



Defence acquisition

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17th May 2016

The efficient procurement of defence equipment has long been a challenge for British governments. It is an extremely complex process that is yet to be mastered with vast sums of money invariably at stake – procurement and support of military equipment consumes around 40 per cent of annual defence cash expenditure¹. In 2013-14 Defence Equipment and Support (DE&S) spent £13.9bn buying and supporting military equipment².

With the House of Commons set to vote on the “Main Gate” decision to replace Trident in 2016, the government is set to embark on what will probably be the last major acquisition programme in the current round of the Royal Navy’s post-Cold War modernisation strategy.

It’s crucial that the errors of the past are not repeated.

Introduction

There has been no shortage of reports from the likes of the National Audit Office and the Public Accounts Committee on the subject of defence acquisition.

By 2010 a £38bn gap had opened up between the equipment programme and the defence budget. £1.5bn was being lost annually due to poor skills and management, the failure to make strategic investment decisions due to blurred roles and accountabilities and delays to projects³.

In 2008, the then Secretary of State for Defence, John Hutton, commissioned Bernard Gray to produce a review of defence acquisition. The findings were published in October 2009. The following criticisms of the procurement process were made⁴:

1 <http://webarchive.nationalarchives.gov.uk/20120913104443/http://www.mod.uk/NR/rdonlyres/78821960-14A0-429E-A90A-FA2A8C292C84/0/ReviewAcquisitionGrayreport.pdf>

2 <https://www.nao.org.uk/report/reforming-defence-acquisition-2015/>

3 <https://www.nao.org.uk/report/reforming-defence-acquisition-2015/>

4 <http://webarchive.nationalarchives.gov.uk/20120913104443/http://www.mod.uk/NR/rdonlyres/78821960-14A0-429E-A90A-FA2A8C292C84/0/ReviewAcquisitionGrayreport.pdf>

- Too many types of equipment are ordered for too large a range of tasks at too high a specification.
- Branches of the armed forces compete for scarce funding and try to secure the largest share of resources for themselves. Thus they have a systematic incentive to underestimate costs.
- The MoD very rarely cancels an equipment order so the process of over-ordering and under-costing is not constrained by fear on the part of those ordering.
- Plan construction is dominated by a “bottom up” aggregation process which makes it hard for “top down” strategic guidance.
- Insufficient clarity over which systems need to be the most technologically advanced and which could be used sensibly with an “80 per cent solution.”
- Encouraging great technical leaps increases risks and makes products less exportable as they are unaffordable in most markets.
- Costs are underestimated so programmes take longer than estimated as the MoD cannot afford to build at the originally planned rate.
- Additional overhead and working capital costs are incurred because programmes take longer than estimated.
- Old equipment has to be run in the interim at a significant additional cost.
- Unclear roles and responsibilities between the MoD, Defence Equipment & Support (DE&S) and commands
- Inadequate skills and freedoms at DE&S

The review found that the average programme overran by 80 per cent or five years from the time specified at the initial approval date. The average increase in the cost was 40 per cent of £300m with the “frictional costs”⁵ incurred by the department because the projects have to be slowed down in the range of £900 million to £2.2 billion a year.

⁵ Costs incurred because of the slowing down of the project: overheads associated with project, keeping older equipment in service, working capital tied up in production etc.

The Successor Programme

The Trident Successor submarine programme may be the last major defence acquisition programme in the current round of the Royal Navy's comprehensive, post-Cold War modernisation strategy. As currently planned, the Successor submarines – or Ship Submersible Ballistic Nuclear (SSBNs) - will be one-for-one replacements of the current four Vanguard class submarines. The Successor class submarines will be armed with the UGM-133 Trident II missiles and will provide Britain's Continuous At-Sea Deterrence (CASD), the sole nuclear deterrent of the UK since 1998. While the Successor submarines are not expected to enter service until 2028, the programme is well into development. The programme passed its Initial Gate decision in 2011, commencing the Concept and Assessment phase. £3.3 billion is expected to be spent on the programme before construction begins with the bulk of the programme's forecasted budget of £31 billion⁶ being spent during the manufacture phase.⁷ This phase is expected to commence following the Main Gate decision scheduled in early 2016. Actual construction is expected to begin in late 2016.

A great deal of thought and planning is required as the Successor's critical Main Gate decision nears, likely in association with the new government's 2015 Strategic Defence and Security Review (SDSR). As with all SSBNs, the political, defence, and financial stakes are very high. Beyond the very important, high-level questions surrounding a nuclear armed United Kingdom, the Successor programme poses its own strategic risk concern. In March 2015, the Royal United Services Institute (RUSI) calculated that at its peak procurement years, the Successor programme could consume 37 per cent of the defence procurement budget. The MoD may be forced to sacrifice other vital equipment programmes to fund the SSBNs. Particularly concerning to RUSI were the potential cuts to personnel numbers.⁸ A balance must be struck between nuclear deterrence and conventional military capability in this age of austere budgets.

To facilitate such grand strategy deliberation, this paper has collected some of the best practices and lessons from recent and ongoing defence acquisition programmes. In many cases, these acquisition programmes have suffered from public criticism for their serious cost increases and schedule delays. Studying these acquisition programmes and analysis surrounding them may help prevent similar mistakes in the Successor programme. In doing so, this paper explores what lessons can be gleaned from various acquisition programmes and what recommendations can be made to decision makers in advance of the Successor Main Gate.

In order to provide a robust set of recommendations for the Trident Successor programme, the remaining sections proceed as follows. The next section travels through a sample of recent and ongoing defence acquisition programmes: the Vanguard and Astute class submarines, the Queen Elizabeth class aircraft carrier, the F-35 Joint Strike Fighter jet, and the Type 26 frigate. Lessons are summarised within each section. Following this analysis is a series of recommendations for the Successor programme, at the programmatic and the strategic levels.

[It should be noted that this paper does not address the current debates surrounding the number of ships to be ordered or Trident alternatives. It operates on the commitment made by the current Conservative government in May 2015 to purchase four submarines and on the selection of the submarine to provide the CASD as assessed in the Trident Alternatives Review of 2011.]

⁶ <https://www.gov.uk/government/publications/successor-submarine-programme-factsheet/successor-submarine-programme-factsheet>

⁷ <http://www.defensenews.com/story/defense/naval/submarines/2015/03/11/uk-boosts-submarine-assessment-funding/70156332/>

⁸ <https://www.rusi.org/downloads/assets/201502-BP-MoD-Emerging-Budgetary-Challenge.pdf> Also: <https://www.rusi.org/news/ref:N4C4ED70C3F1F7/#.VdyxTPIVikp>

Lessons to be learned from past acquisition efforts

Submarine acquisitions: Vanguard and Astute classes

When drawing upon lessons learned across modern British defence acquisition programmes, it is perhaps most important and appropriate to study the two most recent submarine programmes, the Vanguard and Astute class submarines. The Vanguard class submarines are the direct predecessors to the Successor programme; they are the current SSBNs providing Britain's Continuous At Sea Deterrent. Because the four Vanguard submarines were developed and entered service in the late 1980s and early 1990s – under largely different political and economic conditions – it is also helpful to study the ongoing acquisition efforts for the Astute class attack submarines. In many ways, these efforts more accurately reflect the current climate for submarine development in the UK.

Vanguard class submarines

Costs

£12.57 billion: Total programme cost, which includes the cost of the four submarines (Vanguard, Victorious, Vigilant, and Vengeance), manpower, refurbishments, and infrastructure.⁹

£3.6 billion: Reduction in real-term costs between the 1982 and 1998 estimates. As argued by Global Security and the Federation of American Scientists, this saving is the result of overall economic conditions rather than savings derived within the programme.¹⁰

Timeline

1982: Prime Minister Thatcher and US President Regan agree to the UK procurement of the Trident II UGM-133 missiles to replace the Polaris missiles used in the Resolution class submarine (the predecessor to the Vanguard class).

1986-1999: Manufacture of the four Vanguard class submarines by Vickers in Barrow-in-Furness.

2020s: Likely service end dates as estimated by the Labour government's 2006 White Paper, 'The Future of the United Kingdom's Nuclear Deterrent'.¹¹

Main facts

The Vanguard class SSBNs are the purpose-built successors to the Resolution class submarines of the 1960s. Because they carry UGM-133A Trident II ballistic missiles, they are also known as the 'Trident fleet' (as will be the Successor class). As of 1998, the Vanguard class submarines provide the UK's sole nuclear deterrent, known as the Continuous At-Sea Deterrence (CASD). The Vanguard submarines will remain in service until they are replaced in the 2020's. The final mass refit/overhaul contract of £350 million was announced by the MoD in April 2015.¹²

Many details of the development and manufacture of the Vanguard class are not readily publicly available although it is understood that the submarines were mainly built on time and at cost. In a 2011 RAND Corporation study on learning from various submarine programmes, a significant observation is made about the nature of the government-industry relationship throughout

⁹ <http://www.globalsecurity.org/wmd/world/uk/vanguard.htm>;
http://www.militaryfactory.com/ships/detail.asp?ship_id=HMS-Vanguard-S28

¹⁰ *Ibid.*; <http://fas.org/nuke/guide/uk/slbn/vanguard.htm>

¹¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/27378/DefenceWhitePaper2006_Cm6994.pdf, p. 6

¹² <http://www.defenseindustrydaily.com/new-nukes-gbp-350m-for-final-refit-of-uks-vanguard-nuclear-missile-subs-07344/>

development. It is noted that the government played a strong role in the setting of requirements and throughout manufacture, placing 50 people at the shipyard to oversee progress: 'MoD acted as design authority and prime contractor...'¹³ RAND credits the success of the programme to the government's willingness to be the 'full carrier of risks'.

A second point on the development of the Vanguard programme is that collaboration with the US Navy and its Ohio class submarines was woven into plans from conception, and that the missile sections of the submarines were built on US designs. This collaboration will continue at least through the life cycle of the Trident missiles in the 2030s.

Lessons

The strong role of the MoD throughout the development and manufacture phases led to no known major slippages in the programme's costs or schedule. A well-defined relationship between the government and industry remains crucial in minimising risks.

The Vanguard submarines are notable as a collection of best practices from previous British submarine programmes and readily available (and occasionally foreign) technologies. Domestic military learning and international collaboration have been applied throughout the lifespan of the programme.¹⁴

Astute class submarines

Costs

£9.6 billion: Total forecast cost to completion. An increase of £1.4 billion on the expected cost to completion at approval.¹⁵

58 months: Difference between expected in service data at approval and actual date for boats one to three¹⁶.

£9.9 billion: Total budgeted whole life costs.¹⁷

Timeline

1991: Initial feasibility studies launched to replace the Trafalgar and Swiftsure class submarines.

1997: Contract signed with GE Marconi for the first three submarines.

2001: Construction begins on the first submarine, HMS Astute.

2003: Major contract re-negotiation between the MoD and BAE in order to create new time and price baselines.

2007: Cost estimate addition of £580 million in order to accommodate inflation and addition technical cost increases.¹⁸

2010: SDSR confirms the purchase of seven total submarines.

¹³ http://www.rand.org/content/dam/rand/pubs/monographs/2011/RAND_MG1128.3.pdf, p. 10

¹⁴ <http://www.globalsecurity.org/wmd/world/uk/vanguard.htm>

¹⁵ <https://www.nao.org.uk/wp-content/uploads/2015/10/Major-Projects-Report-2015-and-the-Equipment-Plan-2015-2025.pdf>

¹⁶ <https://www.nao.org.uk/wp-content/uploads/2015/10/Major-Projects-Report-2015-and-the-Equipment-Plan-2015-2025.pdf>

¹⁷ <https://www.gov.uk/government/publications/mod-government-major-projects-portfolio-data-2015>

¹⁸ <https://www.nao.org.uk/wp-content/uploads/2008/12/080964ii.pdf>

2011: Astute commissioned.

2012: Final order placed for long lead-time items placed for submarines six and seven, Agamemnon and Ajax19.

Main facts

The Astute class submarine programme has been a story of notorious, major cost overspends and delays. The NAO's 2014 MoD Major Projects Report estimates that the first three boats were delivered 58 months late and 58 per cent (£1.3 billion) over budget.

RAND's 2011 monograph on the programme attributes these significant slippages to a number of programmatic factors, but the main problem identified was the government's eagerness to transfer responsibilities to the contractor (GE Marconi then BAE), otherwise known as 'privatising risk'. From the beginning of the programme, the MoD provided minimal oversight or programme support, known as its 'eyes on hands off' policy. The MoD had little insight into the technical troubles that BAE was undergoing until the company issued a profit warning in late 2002. In order to save the company and the programme, a new contract was negotiated in 2003. BAE and the MoD paid £250 million and £430 million respectively in order to re-baseline the programme. A second budget adjustment was made in 2007: an additional £580 million was added to the programme budget in order to accommodate for estimate miscalculations and technical immaturity of some components.

As the first few submarines have entered service and began field trials, technical difficulties have also plagued the programme. In 2010, HMS Astute ran aground off of the Isle of Skye, and the commander was relieved of his post for marooning the vessel. In late 2012, she was forced to make an emergency surfacing due to leaks and flood warnings.²⁰ Corrosion and failures to reach top speeds have also been reported.

The Astute programme demonstrates high levels of learning and redemption. As the 2011 RAND report on the programme rightly identified, the MoD grossly underestimated the impact of the privatisation of responsibilities. The MoD has had to learn how to be a more 'intelligent' customer and how to delineate the roles and responsibilities between its staff and the contractors.²¹ The 2010 SDSR and subsequent Equipment Plans have identified savings in the programme.

Lessons

The 2011 RAND report identifies a series of programmatic and strategic recommendations for those working within the Astute programme and for those analysing larger UK acquisition issues. Many of these recommendations centre on a strong and clear contractual relationship between the MoD and the contractor in order to manage risks from the outset. This is especially important in setting requirements and programme oversight throughout development and manufacturing. RAND identified improvements established by the programme since 2010; for example, the Construction Vision was created in order to make parts and tool delivery more efficient.²²

The two other main lessons learned from the ongoing procurement of the Astute class submarine are perhaps more difficult to achieve. The first derives from the timing of the programme. Due to the large gap between the designing and building of Royal Navy submarines (roughly 15 years

¹⁹ <http://www.defenseindustrydaily.com/astute-buy-britain-spends-big-on-its-next-fast-submarines-07635/>; and RAND (2011), p. 17

²⁰ <http://www.theguardian.com/uk/2012/dec/26/royal-navy-submarine-astute-problems>

²¹ RAND (2011), p. xii

²² RAND (2011), p. 47

between the Vanguard and Astute programmes), skills and corporate memory had disappeared. RAND recommends that the government take a large-term view of its submarine programmes and the industrial base required to maintain them. 'Learning from scratch' is an inefficient and frustrating experience for both client and manufacturer.

While it is important, and potentially profitable, for the UK to maintain its own high-tech skill sets in the defence sector, collaboration with other nations has proven beneficial for submarine programmes. For example, the Astute programme learned much from the US Navy's Virginia class programme, likewise for the Vanguard and Ohio class submarines. Collaboration with France on nuclear submarine technologies is expected to dramatically increase as agreements are established under the 2010 UK-France Defence and Security Co-operation Treaty.²³

Queen Elizabeth class aircraft carriers

Costs

£3.5 billion: Expected cost to completion at approval.

£6.2 billion: Current forecast cost for completion.²⁴

Timeline

1998: SDSR announces the replacement of three Invincible class carriers with two larger aircraft carriers.

2007: MoD announces contract for the construction of two vessels.

2008: Contract signed.

2009: Construction begins on the HMS Queen Elizabeth carrier.

2010: SDSR announces the F-35 Lightning II variant switch to the C (carrier); the Coalition government raises doubts to the commissioning/use of the second carrier.

2012: F-35 Lightning II variant U-turn, reversion to the B (STOVL). The cost of the decision reversal is estimated by the NAO and the Commons public accounts committee to be £74 million.²⁵

2013: Contract renegotiations due to massive cost overruns.

2014: Prime Minister David Cameron confirms that the second carrier, Prince of Wales, will enter service.²⁶

2017: Planned commissioning of HMS Queen Elizabeth.

2020: Initial operating capability planned for HMS Queen Elizabeth; planned commissioning of HMS Prince of Wales.

Main facts

²³ RAND (2011), p. 48; and <http://www.nuclearinfo.org/article/government-development-awe-aldermaston/uk-and-france-extend-warhead-research-collaboration>

²⁴ <https://www.nao.org.uk/wp-content/uploads/2015/10/Major-Projects-Report-2015-and-the-Equipment-Plan-2015-2025.pdf>

²⁵ <http://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news/carrier-strike-report/>; <http://theworldoutline.com/2013/05/britains-aircraft-carriers/>

²⁶ <http://www.bbc.com/news/uk-politics-29075307>

The Queen Elizabeth class aircraft carriers are the largest warships ever built in the United Kingdom: 65,000 tonnes and 4 acres of surface space. Once completed, they will be the flagships of the modern Royal Navy. The two carriers are being built in shipyards across the UK and assembled in Rosyth by the Aircraft Carrier Alliance (ACA), a consortium of BAE, Thales, Babcock and the MoD.²⁷ The HMS Queen Elizabeth was launched in 2014 and is expected to reach 'full operational capability' by 2022. The HMS Prince of Wales trails by approximately three to four years. The QE class carriers will launch the F-35B fighter jets and Merlin helicopters. Together the aircraft and the carriers constitute the 'carrier strike capability'. Because the fighter jet and aircraft carrier acquisition programmes are so interdependent, schedules and costs are often calculated for the entire capability.

The QE carrier programme is the quintessential tale of modern defence acquisition: cost estimates have nearly doubled – from £3.5 billion to £6.2 billion – and the delays to reaching full operational capability have reached five years.²⁸ The original contract was signed for £3.65 billion in 2008. Programme costs were re-estimated in 2010 for £5.2 billion in an attempt to account for technology immaturity, faulty estimations, inflation, and other factors.²⁹ By 2013, costs had spiralled again; the NAO calculated that whilst all other major programmes had retained or reduced costs, the carrier programme had accrued an additional £754 million.³⁰ Contract re-negotiations were conducted and completed in 2013 in an effort to control cost overruns and to more evenly distribute cost-growth risk amongst the industrial partners and MoD.³¹ The QE carrier programme has also suffered from a great amount of politicking throughout its development. The Coalition government blamed the previous Labour administration for signing a 'faulty' contract in 2008, and the Public Accounts Committee reported that the Coalition government failed to include inflation and VAT in any of its cost estimates.³²

The QE carrier programme was always going to be expensive and technologically complex, but it has also encountered several potentially preventable controversies. The 2012 fighter jet U-turn decision was one of the largest public scandals surrounding the building of the QE class carriers. In an effort to cut defence costs as much as possible, the new Coalition government identified potential savings between the carrier (C) and short take-off (B) variants of the F-35 II Lightning fighter jet that would be the centrepiece of the strike capability on the carriers. In order to switch to the procurement of the C variant, the new carriers required additional launch and arrestor gear (known as CATOBAR) to be fitted to the flight decks. At the time of SDSR publication, the government believed that the CATOBAR fitting would cost between £500 and £800 million. Further investigation revealed that the real fitting costs would run to approximately £2 billion, a 150 per cent increase. Such costs were prohibitive, and the government reversed its variant decision. The carriers would be built as originally designed, and the F-35B would be the fighter jet procured. Based on NAO calculations earlier in the spring, the Commons public accounts committee announced in September 2013 that the variant decision U-turn had cost the government £74 million and a delay of at least two years.³³

²⁷ <https://www.gov.uk/government/publications/aircraft-carrier-what-you-need-to-know/about-aircraft-carrier>;
<http://www.aircraftcarrieralliance.co.uk/>

²⁸ See, <http://www.bbc.com/news/uk-24801942>

²⁹ <http://spendmatters.com/uk/aircraft-carriers-a-shining-example-of-defence-procurement-how-not-to-do-it-that-is/>

³⁰ <http://www.nao.org.uk/report/ministry-of-defence-the-major-projects-report-2013/>

³¹ <http://www.bbc.com/news/uk-24801942>

³² *Ibid.*

³³ See also <http://www.nao.org.uk/wp-content/uploads/2013/05/10149-001-Carrier.full-report.pdf>;
http://www.bbc.co.uk/blogs/thereporters/robertpeston/2011/04/aircraft_carrier_costs_to_rise.html

The 2013 NAO report on the Carrier Strike Capability highlighted a second major issue with the programme. In an effort to create short-term savings, the 2010 SDSR delayed investment in the early-warning radar system called Crowsnest. The NAO confirmed that this development delay pushed back the HMS Queen Elizabeth's 'fully operational' status by at least two years, until 2022.³⁴ The report sparked public outrage; the UK is currently enduring a 12-year strategic gap in carrier capability. The programme was labelled 'omnishambles' by the Daily Telegraph.³⁵

A third political controversy surrounding the QE class carriers is particularly relevant: the eventual decision to commission and employ the second carrier. The budgetary cuts of the 2010 SDSR suggested that the HMS Prince of Wales would be mothballed, kept in reserve, or sold. Within months the Chief Executive of BAE, Ian King, issued a letter of warning to the MoD over the potential cancellation of the second carrier:

*"If both carriers are completed the cost will be £5.25bn. If Prince of Wales is cancelled the direct cost of the programme will be £4.8bn... Under Treasury rules and the agreements I have outlined, there will be consequential costs, including those related to rationalisation, which we estimate would amount to £690m."*³⁶

It was widely publicised that it would cost more to cancel the second carrier than to build it. While this is not truly accurate, the NAO's 2011 Carrier Strike report calculated that scrapping the HMS PoW would save only £200 million over the life of the entire QE programme.³⁷ However, these figures did not bring about a rapid decision reversal; the HMS PoW remained in limbo for nearly four years. Prime Minister David Cameron announced in September 2014 that the HMS PoW would fully enter into service.³⁸

Lessons

The QE carrier programme continues to contain a plethora of technical lessons and analyses about managing complementary and/or complex acquisition projects. Within the scope of this paper, the most important lessons drawn from the programme thus far are mostly political.

As with the Astute class submarine programme, clear contracts and a clear delineation of industrial and government roles are crucial for providing long-term, meaningful oversight. As the government has learned in recent years, shared risk is central to attempting to control cost spirals. In the case of the QE class carriers, the 2008 contract allocated only ten per cent of the financial risk to the industrial partners of the ACA. As of the 2013 renegotiations, the risk is divided 50:50.

The original manufacturing contract didn't include VAT or inflation estimates, leading to large and embarrassing cost recalibrations. While the NAO has recently reported significant improvement within the MoD over cost estimates, much work remains to be done. Any future acquisition programme must capitalise on this improvement and work to create realistic cost forecasts.

Finally, indecision over technology and reversal decisions – political decisions – cost time and money. A balance must always be struck between the near- and far-terms, but often the long-term outlook of an acquisition programme must be considered before short-term political gains.

³⁴ <http://www.telegraph.co.uk/news/uknews/defence/10047657/Aircraft-carrier-omnishambles-wastes-100-million.html>

³⁵ *Ibid.*

³⁶ <http://www.theguardian.com/politics/2010/nov/04/bae-cameron-aircraft-carrier-contract>

³⁷ <http://www.nao.org.uk/report/carrier-strike/>; <http://blogs.channel4.com/factcheck/factcheck-the-real-cost-of-cancelling-aircraft-carriers/7210>

³⁸ See, for example, <http://www.telegraph.co.uk/news/uknews/defence/11078244/Britain-will-have-a-second-aircraft-carrier.html>;

F-35B/Lightning II Joint Combat Aircraft

Costs

\$1.5 trillion: Total programme costs.³⁹

£13.2 billion: Budgeted whole life costs of Lightning II Programme.⁴⁰

\$136 million: Average procurement unit cost (APUC), the cost per jet, US Government Accountability Office estimate.⁴¹

Timeline

1997-2001: Concept and Development Phase.

2001: Main Gate-equivalent decision, launch of the System Design and Development Phase.

2006: First jet flown.

2015-2018: Initial operating capability planned for US Marine Corps, Air Force, and Navy.

2018: Initial operating capability on land for UK.

2019: Full-rate production to begin.

2020: Initial operation capability on sea for UK.

Main facts

The Lockheed Martin F-35 Lightning II, commonly known as the Joint Strike Fighter (JSF), is a family of single-seat, single-engine, fifth-generation multirole fighter jets. There are three variants of the F-35:

- 1) F-35A for the US Air Force, the Conventional Take-off and Landing (CTOL) version
- 2) F-35B for the US Marine Corps, the Short Take-off and Vertical Landing (STOVL) version
- 3) F-35C for the US Navy, the Carrier Version (CV).

The JSF programme is a multinational acquisition effort with the United States acting as the largest customer and financial sponsor. The US plans to procure a total of 2,457 jets.⁴² Eight nations – the United Kingdom, Italy, the Netherlands, Canada, Turkey, Australia, Norway, and Denmark – have contributed development costs to the programme. Several other nations are expected to be customers.

The United Kingdom is the sole Level 1 development partner in the JSF programme and has been involved since the jet's concept development in the 1990s.⁴³ The UK government committed to purchasing 138 F-35Bs for the Royal Navy in December 2006.⁴⁴ The variant switch (to C) announced by the 2010 SDSR and the subsequent, costly decision reversal in 2012 is discussed in detail in the above aircraft carrier section. At the 2015 SDSR, the plan to purchase 138 aircraft over the lifetime of the programme was reaffirmed. According to at 2015 HoC library report, the bulk buy of the jets, the fifth and final Main Gate, is planned for 2017.⁴⁵

³⁹ http://www.jsf.mil/news/docs/20160324_Fact-Sheet.pdf

⁴⁰ <https://www.gov.uk/government/publications/mod-government-major-projects-portfolio-data-2015>

⁴¹ <http://www.gao.gov/assets/670/669619.pdf>

⁴² <https://www.fas.org/sqp/crs/weapons/RL30563.pdf>

⁴³ <http://www.raf.mod.uk/equipment/f35jointstrikefighter.cfm>

⁴⁴ <http://www.lockheedmartin.co.uk/uk/what-we-do/products/f35b.html>

⁴⁵ <http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN06278>

In 2012 the UK took delivery of two F-35Bs for training and operational testing purposes. They are resident in Eglin Air Force Base, USA. Currently, the UK is flying three of its own jets with an additional five on order. They are expected to arrive in RAF Marham, Norfolk, as a part of the 617 'Dambusters' squadron in 2016.

The JSF programme has been the subject of intense scrutiny and criticism throughout its development history. Primary concerns are cost growth, schedule delays, and performance requirement degradation, all of which pose a serious threat to strategic defence planning.

As the largest and most expensive acquisition programme in US history, the cost growth figures have raised the most concern. The unit cost estimates almost doubled between the programme's inception in 2001 and 2012.⁴⁶ The cost spiral scandals were exacerbated in the public eye by the even heftier price tag for those small-batch units purchased under Low-Rate Initial Production (LRIP) contracts. Schedule delays have also plagued the JSF programme. Full-rate Production has slipped from 2012 to 2019. Thirdly, criticisms over performance and safety of all three variants continue to hinder the JSF's progress. One of the most prominent issues was the downgrading of the JSF's stealth designation from "Very Low Observable" to "Low Observable" in 2006, which is the radar signature size growth from marble to beach ball.⁴⁷

It should be noted that unit cost estimates have declined since 2012. The Joint Program Office, overseeing the entire programme, claims that the programme has been on cost and on time since its 2011 re-baselining. The unit costs of the jets have dropped 57 per cent between the first batch of orders (LRIP 1) and LRIP 7 in 2014.⁴⁸ True cost savings will be captured during Full-Rate Production, beginning in 2019.

Importantly for the UK, the F-35B completed its first ski-jump launch without incident. This is the type of launch used on the Queen Elizabeth class carriers (as well as by other nations). While this may not be considered the story of redemption sought by the public, it reflects the political reality of the F-35 fighter jet suite. Regardless of cost spirals or delays, the B version remains the only technical option for the Queen Elizabeth class aircraft carriers.

Lessons

Despite the UK's Level 1 partnership status, it has found itself at the mercy of the programme's cost spirals and technical events.

However by claiming a ten per cent stake in the programme's early development, the UK continues to reap benefits that it would not have if the government had decided simply to purchase the jet off-the-shelf upon completion. The UK was able to insert some of its technical preferences early in the programme's development, and it has exclusively enjoyed an embedded training status for its pilots and maintenance support staff in the US.

The government must choose its desired volume thoughtfully. Deliberation is required in order to avoid a repeat of the embarrassing variant indecision of 2010-2012. Too few jets – although considerably cheaper – may render the fleet too thinly stretched to be consistently capable. The carriers without their strike will be relatively invaluable. Too many jets are also wasteful. If the correct number lies between 48 and 138, the current government must do its best to order strategically.

⁴⁶ See again, GAO-15-364, p. 5

⁴⁷ "Not so stealthy: the \$15b fighters." *The Sydney Morning Herald*, 14 March 2006

⁴⁸ <http://breakingdefense.com/2014/11/new-f-35-prices-a-95m-b-116m-c-102m/>

Type 26 Global Combat Ship frigate

Costs/projected costs

£250 - £350 million: Per frigate, as estimated by the Parliamentary Scottish Affairs Committee Report on Scottish Shipbuilding.⁴⁹

Timeline

1998: Future Surface Combatant programme was launched to replace Type 22 and Type 23 frigates.

2000s: Requirements fluctuations within the Royal Navy.

2010: Vessels designated the Type 26 frigate; 4-year development contract signed with BAE Maritime Systems.

2015: Main Gate 1 passed, beginning the programme's Demonstration Phase; a £859 million contract was awarded to support the initial assessment phase.⁵⁰

2015: First parts ordered for 13 vessels.⁵¹

2016: Manufacturing to begin.

2022: Expected delivery of the first vessel.

Main facts

The Type 26 Global Combat Ship (GCS) is a multi-role frigate designed to replace the 13 Type 23 Duke class frigates in the 2020s. While most of the ships are designated as general purpose, variants for anti-submarine and anti-aircraft warfare (ASW and AAW, respectively) are planned. Current plans are to build 13 frigates for British use, although there has been recent tension between BAE and the government over the size of the order. BAE prefers a single contract for the entire order, while the government insists upon ordering the frigates in batches.⁵²

There are three interwoven aspects to the Type 26 GCS programme that make it unique amongst British defence acquisitions.⁵³ Largely due to the fact that requirements were being honed during the time of the 2010 SDSR, affordability is the key watchword of the programme. As described by a 2012 RUSI report on the ship, the Type 26 GCS is designed to cost (as opposed to designed to capability). Should costs rise dramatically, capabilities will be sacrificed rather than the budget. Additionally, much of the equipment on the ship is designed to be extremely low risk, with an emphasis on available and commercial-off-the-shelf (COTS) solutions. This approach is designed to minimise budget and schedule slippages, but it has also attracted criticism from those preferring to use the most advanced technologies in order to remain pre-eminent and to hedge against obsolescence. One critic called the Type 26 GCS as having a 'recycling strategy of second-hand equipment like I've never seen before on a warship programme'.⁵⁴

The designed to cost approach of the Type 26 GCS makes it very attractive to national militaries looking to expand their current fleets. Indeed, the international component is the third unique

⁴⁹ <http://www.publications.parliament.uk/pa/cm201213/cmselect/cmsscota/892/89205.htm#note24>

⁵⁰ *Ibid.*

⁵¹ <http://www.janes.com/article/53476/first-parts-ordered-for-uk-s-new-type-26-frigates>

⁵² http://www.thesundaytimes.co.uk/sto/news/uk_news/scotland/article1580410.ece

⁵³ [http://www.defenseindustrydaily.com/britains-future-frigates-06268/;](http://www.defenseindustrydaily.com/britains-future-frigates-06268/)

⁵⁴ <http://ukarmedforcescommentary.blogspot.com/2014/11/type-26-and-credibility.html>

component built in to the programme. Rather than focusing on international collaboration with allies in the design and demonstration phases, the Type 26 GCS programme is emphasising the exportability of the design. Australia, Brazil, Canada, India, Malaysia, New Zealand and Turkey have all expressed interest in the ship, although Canada and Turkey have already ruled out the option. Most recently, *Defence News* reported that the Type 26 design may place BAE in contention as a bidder on the German combat ship tender expected in late 2015.⁵⁵ At any rate, the affordability emphasis and the predictability of known equipment makes the prospective frigate an attractive option to those nations lacking native shipbuilding expertise. In addition to serving as the 'eyes' of the Royal Navy's new fleet, the Type 26 GCS programme may serve to boost UK exports in a truly meaningful way.

Lessons

There is little denying that the Type 26 GCS programme floundered during its conceptual and Initial Gate phases. These delays were exacerbated by the 2014 Scottish referendum, which halted progress in the defence shipbuilding industry for over a year. Such delays led one blogger to observe in early 2015 that "it seems by the time the Type 26 Global Combat ship gets to the manufacture stage it should really be called the Type 29". This behaviour – especially in programmes lower in innovations – is risky in defence acquisition practice and should be minimised in future programmes.

A second lesson from the Type 26 GCS programme is one of second order. In developing new equipment, the military must always strike a balance between currently available technologies and the potential of the risky and truly innovative. The risk of premature obsolescence must balance the uncontrollable nature of high-technology development. Whatever balance is struck for national strategic purposes, the lesson from the Type 26 GCS is that of exportability. Building an affordable, lower risk technological vessel is attractive to both Western governments with limited budgets and to nations looking to rapidly expand their military capability but lacking some indigenous skill. Defence acquisitions always contain a strategic component; expanding the British industrial base and export economy is an excellent element to a programme.

⁵⁵ <http://www.defensenews.com/story/defense/naval/ships/2015/07/25/bae-seeks-new-market--type-26-frigate--germany/30513361/>

Recommendations for the Successor programme

Even in this small sample of British defence acquisition programmes, it is clear that defence procurement is complicated and very individual in context and technology. In some ways it is inappropriate to compare programmes or to apply lessons from one to another. However, it is also evident that patterns of behaviour have emerged across programmes. These patterns provide both positive and negative lessons from which the Successor programme can learn. They are the most relevant in providing recommendations for moving forward. These recommendations are likewise divided into two levels: for the programme and for larger strategy development.

The first recommendation to the Successor programme is that it update the Successor's cost estimates. The last genuine estimates were conducted for the December 2006 Defence White Paper on the UK's future nuclear deterrent.⁵⁶ The government's 2013 Trident Alternatives Review could only report a 50 per cent confidence rate of its figures for the Successor programme and entire SSBN deterrent capability.⁵⁷ One only has to look at the Queen Elizabeth class aircraft carriers to see the danger in not having robust cost estimates. In order to boost calculation confidence for the programme, its cost estimates must be recalculated prior to the Main Gate decision. Furthermore, they must be regularly updated as the programme proceeds. Despite the well-known constraints to accurate cost estimation in defence programmes,⁵⁸ efforts must be ongoing and emphatic in this area.

The second programmatic recommendation is for the Successor to continue its international collaboration practices. The UK and US have engaged in long-term collaboration over lifetime extensions of the Trident II missiles. The two nations have collaborated in the development of the Common Missile Compartment (CMC), the section of the submarine which will house the Tridents. In April 2014, it was reported that the US Navy had formalised the requirement that it will use the CMC in its Ohio class submarines.⁵⁹ The Successor programme will likely formally commit to using the CMC. The programme should also continue to seek international collaboration on design and other elements as politically acceptable. The Astute class provides a good example of such recommended practice. While the submarines are manufactured to British specification in the UK, the programme has sought collaboration in some areas in order to avoid 'reinventing the wheel'. Existing technological knowledge may help the Successor programme stay on cost and in time.

The Successor programme must also work to strike an intelligent scheduling balance moving forward. The programme should continue to avoid the floundering so prevalent in the Type 26 frigate programme. It should also learn from the Astute programme and avoid a large gap between its design and build phases. The other side of that balance is heavy concurrency in the schedule: overlapping design, build and test stages. As the GAO has observed in the F-35 Lightning jet, concurrency creates unnecessary technical, financial and schedule risks. To whatever extent possible, the Successor programme must minimise floundering but also ensure that its designs are sufficiently mature and that its test structure is in place prior to manufacturing.

⁵⁶ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/27378/DefenceWhitePaper2006_Cm6994.pdf

⁵⁷ P. 42,

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/212745/20130716_Trident_Alternatives_Study.pdf; and <https://www.iiss.org/en/militarybalanceblog/blogsections/2015-090c/may-b1c8/european-defence-bcf2>

⁵⁸ <https://ukdefencejournal.org.uk/how-much-will-replacing-trident-cost-us/>

⁵⁹ <http://www.defenseindustrydaily.com/cmc-contract-to-define-future-ssbn-launchers-for-uk-usa-05221/>

Strategic

Domestic defence industry considerations

In analysing multiple defence acquisition programmes, two trends become very clear, both of which should be minimised in the Successor programme. The first is the tendency of the MoD to 'privatise risk'. Whatever the size of the programme or defence budget, the MoD must maintain the capability of being an intelligent customer. It cannot offload all risks (technical, financial, etc.) onto the industrial supplier. Certain functions cannot be privatised. As a rule, the government must be responsible for requirements and oversight. Shared risks are ideal, as are well-defined roles between the customer and supplier. These lessons have been learned; they need not be re-learned in the Successor programme. This is not to advocate for a large government presence in the manufacturing process, just one that understands its responsibilities to its programme. Losing a minimal oversight capability within the government is not ideal; re-developing such skills is expensive and slow when possible. It can also cost the programme considerable time and funds.

In a similar vein, it is also evident that the long-term health of an acquisition programme is routinely sacrificed for short-term political gains in the UK. As with the Crowsnest system, delays in component orders saved money in the very short term, but ultimately cost the overall programme no less and delayed its capability delivery for years. Late-in-game technical requirement changes have also proved fruitless. Attaching CATOBAR equipment to the Queen Elizabeth class carriers in order to save on the per-unit cost of the F-35 fighter jet proved impossible and expensive. The Successor class submarines likely will be in service until the 2040s. To whatever extent possible, the programme must be viewed as a long-term entity. Deliberate and strategic plans made now should be able to survive some political fray. This will allow the programme to develop as closely on time and on schedule as possible. Fielding a financially and politically successful Successor fleet requires thoughtful long-term planning. The time to do this is in support of the Main Gate decision; deliberation is required this autumn.

Financial support for this research paper was provided by the Politics and Economics Research Trust (charity number 1121849). Any views expressed in this paper are those of the author and not those of the research trust or of its trustees.

