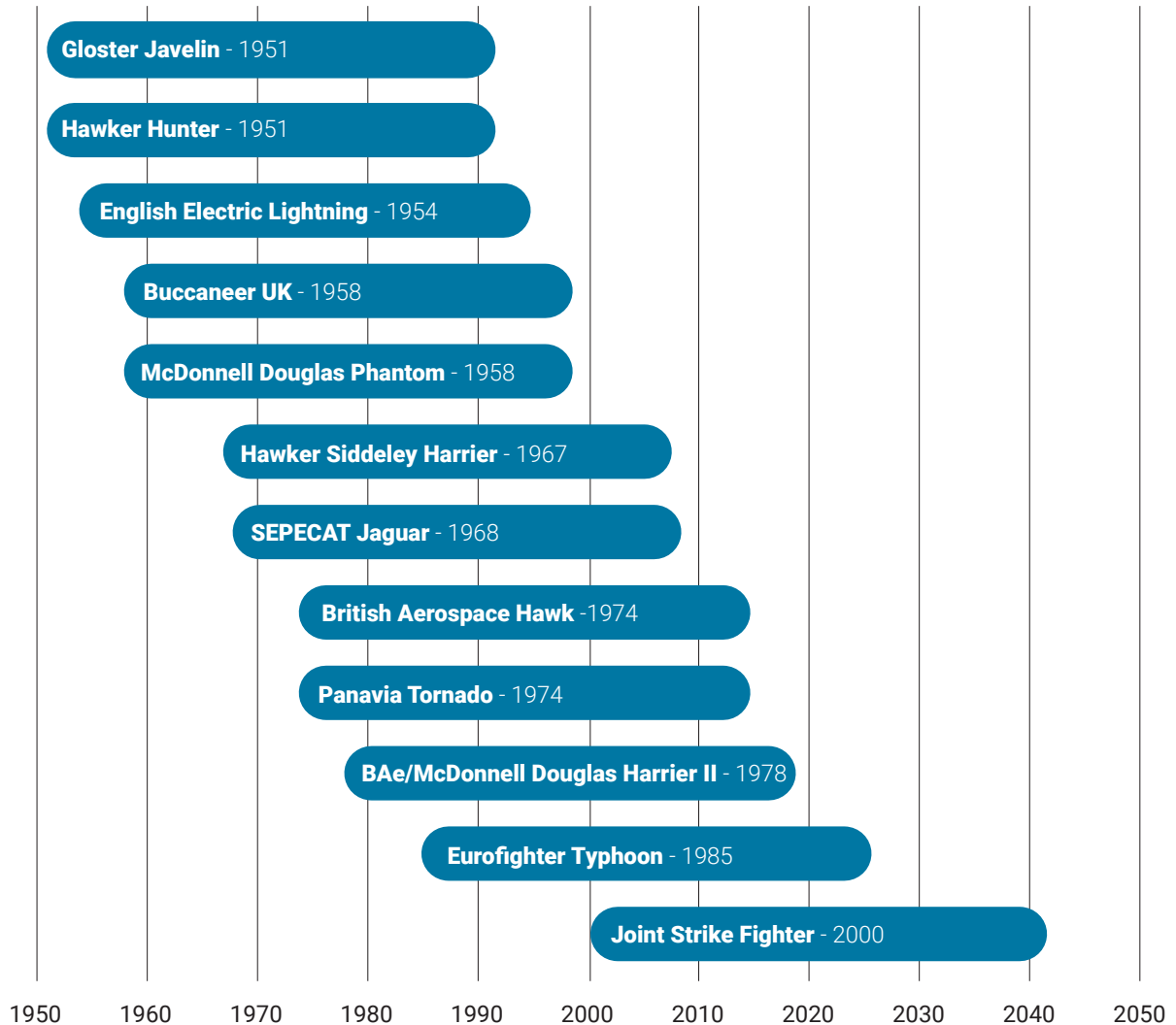
11 Retter et al. (2015); Silfversten et al. (2018); Galai et al. (2019); Muravska et al. (2020).

12 Schank (2011); Australian NAO (2014).

13 Schank et al. (2011).

14 Bassford et al. (2010), Jenkins et al. (2015); Black et al. (2018).

Figure 2. A 40-year career of a design engineer in the UK defence aerospace industry (duration of past UK combat aircraft programmes)



Source: Jenkins et al. (2015).

gaps) can be costly and time-consuming, and can jeopardise the programme's overall performance.¹⁵ Furthermore, many of the critical skills on defence programmes may not have any analogues in the civil sector (e.g. there is no need for commercial aviation to develop a workforce with skills in

low-observable materials or supersonic engine design), limiting transferability.

To the authors' best knowledge, there is no periodic review of the UK defence acquisition workforce as a whole, undertaken to provide a regular (rather than a one-off) and comprehensive assessment of the quantity

and quality of the workforce to perform all its necessary functions. This includes ensuring SQEP for contracting, design approval, test and evaluation, project management and many other activities vital to successful programme delivery. Most likely, the picture is quite diverse and varies across different capability areas, with a more in-depth understanding of the skills picture available for areas where sovereign capability is required (e.g. complex weapons, submarines, combat aircraft). Other areas are not helped by the unique nature of the defence workforce split between civil servants and military personnel, who routinely rotate postings, with implications for corporate memory and skill atrophy. Undoubtedly, the MOD faces stark competition for key acquisition skills against the private sector, which may be able to offer a more attractive package of both financial and non-financial

incentives to employees. Yet it is unclear where the most significant gaps and shortages in skills are, how intractable they may be, or what exactly the long-term risks are that these shortfalls introduce into individual programmes or the overall Defence Equipment Plan.

Contracting, incentives and supplier performance

The commercial strategy employed for an acquisition programme has a significant influence on programme performance and the effective delivery of capability. Since different contract types suit different acquisition strategies and represent varied approaches to risk sharing between MOD and industry, an appropriate type of contract needs to be used. Table 1 summarises the main different types of contracts and the market

Table 1. Principal contract types and uses in major acquisition projects

Contract type	Description	Use in acquisition
FIRM PRICE	Contractor is responsible for performance with a specified price	More appropriate for procuring off-the-shelf systems and platforms
TARGET COST INCENTIVE FEE	Contractor is responsible for performance under a target price with a target profit incentive	More appropriate when more units are produced and there is an opportunity for the contractor to gain efficiency savings and the government to share in savings; more complicated to administer than a firm price contract
COST-PLUS FIXED FEE	Contractor receives a predetermined fee	More appropriate for developmental programmes or when costs cannot accurately be estimated; typically requires greater oversight and administration
COST-PLUS INCENTIVE FEE	Contractor receives a smaller or larger fee based on how it performs against cost or performance targets	
COST-PLUS AWARD FEE	Contractor receives an award fee for meeting specific performance targets	

Source: RR-767 (2011).

environment in which they are most suitable; for example, whether they are better suited for competitive purchase of off-the-shelf systems or development of indigenous capability with domestic suppliers (i.e. in a monopoly–monopsony market structure).

Problems often occur in acquisition programmes when the commercial relationship and incentive structure between the MOD and suppliers is configured with the potential to adversely impact programme delivery and embedded in a contract. More specifically, two main types of structural challenges to aligning contractual arrangements with acquisition approaches have been identified by RAND reports and experts, including misaligned assumptions and inappropriate apportionment of risk.

While robust assumptions are inevitably difficult to get right, it is important that they are accepted and shared between MOD and the suppliers

No matter how well put together, any capability delivery plan and acquisition strategy can only be based on a series of assumptions, as are the accompanying baseline cost and schedule estimates. These assumptions may have different levels of certainty attached to them and may be the product of more or less sophisticated modelling and estimation methods. Whether they are robust or poor, it is crucial that these assumptions are jointly understood by both the customer and supplier and that they are continuously interrogated as new data and learning from experience become available. Misaligned assumptions occur in a wide range of areas, with some

of the most critical to effective programme delivery concerning:

- Design maturity and integration challenges.
- Technology maturity.
- Industrial base capabilities and capacity (including facilities and other delivery commitments).
- Workforce productivity.
- The ability of the MOD customer to deliver required inputs, including Government Furnished Assets (GFX), decision making and timely approvals.

Misaligned assumptions often mean that at least one side may not be making programme decisions based on the best available evidence, undermining the realism of cost and timeline estimates, which are then taken forward as a baseline for the delivery of the project. Right from the outset, therefore, the programme may be starting with erroneous assumptions. This increases the likelihood of cost growth and schedule slippage, while the communication of unrealistic expectations to political leadership and end users can undermine confidence in the MOD and cascade problems onto other interdependent programmes.¹⁶

Understanding of the causes of risk is a prerequisite for effective apportionment of responsibility for different risk types, but it is often lacking

The issue of misaligned assumptions is linked to the inherent level of risk involved in any defence equipment programme that includes at least some element of design and development work. These risks concern technical, design, integration and business



elements,¹⁷ and are not always fully understood by the MOD or even by the supplier(s). This lack of understanding then makes risk management less effective and can result in a mismatch between risk sharing approaches and contractual arrangements and incentives. As a result, cost overruns, schedule slippages and quality issues may be difficult to identify, foresee, track, quantify and address, also because liability can be difficult to apportion and there may be limited visibility for the MOD to see what is happening in the supply chain below the prime contractor level.

Successful contracting strategies hold contractors responsible for those risk factors

under their control (e.g. productivity, labour and material costs) and the government responsible for those risks outside of the contractors' control (e.g. requirements changes, legal changes, etc.). Coming to an effective division like this, however, requires a solid understanding of the *causes* of risk, not just the consequences in terms of cost, schedule and performance. Additionally, there may be a disconnect between the theoretical allocation of risk through the contract and the practical (and political) reality and the ability of MOD to enforce this. As witnessed in the Astute programme, the hollowed out industrial capability to deliver the programme meant that the MOD had to take on more risk than

17 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 (Source: Murphy & Birkler 2009).

initially envisaged to ensure the programme could be delivered at all.¹⁸ In other situations, suppliers may be placed in a position to extract favourable terms (but potentially detrimental to MOD) by virtue of being the preferred or indeed remaining bidder in contract negotiations. Similarly, there may be a theoretical apportionment of risk in the contract that the MOD may not be able to enforce as it could result in significant financial harm to the supplier, which may have a wider impact on the industrial base and industrial capability needed for any future programmes.

Clarity at the contracting phase is therefore essential. The NAO has previously found that poor definition of responsibilities left the government open to compensation claims from industry. Such issues can similarly undermine trust and influence behaviours between the MOD and its suppliers on other or future programmes; this means that a poorly designed contract in one programme might damage long-term relations to the detriment of other areas of delivery or even the overall defence industrial strategy.

Programme management approach

Much of what has been said so far concerns problems that are experienced to some degree by any national defence acquisition system and have been highlighted by RAND studies covering different systems in the UK, Europe, Australia, Canada and the US. In this section, we examine factors that are specific to the UK's defence acquisition system and present underlying challenges for effective delivery of equipment programmes. These include competition between the Services (the British Army, the

Royal Navy (RN) and the Royal Air Force (RAF), and potentially the joint Strategic Command), constant adjustments to programme delivery management and systemically insufficient financial provisions for risk.

Imbalance between Services undermines opportunities to use defence equipment budgets for modernisation efforts across all Services

There is an inherent imbalance between the Services and domains in terms of weapon system acquisition requirements; the RN and the RAF arguably take a more platform-centric approach (and have benefited from the bulk of capital spending in recent decades), whereas the Army is centred more around the capabilities of its personnel, with equipment programmes being essentially incremental improvements to hull structures that see little fundamental change between generations.¹⁹ From a technological perspective, weapon system acquisition programmes for the Army tend to have shorter lead times and are generally less complex than systems acquired for the RN and RAF, while being procured in larger platform numbers. Yet, the majority of the defence equipment budget tends to be allocated to long-term RN and RAF programmes. With costs for some high-profile Army modernisation programmes remaining uncommitted, while budgets for RN and RAF long-term programmes become already committed costs, funding for Army weapon system modernisation programmes may not materialise. There are, of course, strategic arguments in favour of funding Air and Sea capabilities considering the UK's geographic and defence posture, but the resulting budgetary imbalance between the Services

¹⁸ Schank et al. (2014).

¹⁹ RAND Europe interview with SME, January 2021.

also stems from the different nature of equipment programmes highlighted above and the Services' approach to pursuing funding for them. The combined impact of these factors could inhibit modernisation efforts across all Services and make it difficult to react to a changing threat environment.

The adverse impact on the overall Defence Equipment Plan is further reinforced by the MOD's reluctance to cancel programmes that fail to meet affordability requirements already in early programme stages. RAND's previous studies on cost growth and cost escalation have noted the importance of national MODs not only identifying early which projects are unaffordable but also being willing and able to cancel them as early as possible; citing the example of the US Better Buying Power acquisition reform initiative, which mandates affordability as part of the requirement. A well-known example of this policy put in practice is the case of the US Army Future Combat System, which was cancelled in 2009 after seven years due to insufficient analysis of alternatives and inability to meet affordability criteria.²⁰ Too often, however, defence equipment programmes are easy to start but too difficult to stop, given the political capital, personal careers and business interests vested in their continuation and the powerful allure of the 'fallacy of sunk costs'.

Frequent adjustments to programme delivery undermine its overall effectiveness

Despite the progress made with the introduction of long-term equipment funding plans during Bernard Gray's tenure as Chief of Defence Materiel, the wider MOD budget remains vulnerable to annualisation given the lack of a long-term, multi-year financial

settlement. This can lead to a narrow focus on in-year affordability. In practice, this creates a system that is constantly 'in flux' as frequent adjustments to programme delivery management need to be made to ensure affordability in line with the Annual Budget Cycle. There is friction between the strategic level financial management and equipment programme budgets, requiring frequent adjustments to the latter to ensure that overall, the UK government's books are balanced year-on-year, and that any affordability issues are effectively pushed down to subsequent years. As such, defence acquisition professionals spend a significant amount of time on re-profiling programmes, with a knock-on impact on delivery schedule and ultimately on overall acquisition cost. This constant adjustment and readjustment of programme delivery thus creates second-order costs and narrows down the programme managers' flexibility to actively manage risk as well as to drive long-term efficiencies. It also creates uncertainties for long-term programme delivery that often translate into further costs in the long run. To give a concrete example, programme managers may be restricted in their ability to commit upfront funding to minimise cost in the long run, for example by pre-ordering or bulk buying larger sets of units.

The perpetual development of options, and therefore the shifting of targets and milestones, results in changes to the production drumbeat. This disrupts the manufacturing process and throughput, jeopardising even the limited production efficiencies that can be achieved in defence manufacturing as discussed in a previous section. Furthermore, these frequent adjustments can often result in penalty costs for the MOD for opening up the contracts and introducing contract variation due to changes



HMS Queen Elizabeth being manoeuvred by tugs as she sails from the Northern Ammunition Jetty in Glen Mallen.

to the delivery plan, with short-term payouts for the industry but long-term disruption to the overall delivery of the programme. This can negate any benefits that were achieved at the initial contract negotiation (for example, via a competitive bidding process).

Budgeting sufficient contingency for risk is appreciated in theory but not implemented in practice

This paper has consistently emphasised the importance of understanding and managing risk as critical aspects of an effective acquisition system. On the theoretical level, this is appreciated by MOD, as well as its principal suppliers. However, in practice, many individual equipment programmes have insufficient risk provision. As described above, allocating sufficient contingency funds to enable effective risk management is fraught with obstacles

stemming from a poor understanding of risk, and also from the cross-cutting issues described below pertaining to the optimism bias and moral hazard. As a result, the level of the risk provision is often inadequate even when some is held centrally at a portfolio level. RAND's analysis of past international programmes suggests a pool of 10–15 per cent of the initial budget estimate should be held as a contingency, as that is roughly the cost burden that is attributable to risks materialising in the programme's duration.²¹ In practice, the funding allocation for the programme risk pool has often been much smaller.

Cross-cutting issues

The previous sections have focused on areas of most interest to the NAO for this discussion paper. In this final section, we cover those factors that cut across capability and

21 Schank et al. (2014).

skills, supplier relationship and programme management aspects. These cross-cutting elements include:

- Perennial optimism bias and under-budgeting.
- Lack of institutional memory hampering learning from the past.
- The presence of moral hazard whereby consistently underperforming programmes continue to receive funding.

These elements are both intertwined with, and less tangible than, the various structural, procedural and contractual elements discussed above. Nonetheless, they are just as important for understanding equipment programme issues, if not more so. Tinkering with the many ‘tactical’ problems facing programme delivery may be insufficient if these more foundational ‘strategic’ issues are not also addressed.

A culture of optimism permeates defence equipment programme decision making, distorting assumptions and planning outcomes

The Gray report,²² the Levene report²³ and several NAO and RAND reports all consistently identify a culture of optimism – ‘a conspiracy of optimism’ in fact – that permeates the defence acquisition system. Incentives exist for project teams to be optimistic on programme cost to increase the chance of funding, while MOD customers and industry are also incentivised to assume the programme will run smoothly. This is demonstrated by the fact that most projects are budgeted for at the 50 per cent confidence interval even though historical evidence suggests that, on average, project costs turn out to be at the 70 per cent confidence level.²⁴

Systemically, therefore, programme budgets do not appear to incorporate historically derived risk assumptions, which consistently leads to overruns and can sometimes lead to underruns, which are equally disruptive to programme management. These then either need to be balanced out elsewhere (e.g. delaying activity into the future or delaying or cancelling other programmes) or ‘bailed out’ through a boost in funding (see the section on moral hazard). This systemic underfunding often leads to delays in capability delivery, which can result in capability depreciation and undermine the ability of Defence to contribute to the delivery of National Security Objectives.

At the same time, this paper acknowledges that cost and risk analyses require judgements that are based on incomplete and uncertain information, making objective and robust assessment difficult to start with. 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.²⁵ As these biases cannot be eradicated, it is important to acknowledge and mitigate their impact, as discussed in the final section.

Lack of institutional memory means that lessons from the past are not learnt as quickly and efficiently as they could be – or not learnt at all

Long programme cycles, combined with long gaps between equipment programmes, staff postings and general staff turnover have

22 Gray (2009).

23 Levene (2011).

24 RAND Europe interview with SME, January 2021; also see Hemsley & Holden (2014).

25 Arena et al. (2006).

had a negative impact on the MOD – and to some degree also on industry – in terms of their ability to retain institutional memory. Numerous past RAND analyses have identified the lack of institutional memory, knowledge capture and sharing on past programme performance as important contributors to inefficiencies on follow-on programmes. There is similarly a reduced incentive for managers to make decisions that might have a negative short-term impact (e.g. in terms of their individual career prospects) but deliver substantial returns over a long-term period. While developing novel weapon systems may present unique technical challenges that the MOD has not been encountered on previous programmes, there are always valuable transferrable lessons that can be learnt from past programmes. Although implementing such learning has historically proven challenging, practical measures, processes and cultural changes that channel past learnings into new programmes can help.

The UK defence acquisition system is prone to moral hazard whereby poor delivery results in only limited negative consequences

Finally, there is a persistence with which underperforming programmes continue to receive funding and, linked to the conspiracy of optimism, the MOD continues to run a budget deficit vis-à-vis its 10-year Equipment Plan.²⁶ Only a few programmes are cancelled if they are deemed unaffordable, creating a moral hazard whereby the individual equipment programmes, as well as MOD as a whole, take on more risk than it can afford because it is unlikely to have to bear the full exposure to the risk. Although a separate historical analysis

would be needed to robustly examine the key factors driving these cycles, overall the MOD seems to oscillate between periods with tighter budgeting and discipline and periods where budget discrepancies increase. As with other organisational change processes and reforms, the strength of character and firm leadership play an important role in leading by example and embedding programme discipline in practice. Availability, motivation and strong performance of the workforce at all levels of the acquisition process in both MOD and industry are likely to be important as well. Strong and independent contestability functions providing continuous challenge and validation represent another critical element of tackling the moral hazard.²⁷

Areas for further consideration

Sustainable, sufficiently resourced and well communicated measures are needed to address persistent acquisition challenges

The Gray review and the Levene report both identified many systemic failures within the defence acquisition system. They also identified recommendations for change. Sir Bernard Gray was appointed as the Chief of Defence Materiel to drive the implementation of some of these. Both reform initiatives recognised the need for systemic measures and broader cultural and organisational change, rather than ad hoc initiatives to mitigate the challenges. Based on past RAND analysis and knowledge of the UK's defence acquisition system, the authors have identified the following examples of measures that could help address seemingly intractable

26 NAO (2021).

27 Cook et al. (2016).

performance issues on defence equipment programmes:

- **Establish and embed effective challenge, scrutiny and red teaming processes:**

Acquisition best practice suggests that 'chaos' (i.e. red teaming and challenging of underlying assumptions) should be introduced at the early stages of the programme set-up in order to identify weak assumptions, appropriately assess risk and prevent unrealistic estimates from becoming contractual milestones. Continuous, in addition to initial, challenge and validation is also essential, not least as a way of tackling the moral hazard.²⁸ While such functions are already in place (e.g. the Cost Assurance and Analysis Service (CAAS), the Project Controls, the Investment Approval Committee (IAC), the NAO) their full effectiveness can be hampered by a lack of institutional memory, frequent organisational changes and insufficient resourcing in terms of both funding and people. It is important to ensure that both internal and external challenge and scrutiny roles are established and allocated to individuals' areas of responsibility – an informal or 'part-time' scrutiny function is unlikely to suffice. Tolerance of and responsiveness to these challenge measures, however, is essential but also difficult to implement; this may only be achieved with a deliberate cultural shift and signalling from leadership.

- **Professionalise, reinforce and enable programme management and cost assurance functions:** This short discussion paper has underscored the importance of strategic financial risk and project management to the effective delivery

of defence programmes. This requires specialised skillsets that do not routinely reside in the military (given the nature of the Forces' priorities). Therefore, an emphasis should be placed on ensuring that a) capability costing and budgeting with which the Financial and Military Capability (FMC) organisation is tasked and b) MOD programme and portfolio delivery with which Defence Equipment & Support (DE&S) is charged are carried out by a corps of programme management, financial and accounting professionals. This can begin with a comprehensive audit of acquisition skillsets and capabilities, which allows a granular view across the equipment portfolio and in individual programmes. This exercise should be repeated regularly, allowing also longitudinal analysis and measures of the effectiveness of different initiatives to address gaps and shortfalls. Similarly, well-functioning independent cost and risk analysis and assurance have an important role to play in mitigating the adverse impact of optimism and other biases. The development and growth of CAAS in particular (now sitting under DG Finance), while intended for this purpose, has so far not provided a powerful enough challenge to the 'conspiracy of optimism'. Continuous reorganisation of CAAS and challenges with recruiting and retaining permanent SQEP have also undermined continuity.

- **Drive a focus on risk management and understanding:** Adequately understanding and anticipating equipment programme risk is in large part a function of adequately capturing and implementing lessons from past programmes, including regarding realistic levels of structural risk, entrusting

risk management to personnel with sufficient professional experience and subject matter knowledge, and acting upon the recommendations of those charged with scrutiny and challenge. These elements have already been discussed in this section. However, adequate risk management is also conditional on aligning the wider MOD budgeting norms and processes to the needs of equipment programmes, which need to be stably resourced, and as such are not compatible with annual budget cycles and in-year affordability. Finally, programme oversight should be based on risk, rather than monetary value.

- **Embed clear processes to capture, share and feed through lessons learned:** To mitigate the impact of the lack of institutional memory and insufficient risk management and scrutiny, it is important to not only understand what has gone wrong in the past but also develop processes and measures to guard against similar issues arising in the future.

These steps need to then filter into future programmes via a clear mechanism, rather than individuals' willingness and ad hoc arrangements. This can be done by conducting an ex-post analysis, capturing lessons learnt and sharing the analysis widely among MOD and industry actors involved in the new programme. Also, senior experts and stakeholders who had been involved in similar past projects can be brought into the project team to provide independent validation and challenge of assumptions.

This paper has attempted to highlight the core drivers that give rise to intractable defence programme delivery challenges but has only been able to scratch the surface of this notoriously complex issue, which sees strategic aspects of national defence and force projection intersect with the democratic need to deliver value for taxpayers' money. However, it is hoped that the reflections and analysis presented here will provoke further discussion within NAO and MOD about how to address these important and pressing issues.

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