National Audit Office

MINISTRY OF DEFENCE

Major Projects Report 2005

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL | HC 595-I Session 2005-2006 | 25 November 2005

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National Audit Office

MINISTRY OF DEFENCE

Major Projects Report 2005

This volume has been published alongside a second volume containing the Project Summary Sheets for the 20 post-Main Gate and 10 pre-Main Gate projects included in this year's report –

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15 November 2005

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EXECUTIVE SUMMARY

1 The Ministry of Defence (the Department) has reported to Parliament on its progress in procuring major defence equipment every year since 1984. Prior to 1991, much of the data submitted to Parliament was classified and, hence, our analyses of the key themes and trends were not published. The Major Projects Report 2005 is the fourteenth Report that we have published since the level of classification was reduced.

2 The Major Projects Report 2005 covers cost, time and performance data for projects in the year ended 31 March 2005. We examined 30 defence equipment projects: 20 of the largest projects where the main investment decision to proceed had been taken by the Department; and ten projects still in the Assessment Phase. Six projects are new to the Major Projects Report, four in the main phase of procurement and two in the Assessment Phase. Part 1 of this report presents the overall performance of these projects and progress in implementing Smart Acquisition. Part 2 examines the Assessment Phase in more detail.

3 The Department expects that, on the basis of Customer agreed metrics, its top 20 equipment projects will meet Key User Requirements but at a cost[1] of £29 billion, some 10 per cent higher than the expected cost at approval. In the last year, forecast costs have decreased by £0.7 billion and project delays have increased by an average of two and a half months. **Figure 1 overleaf** summarises project cost and time changes in the last year. The decrease in forecast costs results mainly from changed requirements or reductions in the quantity or capability of equipment being procured.

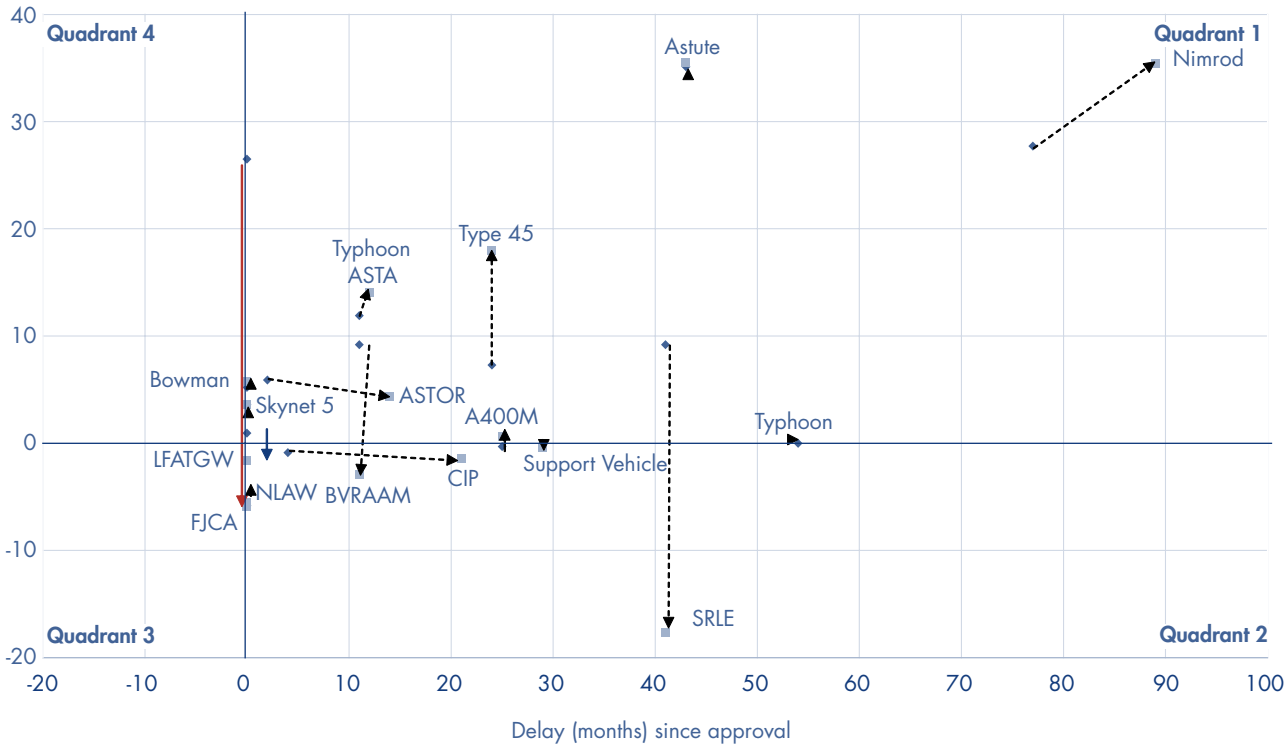
4 There has been further progress on measures to improve performance within the Defence Procurement Agency and elsewhere in the Department. These improvements focus on the following areas: performance of key suppliers; the skills and development of staff; project and risk management; increased use of trade-offs between time, cost and capability of equipment; better joint working of those responsible for acquisition within the Department; and stronger project scrutiny at all levels. It will take some time before the full impact of these measures will be felt on the large and lengthy projects within the Major Projects Report but we may see improvements sooner in other projects. In 2004-05, the Defence Procurement Agency has achieved five out of its six key targets on equipment procurement across a wider spread of its projects and partly achieved the remaining target.

1 Excludes the costs of Typhoon which are commercially sensitive.

1 Analysis of project cost and time variance and movement since the Major Projects Report 2004

Future Joint Combat Aircraft does not yet have an approved in service date, therefore only its cost variation has been plotted. Costs on Typhoon are commercially sensitive therefore only its time movement has been plotted.

Percentage cost overrun since approval



Key

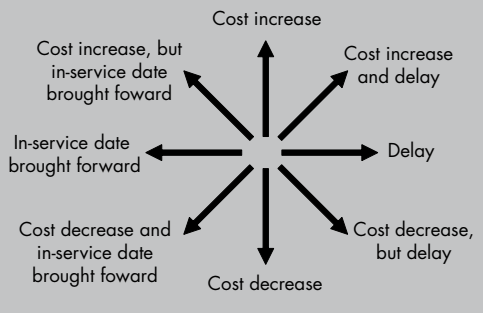
◆ Major Projects Report 2004 ■ Major Projects Report 2005

ASTOR	Airborne Stand-Off Radar
BVRAAM	Beyond Visual Range Air-to-Air Missile
CIP	ComBAT, Infrastructure and Platform BISA
FJCA	Future Joint Combat Aircraft
LFATGW	Light Forces Anti-Tank Guided Weapon
NLAW	Next Generation Light Anti-Armour Weapon
SRLE	Sting Ray Life Extension
Typhoon ASTA	Typhoon Aircrew Synthetic Training Aids

Source: National Audit Office

NOTE

The direction of the arrows indicate the following:



5 In previous years, we have reported concerns about the outcome of the Assessment Phase with some projects running into forecast time and cost overruns soon after the main investment decision has been made by the Department. This year, we have examined a sample of projects in different parts of the procurement cycle and interviewed other stakeholders about their experiences of the Assessment Phase.

6 We found that whilst the approach to the Assessment Phase has improved and the principles underpinning the Phase are better understood, more remains to be done to secure the desired improvements of more projects being delivered of the right quality, on time and to cost. Practitioners have generally accepted and welcomed the aim that the outcome of the Assessment Phase should be a mature understanding of the future project and the associated risks, with those risks being quantified and mitigated where possible. However, practitioners did not always have a complete understanding of what constituted maturity for individual projects. There is also further to go in developing robust cost estimates for future projects but the Department has work in hand to achieve this through better use of cost modelling and historic cost data.

CONCLUSIONS AND RECOMMENDATIONS

The Assessment Phase

Defence equipment projects are widely different. They range from off-the-shelf arrangements to cutting edge technology developments; from the replacement of existing capability to the delivery of radically new capability; and from projects where the Department is the only procurer to complex international collaborative procurements. The urgency with which a new equipment capability may be required or the strength of industrial or other wider imperatives will also vary. Each project thus poses different risks and challenges, some of which it will be neither cost effective nor possible to mitigate fully in the Assessment Phase. To help ensure the cost-effective and timely delivery of mission critical equipments, the diversity of projects and motivations to progress them quickly need to be fully recognised when the main investment decision is made.

The point when a project is mature enough for the main investment decision to be taken will look very different from one project to another dependent upon the perceived benefits of progressing the project quickly albeit with a greater level of recognised uncertainty and risk. The Department should clarify what is required to demonstrate maturity for different types of project. This definition should include: a clear statement of required best practice; and an articulation of the treatment of risk and appropriate ranges of cost and time estimates that are acceptable in the circumstances of individual projects. It is then for the Department to manage varying levels of risk and identified benefit on both the individual projects and at the aggregate level through its Equipment Programme.

PART ONE

Overall, the performance of projects has improved but challenges remain

1.1 In the first part of this Report, we examine progress on the Department's 20 largest post-Main Gate[2] procurement projects against original budgeted cost, expected delivery time and the achievement of the Customer's Key User Requirements for the equipment. In the Major Projects Report 2004, we reported a total forecast cost increase of £1.7 billion for 2003-04 and delays totalling 62 months in the same period. This year, to the end of March 2005, forecast costs decreased by a total of £699 million and delays increased by 45 months. Although performance has improved, the Department recognises the continuing challenge of limiting further time slippage and sustaining control of costs. The implementation of Smart Acquisition is an ongoing process which the Department is actively trying to embed fully.

1.2 **Figure 2 overleaf** summarises the 20 post-Main Gate projects in the Major Projects Report 2005. Four of the projects are new to this year's Report: they are the C-Vehicle Capability Private Finance Initiative, Guided Multiple Launch Rocket System, Precision Guided Bomb and Terrier (armoured earthmoving vehicle). Appendix 1 details the ten Assessment Phase projects, two of which are new to the Assessment Phase population (Advanced Jet Trainer and the Frigates and Destroyers Programme). They replace the Battlefield Light Utility Helicopter and Surface Combatant Maritime Rotorcraft projects which were halted pending the outcome of a reassessment of the approach to them.

Results are better than last year as a whole, but performance is not consistent across all projects

There has been an in-year decrease of £699 million in project cost

1.3 One project, the Typhoon aircraft, is excluded from the analysis of costs as the information is commercially sensitive. In 2004-05, the remaining 19 post-Main Gate projects included in the analysis have forecast a net overall decrease in costs of £699 million. In comparison to the total budgeted costs approved at Main Gate the portfolio of projects is forecast to be over budget by £2.7 billion or around 10 per cent, as summarised in **Figure 3 on page 9**. Appendix 3 provides further details of total cost variations against the budgeted cost approved at Main Gate.

2 Main Gate is the main investment decision. See Figure 12 and Appendix 2 for a description of the project lifecycle, and the distinction between the Assessment and post-Main Gate phases.

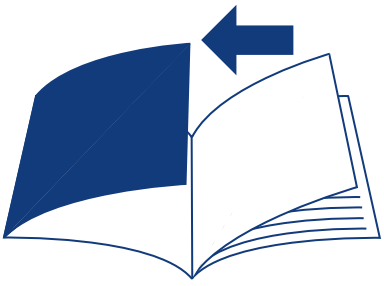


Figure 2 overleaf

Project		Description	In-year change on costs to completion (£ millions)	In-year change on in-service date (months)	In-year change on Key User Requirements	Current Forecast Costs to completion (£ millions)	Budgeted Costs to completion at Approval (£ millions)	Current Forecast In-service date	Expected In-service date at Approval
	A400M	Heavy transport aircraft	+25	0	No change	2644	2628	March 2011	February 2009
	Airborne Stand-Off Radar (ASTOR)	Long-range surveillance and targeting system	-14	+12	No change	954	914	November 2006	June 2005
	Astute Class Submarine	Attack submarine	+8	0	No change	3492	2578	January 2009	June 2005
	Bowman	Data and voice communication radios	16	Met in-service date March 2004	No change	2007	1898	March 2004	March 2004
	Beyond Visual Range Air-to-Air Missile (BVRAAM), also known as Meteor	Air-to-Air missile	-151	0	No change	1204	1240	August 2012	September 2011
	C Vehicle Capability	Vehicle fleet	+36	+3	No change	710	674	March 2006	October 2005
	ComBAT, DBL Infrastructure & Platform BISA (CIP)	Bowman-related software, hardware and integration systems and tools	-2	+17	No change	338	343	December 2005	March 2004
	Future Joint Combat Aircraft (FJCA)	Fighter/ attack aircraft	-659	In-service date not yet approved	No change	1914	2034	In-service date not yet approved	In-service date not yet approved
	Guided Multiple Launch Rocket System (GMLRS)	Global Positioning System guided rockets	-35	0	No change	263	319	April 2007	March 2007
	Light Forces Anti-Tank Guided Weapon (LFATGW)	Anti-armour firepower system	-8	0	No change	310	315	November 2005	November 2005
	Nimrod Maritime Reconnaissance and Attack Mk4	Reconnaissance and attack patrol aircraft	+215	+12	No change	3808	2813	September 2010	April 2003
	Next Generation Light Anti-Armour Weapon (NLAW)	Short range anti-armour weapon	+1	0	No change	356	377	November 2006	November 2006
	Precision Guided Bomb	All weather 24 hours general purpose precision bomb	+13	0	No change	352	339	September 2007	June 2007
	Skynet 5	Satellite communications systems	0	0	No change	2775	2679	February 2005	February 2005
	Sting Ray Life Extension & Capability Upgrade	Life extension and capability-enhancement for Sting Ray Lightweight Torpedo	-195	0	No change	599	727	May 2006	December 2002
	Support Vehicle (SV)	Cargo and recovery vehicles, and trailers	-25	0	No change	1362	1367	February 2008	September 2005
	TERRIER	Armoured earth moving vehicle	+4	0	No change	299	294	September 2008	September 2008
	Type 45 Destroyer	Anti-Air warfare Destroyer	+68	0	No change	5896	5000	May 2009	May 2007
	Typhoon, formerly known as Eurofighter	Fighter aircraft	Commercially Sensitive	Met in-service date (June 2003)	No change	Commercially Sensitive	16671	June 2003	December 1998
	Typhoon Aircrew Synthetic Training Aids (ASTA)	Ground-based aircrew training equipment for Typhoon	+4	+1	No change	211	185	June 2005	June 2004

Source: National Audit Office

3 Summary of overall cost performance against forecasts and in-year variation

	All 20 projects £ billion
Total of budgeted costs at approval	26
Total forecast costs at March 2005	29
Difference from budgeted costs at approval	2.7
In-year variation	-0.699
Average in-year cost variation	-0.036

Source: National Audit Office

NOTES

1 The basis of approvals is covered at Appendix 2.

2 The average in-year cost variation is calculated across 19 projects: Typhoon is excluded as its costs are commercially sensitive.

1.4 **Figure 4 on page 10** shows the in-year forecast cost variations on each of the 19 projects. There were in-year increases on seven projects, the largest being £215 million on the Nimrod MRA4 aircraft. Seven projects had in-year decreases with the most significant being Future Joint Combat Aircraft (£659 million), Sting Ray Torpedo Life Extension (£195 million) and Beyond Visual Range Air-to-Air Missile (£151 million). The remaining five projects were stable with cost increases or decreases of less than one per cent.

1.5 The decreases in forecast costs this year were primarily due to reductions in the numbers or capability of the equipment driven by changed budgetary priorities and changed Customer requirements. These causes of cost variation are essentially measures the internal Customer can take to manage the portfolio of projects and they, along with exchange rates, were the largest causes of cost decrease in the last year. They also occurred on projects that, overall, had a net forecast cost increase. For example, Nimrod MRA4 forecast a cost decrease of £165 million due to the reduction in the number of aircraft being procured from 18 to 12. Also, the capabilities of the Type 45 Destroyers were reduced, due to changed budgetary priorities saving £145 million. The cost decreases reflect application of one of the key principles of Smart Acquisition, namely trading off performance, time and cost, and greater realism on the part of the acquisition community.

Some projects are still experiencing delays

1.6 One project, the Future Joint Combat Aircraft, is excluded from the analysis of time as it does not yet have an approved in-service date.[3] **Figure 5 on page 10** summarises the overall time performance across the 19 projects and shows that they are, in total, running 375 months later than expected when they were approved, an average of some 20 months per project. However, much of this cumulative delay is due to the problems experienced by the Astute Class Submarine (43 months), Typhoon aircraft (54 months) and the Nimrod MRA4 aircraft (89 months). Appendix 3 provides further details of total time variations against approved in-service dates.

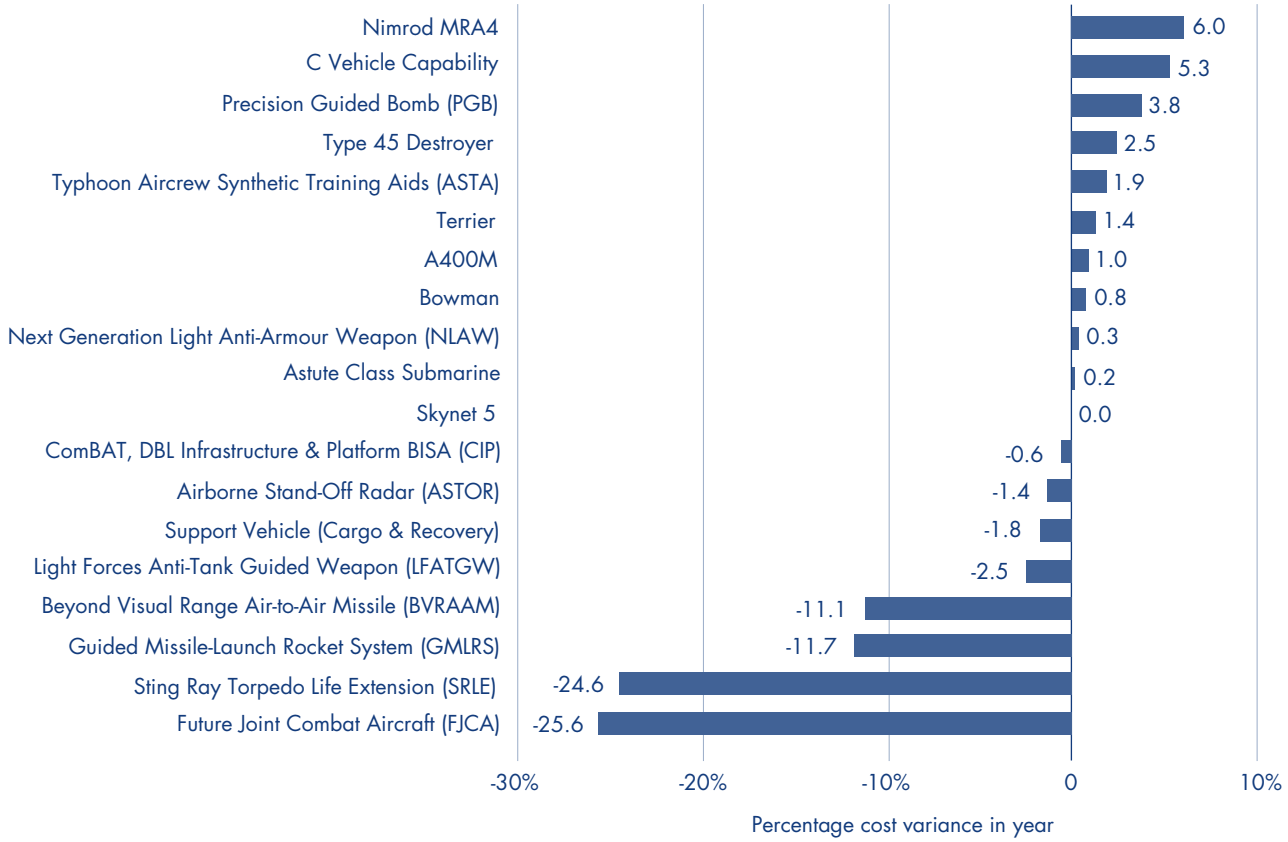
1.7 **Figure 6 on page 11** shows the delay that occurred on each project in the last year. The total in-year delay is 45 months. Timescales on 14 projects have not changed in the last year. The majority of the in-year delay is due to three projects: ComBAT, Infrastructure and Platform BISA projects (known as CIP – covering a number of software and hardware systems building on the Bowman communications project)[4] (17 months), Nimrod MRA4 aircraft (12 months) and Airborne Stand-off Radar (12 months). These delays were all due to technical problems. The other two projects which experienced delays in the last year were C Vehicle Capability (3 months due to an extended contracting process) and Typhoon Aircrew Synthetic Training Aids (1 month due to technical problems).

3 Future Joint Combat Aircraft is part of the United States Joint Strike Fighter programme and is aligned with the United States acquisition lifecycle. The current approval is for the cost of System Demonstration and Development only and further approval will be sought for the cost and in-service date of the main procurement phases.

4 We are planning to report separately on the introduction of the Bowman capability in early 2006.

4 Cost variation in-year by project

Costs have increased in-year on seven projects, decreased on seven projects and are stable on five projects. Two projects have had particularly large in-year decreases.



Source: National Audit Office

Time and cost increases are still to a large extent caused by technical factors

1.8 We are concerned at the extent to which factors that should have been properly identified as risks, such as technical issues or contracting process, contribute to time and cost increases each year. **Figure 7** shows the reasons for delay since 2003 with technical factors contributing the largest single proportion of total delay each year. These causes of variation relate to the key areas that should be addressed during the Assessment Phase, such as technology maturity or commercial arrangements, and we would therefore expect them to become less prevalent although the occurrence of these factors should be seen against the backdrop of ongoing problems experienced by older projects. Part 2 of this Report examines the Assessment Phase in more detail.

5 Summary of overall time performance against forecasts and in-year variation

	All 20 projects
Difference from expected delivery time at Approval (months)	375
In year variation (months)	45
Average in-year variation	2.4

Source: National Audit Office

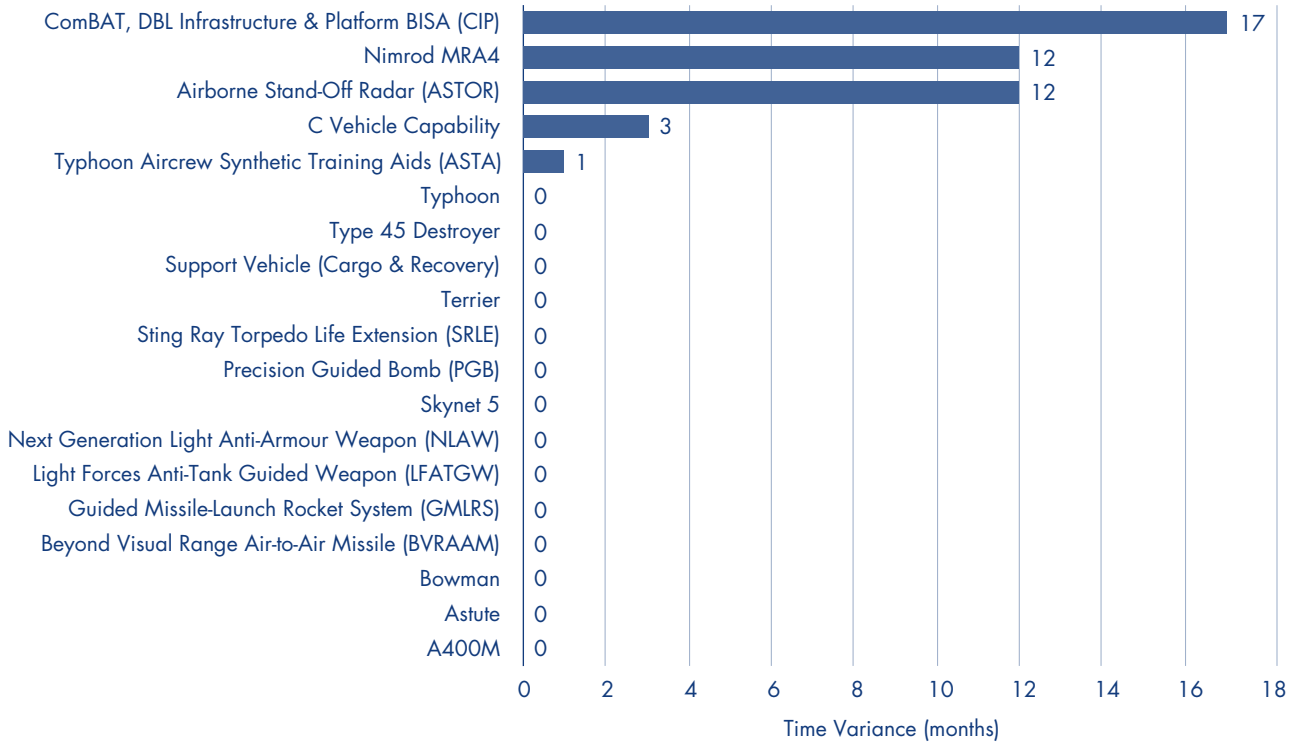
NOTES

1 The basis of approvals is covered at Appendix 2.

2 The average in-year time variation is calculated across 19 projects: Future Joint Combat Aircraft is excluded as it does not yet have an approved in-service date.

6 Time variation in-year by project

Three projects account for the majority of the delays and 14 have experienced no change.



Source: National Audit Office

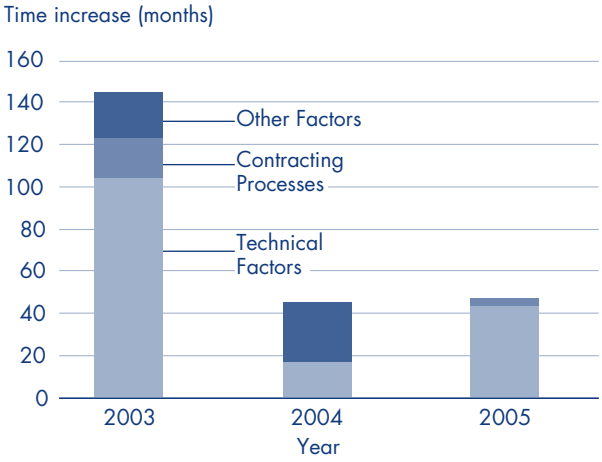
Key User Requirements are expected to be met

1.9 Eighteen projects are expected to meet all of their Key User Requirements (98.6 per cent). Support Vehicle is forecasting to miss two Key User Requirements due to trade-offs of cost and capability (described in more detail in the Major Projects Report 2004) and the other missed Key User Requirement is historic and relates to the landing distance of the Typhoon aircraft.

1.10 For the first time this year, the Department has included extra data on project performance against approved Key User Requirements by including an 'At Risk' section to highlight current areas of difficulty. Five projects, Future Joint Combat Aircraft, Nimrod MRA4 aircraft, Bowman, ComBAT Infrastructure and Platform BISA and Terrier assessed one or more of their Key User Requirements as being at risk, a total of eight which is some four per cent of the overall total.

7 Reasons for time increases in-year

Technical factors and contracting processes contribute a significant proportion of forecast project delays each year.



Source: National Audit Office

Projects have consumed less of their risk differential in comparison to last year

1.11 Risk differential was introduced as a cost and time variation category in the Major Projects Report 2000 to reflect the Department's project forecasting and budgeting process under Smart Acquisition. It represents the difference between the budgeted and highest acceptable cost or time estimates approved at Main Gate. The budgeted estimates are the basis on which the Department plans its Equipment Programme, while highest acceptable estimates are not to be exceeded values for the cost and in-service date of equipment and represent the situation should most of the identified risks materialise. A project is therefore required to seek re-approval from the Investment Approvals Board if an existing approved highest estimate has been or is likely to be breached.

1.12 **Figure 8** shows the consumption of risk differential by project ordered by stage in the procurement lifecycle. In comparison to last year, eight rather than five projects are forecasting to be completed within their budgeted cost estimates and three of the projects new to the population this year, and at early stages of their procurement lifecycles, are forecasting to be completed within both their cost and time risk differentials. One project at a relatively early stage however, Beyond Visual Range Air-to-Air Missile, has consumed 100 per cent of its risk differential for time. To compare further:

- The two projects forecasting to exceed their highest acceptable cost estimates in 2004, Sting Ray Life Extension and Future Joint Combat Aircraft, are now back within their budgeted cost estimates having reduced the quantity required or deferred capability. Since last year two other projects are now forecasting to exceed their highest acceptable cost approvals: Typhoon Aircrew Synthetic Training Aids and Type 45 Destroyer.
- Five projects are forecasting to exceed their time risk differentials, four of which were also doing so last year. ComBAT Infrastructure Platform BISA exceeded its time risk differential in the last year.

There have been important developments on some projects

1.13 In March 2005 the Advanced Air-Launched Anti-Armour Weapon, known as Brimstone, went into service on the Tornado GR4/4a aircraft. Previously, this project experienced some 36 months of delay including, most recently, 6 months delay for updated guidance and control software to be implemented. These problems were overcome by an extremely high level of co-operation between the project team, Customer, safety assessment agencies and the contractor (MBDA). The project is on target to deliver full operating capability in December 2005.

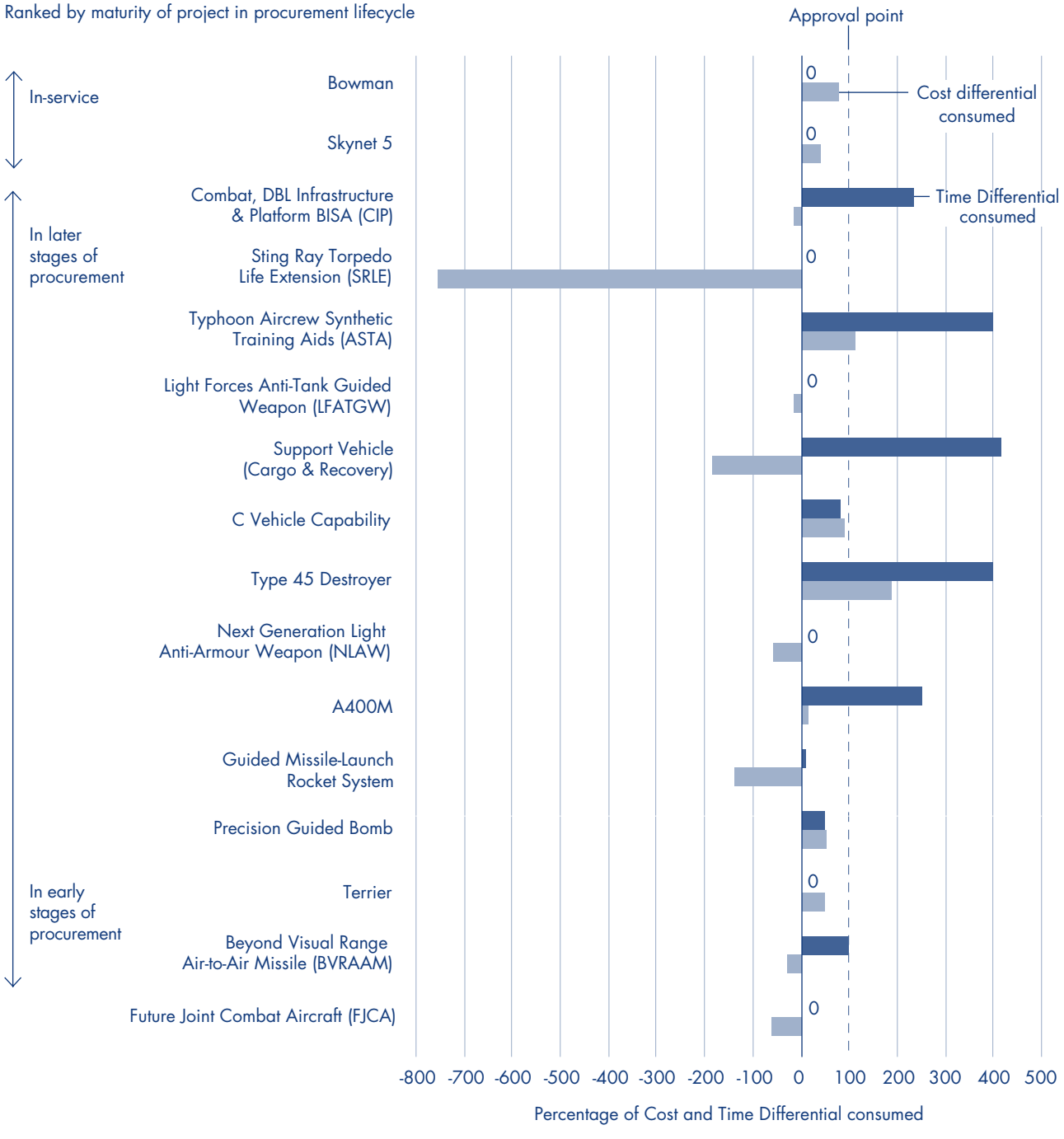
1.14 In July 2005, the Light Forces Anti-Tank Guided Weapon also known as Javelin entered service with the Army some four months before the expected delivery date of November 2005 approved at Main Gate. Training was completed before the in-service date was declared and the equipment is fully operational.

1.15 The Typhoon aircraft successfully entered service with the Royal Air Force in June 2003 and will take over key operational roles progressively during the second half of the decade. The initial phase known as "Case White", which involved over 1,000 sorties and associated training for pilots and ground crew to bring the aircraft up to the standard for flying operations, finished on schedule in June 2005. The squadrons are starting to develop initial air-to-air capabilities and have taken delivery of the first single-seat aircraft and training simulators with the rest of the aircraft from the first tranche to be delivered over the next three years. The second tranche of aircraft are due to start being delivered in 2008.

1.16 The Falcon project, a tri-service secure communication system, first appeared as a pre-Main Gate project last year. The equipment, comprising vehicles, radios and software, was originally intended to be procured in four increments. Due to funding constraints, a revised procurement strategy that encompassed all four increments was adopted. This strategy delayed the in-service date by four years and was reported this year. Following Customer concerns regarding this delay, a recovery plan was instigated and approved allowing the recovery of two of the four years slippage. In July 2005, BAE Systems Insyte was named as preferred bidder to develop the first increment of Falcon, which is designed primarily for the UK-led Allied Command Europe Rapid Reaction Corps and is a key part of Network Enabled Capability.

8 Percentage of Cost and Time Risk Differential consumed

Eight projects are within their budgeted cost estimates and the projects that are exceeding cost or time estimates are further through the procurement lifecycle.



Source: National Audit Office

The Department is still working to improve acquisition performance but challenges remain

The Defence Procurement Agency has performed well against its Key Targets this year

1.17 In April 2004, the Defence Procurement Agency expanded the targets it uses to measure the performance of its business as a whole. It increased the number of projects feeding into the results to include all projects valued at £20 million or more rather than just the 20 largest post-Main Gate projects used previously. It also added targets relating to the efficiency of the business. The changes are intended to give a more representative basis for the Agency's performance. **Figure 9** shows that in 2004-05 five out of six of the targets were met with the remaining target partly met.

9 Summary of changes to the Defence Procurement Agency's 2004-05 Key Targets and performance against them

Target	Basis for measurement	Results
1 Equipment Performance **97 per cent**	All projects with a value greater than £20 million: 61 projects in 2004-05	Achieved (99 per cent)
2 Programme Slippage **not more than 0.9 months on average**	All projects with a value greater than £20 million: 60 projects in 2004-05[5]	Achieved (0.9 months)
3 Cost Growth **not more than 0.5 per cent average cost growth**	All projects with a value greater than £20 million: 61 projects in 2004-05	Achieved (-2.2 per cent cost reduction)
4 Customer Satisfaction **72 per cent**	Survey on a rolling basis (instead of at a single point in the year)	Partly achieved (71.9 per cent)
5 Efficiency[6]	Agency Accounts	
■ Asset turnover **70 months or less**		Achieved (asset turnover 59 months)
■ Assets delivered per £ operating cost **£10.72 or more**		Achieved (assets delivered £14.36)
■ Assets produced per £ operating cost **£16.23 or more**		Achieved (assets produced £19.13)
6 Asset Deliveries of **85 per cent by value of forecast for the year**	Agency Accounts	Achieved (100 per cent)

Source: Ministry of Defence

5 Future Joint Combat Aircraft is excluded as it does not yet have an approved in-service date.
6 This group of targets replaces the previous target measuring operating costs.

There has been progress in the Defence Procurement Agency change programme and in wider Departmental initiatives

1.18 Last year we reported on the changes implemented in the Defence Procurement Agency to improve the application of Smart Acquisition. Subsequently, around 150 strands of work were identified and these were brought together into a single change programme, "DPA Forward", launched in October 2004. The programme has appropriate planning and management arrangements in place and focuses on four key areas: performance, people, process and projects. Within these four areas, the Defence Procurement Agency's Executive Board identified the following key initiatives:

- **Performance**. Key Supplier Management to improve understanding of what drives performance on both sides of the relationship with industry. To do this, senior Key Supplier Representatives are in place to act as focal points for the Department's business with the 18 prime key suppliers and are meeting with them on a regular basis.
- **People**. Skills and staff development based on a workforce and skills planning database that will profile the skills levels in the Defence Procurement Agency in areas such as finance, commercial, project and risk management and engineering. This will enable the Agency to identify and address any skills gaps. "Development Partners", senior officers experienced in key specialisms, are also being established to provide career guidance and skills requirement advice.
- **Process**. Achieving a consistent approach to project and risk management across project teams through the Project Management Handbook, project review and assurance criteria and Acquisition Management System. The More Effective Contracting initiative was also introduced with improved contracting arrangements that include clearer exit/proceed points linked to Earned Value Management and other techniques of measuring progress.
- **Projects**. Improving the ability to trade-off time, cost and performance through consultation across the Department with a view to issuing clear guidance on priorities and the scope for trade-offs both before and after the main investment decision. Areas for discussion include maintaining flexibility and keeping options open on a project for as long as possible during the Assessment Phase; increased use of staged procurement strategies and early warning arrangements such as Earned Value Management and anchor milestones; and refinements to the definition of Customer Key User Requirements for equipment to include minimum and optimum levels of acceptable military capability.

1.19 Another key aspect is joint working with the Defence Logistics Organisation, which hosts the project teams for equipments in service. It also operates Key Supplier Management, risk management and project review and assurance and shares a Human Resources function with the Defence Procurement Agency. There is work in hand to expand this joint working further.

1.20 Many of the changes in the "DPA Forward" programme are due to be implemented by late 2006. The changes may not have an identifiable short term impact on the performance of projects in the Major Projects Report due to the limited flexibility remaining within some older projects. The Department is confident however that, over time, newer projects entering the Major Projects Report should start to display better performance.

1.21 In autumn 2004, the Acquisition Policy Board was formed. It is chaired by the Minister for Defence Procurement, has a total of eight members and brings together issues that had previously been considered by three separate Ministerially-chaired groups. It is intended to provide a clear Department-level focus to direct and drive forward acquisition and industrial policy. The Department is currently developing a Defence Industrial Strategy based on the Defence Industrial Policy published in October 2002. The Department plans to complete this by the end of 2005 and this will, once in place, affect future procurement projects.

PART TWO

The understanding of the nature of the Assessment Phase is improving, but obstacles remain to effective implementation

2.1 Against the backdrop of the findings from the two previous Major Projects Reports and the subsequent reports by the Committee of Public Accounts, which indicated that the principles underpinning the Assessment Phase were not being implemented fully, this part examines the theory and practice of the Assessment Phase by focusing on six case studies presented in **Figure 10** below. The case studies illustrate both the diversity of defence projects, **Figure 11 overleaf**, and the variety of approaches taken in the Assessment Phase. They also serve to shed light on the evolution of the Assessment Phase, as both Airborne Stand-Off Radar (ASTOR) and Beyond Visual Range Air-to-Air Missile (BVRAAM, also known as Meteor) were approved early on in the advent of Smart Acquisition. We interviewed key stakeholders from across the Department and industry to gain an insight into the context of the Assessment Phase from different perspectives.

10 Summary of Assessment Phase case studies, in order of date of Main Gate

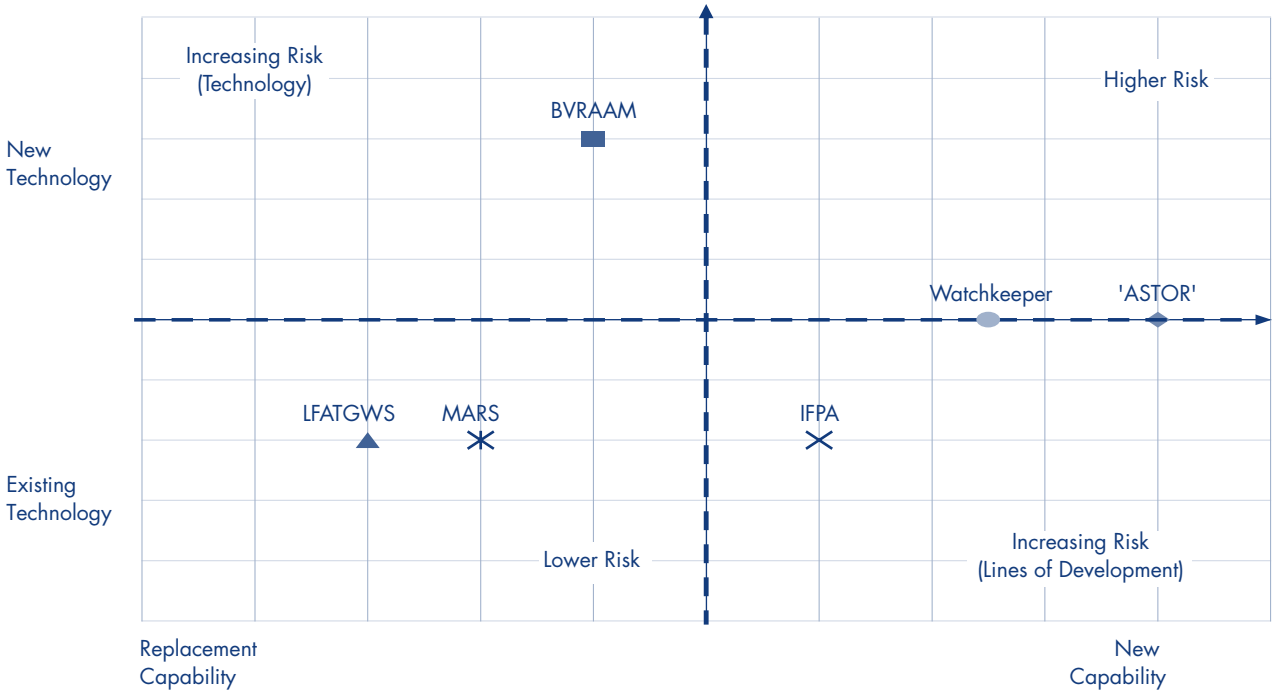
Project	Director Equipment Capability (Customer One)	Phase	Date of Initial Gate	Actual/Forecast Date of Main Gate[7]
Airborne Stand-Off Radar (ASTOR)	Intelligence, Surveillance, Target Acquisition and Reconnaissance	Demonstration and Manufacture	September 1993	June 1999
Beyond Visual Range Air-to-Air Missile (BVRAAM)	Theatre Airspace	Demonstration	May 1997	May 2000
Light Forces Anti-Tank Guided Weapon System (LFATGWS)	Ground Manoeuvre	In-service	July 2000	January 2003
Watchkeeper	Intelligence, Surveillance, Target Acquisition and Reconnaissance	Early Demonstration	July 2000	July 2005
Indirect Fire Precision Attack (IFPA)	Deep Target Attack	Late Assessment	May 2001	Early 2006
Military Afloat Reach Sustainability (MARS)	Expeditionary Logistics and Support	Early Assessment	July 2005	Later in the decade

Source: National Audit Office

7 Forecast dates for the main investment decision (Main Gate) are subject to change as submission for Main Gate approval is driven by the maturity of the project rather than a set timetable.

11 Diagram showing the level of challenges faced by each case study project

Our case studies illustrate the diversity of defence projects.



Source: National Audit Office

2.2 Overall, we found that improvements have been made to implementing the principles of the Assessment Phase but more remains to be done. We found a wide understanding that the overarching aim of the phase is to gain a mature understanding of the project and how it will be delivered, although more clarity on the nature of maturity is needed given the diversity of projects. Developing realistic estimates of what a project is likely to cost is an ongoing challenge for the Department but it has work in hand to improve this. There is an emerging consensus that identifying the cost, time and performance boundaries, known as the trade space, early is beneficial as a de-risking and scoping activity. Finally, we found that the Department recognised the importance of constructive engagement with industry.

The approach to the Assessment Phase has evolved

There were problems with the approach to the Assessment Phase in the past

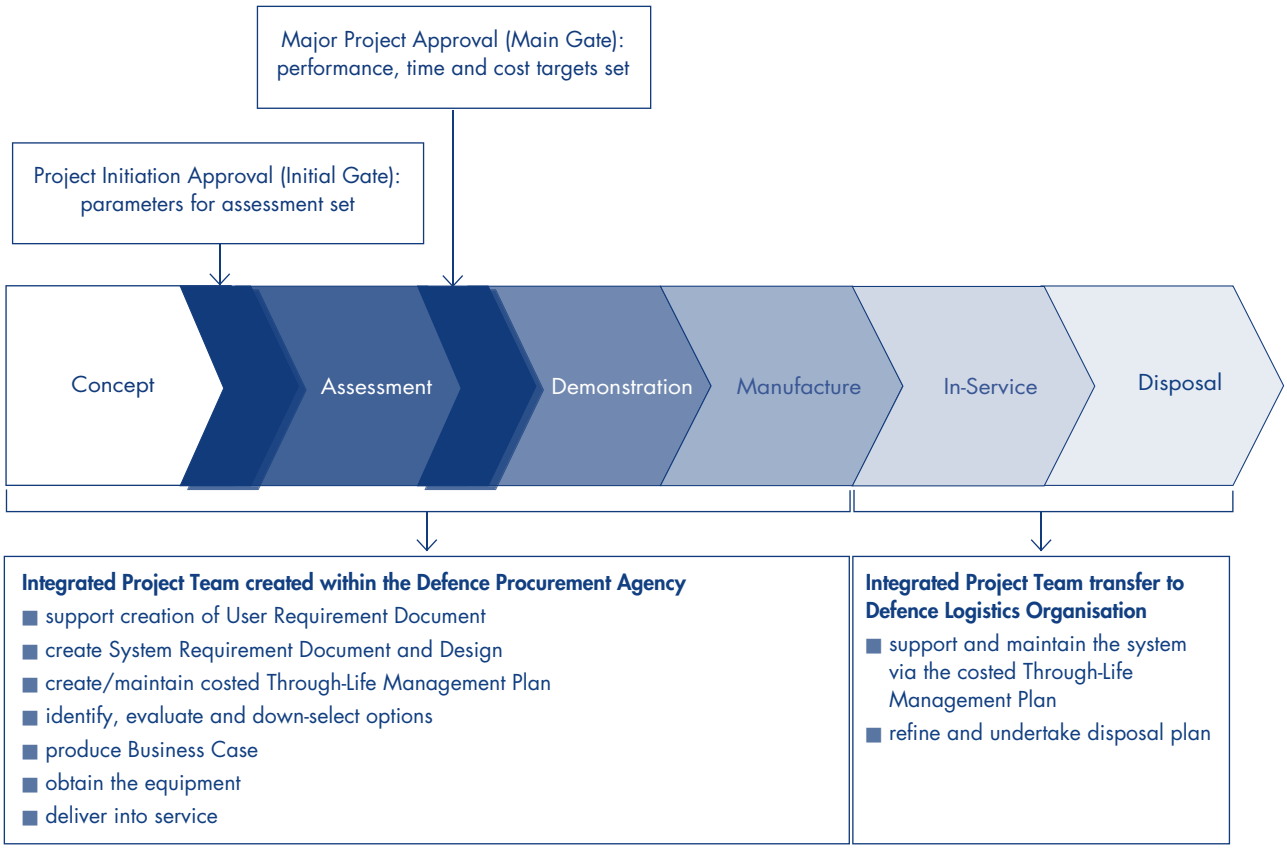
2.3 The poor performance of some of the recently approved projects in Major Projects Reports 2003 and 2004 indicated that the Department had not adequately de-risked and understood the levels of maturity of these projects. This may have resulted in over-optimistic cost and time estimates. These earlier Reports concluded that the purpose of the Assessment Phase was not being fully realised.

The approach to the Assessment Phase has improved

2.4 The introduction of the Smart Acquisition lifecycle in 1999, and the Assessment Phase in particular, recognised the limitations of the previous procurement system. The Smart Acquisition lifecycle is shown in **Figure 12** and further details can be found in Appendix 2. However, some six years on and in light of emerging and ongoing problems on projects that have been through the Assessment Phase, the Department recognised that some of the principles of Smart Acquisition needed to be reinvigorated. In particular, these were the principles of more investment during early project phases, effective trade-offs between system performance, through-life costs and in-service dates and use of new procurement approaches including incremental acquisition.[8] The Department also has a constrained equipment budget with which to deliver its projects with a pressing need to avoid further large cost and time increases. It needs to gain more certainty on those projects coming forward for approval to enable better management of risk across the whole budget. The Department recognises that better implementation of the Assessment Phase is key to achieving this.

12 The Smart Acquisition lifecycle

The Assessment Phase is the second phase in the Smart Acquisition lifecycle in-between the two approval points.



Source: National Audit Office

8 The other principles of Smart Acquisition are a whole-life approach, use of integrated project teams with clearly identified customers, a better, more open relationship with industry and a streamlined process for project approvals.

2.5 Since April 2004, the Department put in place improvements in three main areas:

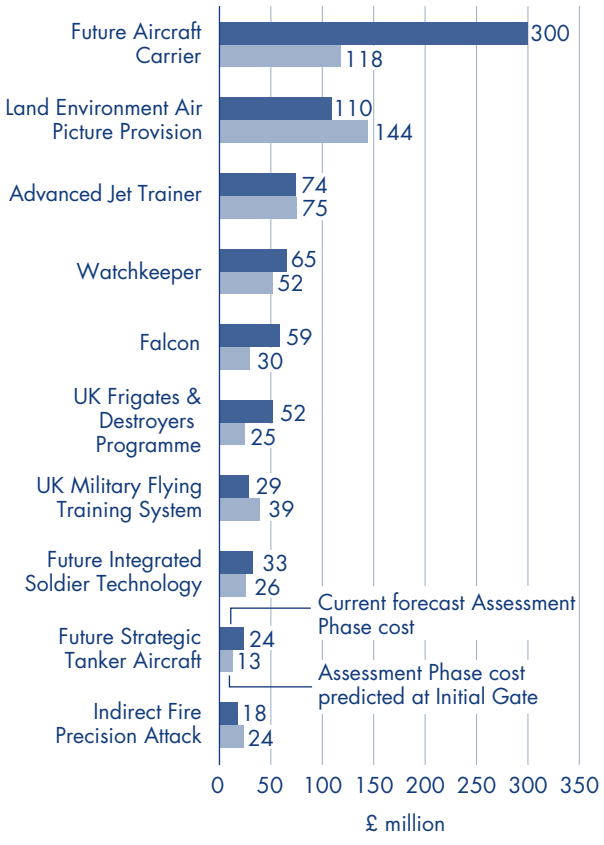
- New emphasis on the need for projects to be mature at the main investment decision (Main Gate). The Department's project approvals guidance states that submission of a Main Gate business case should not be driven by event driven constraints or timetables. In addition, the guidance states that if sufficient maturity cannot be demonstrated at Main Gate for the entire project, subsequent approvals may be needed for those elements where the risk is deemed too great. The outcome of the Assessment Phase is therefore expected to be a mature, well understood project with risks identified and under control as far as possible.
- More robust quantification of risk at Main Gate through refinements to the presentation of risk and, more recently, the requirement for more disciplined cost estimates at Main Gate based on analysis of historic costs on previous, similar projects to remove over-optimism.
- An ongoing consultation exercise with a view to producing clear guidance on how and when projects can trade the performance, time and cost of the equipment being procured. There has been a clear articulation at senior levels within the Department that projects must be able to trade out elements of performance in order to deliver equipment on time and to budget.

2.6 Since April 2002, the Department has stipulated that Technology Readiness Levels and System Readiness Levels are defined for each project at Main Gate. These two measures are useful indicators of whether the technologies proposed to be used in a project actually work and whether they can fit together to deliver the performance required by the Customer. There is a scale, from one to nine, of technology readiness with one being, for example, a paper study of a technology's basic properties and nine being use of the system under operational mission conditions. There is a similar scale for system readiness, with one being articulation by the Customer of the needs of each component part and nine being complete system validation and delivery into service. From the start to the end of the Assessment Phase, the Department expects a project's technology readiness to progress from around level three to level seven and its system readiness to progress from level one to level four. From next year, there is potential for the Major Projects Report to track technology and system readiness levels.

2.7 The Department has recognised that the proportion of total procurement cost spent in the Assessment Phase has been too low in the past and that it should rise, as appropriate on a project by project basis, to gain a better understanding of the proposition at Main Gate. There are indications that this is already happening. Over half of the 10 Assessment Phase projects in this year's Report are projecting to spend more time and cost in the Assessment Phase than they originally planned when they entered the Phase at Initial Gate, as summarised in **Figure 13**. In addition, Watchkeeper's Assessment Phase was extended by 12 months and resources brought forward to fund an additional £7.5 million of de-risking activity before Main Gate. This enabled final trade-off of performance and time in order to gain greater confidence in the cost and in-service date estimates proposed at Main Gate and brought the project back within affordability constraints. Watchkeeper in the event spent approximately

13 Current forecast costs of Assessment Phase projects in the Major Projects Report against projected costs at Initial Gate

Six projects are forecasting to spend more in the Assessment Phase than originally planned.



Source: National Audit Office

seven per cent of its total procurement cost approved at Main Gate and, as a result of this extra resource, had a better understanding of the cost drivers underpinning the estimates put forward at Main Gate.

The principles of the Assessment Phase have been better understood but obstacles remain to realising the full benefits

2.8 There is a firm understanding that the purpose of the Assessment Phase is to reduce the risks of projects, in both commercial and technical terms. Furthermore, all three of our case studies that were still in the Assessment Phase were clear that getting their projects to a suitably mature state was the key driver for submitting their Main Gate business cases for approval. The other three case studies, approved and in the Demonstration and Manufacture phases, all reflected that maturity is important and would have been a useful approach to take.

2.9 There was widespread consensus that there are, however, counter pressures that can drive a project to pass through Main Gate in a less mature state. In particular, the obsolescence of existing equipment can create a sense of urgency for project teams which can give a project momentum as experienced by the Javelin missile team (that opted for a proven, modified-off-the-shelf procurement strategy to address this pressing need). In addition, the high degree of staff turnover widely acknowledged by interviewees, which on average occurs every two years for military staff and every three years for civilian staff, and the desire of staff to achieve key milestones, can also contribute to the momentum to get to Main Gate.

Greater clarity on the nature of maturity is needed

2.10 Projects can be diverse both in terms of the types of challenges they face and the ways in which they choose to tackle them as there can be no single procurement strategy applicable to all projects. In some cases, significant investment is required to develop cutting edge technologies which can only be done when the main contract has been awarded and the contractor has some certainty of funding. For projects undertaken as part of international collaboration, there can be extensive negotiation periods and elaborate and different governance arrangements for each partner and project team. These and other factors contribute to less certainty when the main investment decision is taken. We did not find a consensus on how a project should decide if it is mature enough to go to Main Gate given the complexity and diversity of projects. The Department has progressively introduced mechanisms such as Key Stage Peer Review and Project Review and Assurance to provide a more disciplined assessment of project maturity. It has also issued high level guidance on maturity requirements at Main Gate.

2.11 The spread of cost estimates is a measure of maturity required at Main Gate and is generated using the three-point estimating technique, which is summarised in Appendix 2. There was no consensus among interviewees as to how the spread of these figures demonstrates maturity. Some were of the opinion that a mature project would have a minimal risk differential as this would indicate that all risks had been mitigated or were under control and would therefore pose minimal risk to the equipment budget as a whole. Others were of the opinion that a mature project would be able to demonstrate an appropriate risk differential that may be large depending on project circumstances. Two of our case studies also illustrate this lack of clarity of how the spread of cost estimates should reflect maturity. Javelin and Meteor, which had different levels of maturity at Main Gate, both had risk differentials equivalent to 10 per cent of their total forecast procurement costs.

2.12 Our case studies also illustrate different approaches to factoring political and industrial uncertainty into cost and time estimates for project delivery. Meteor's risk differential for time at Main Gate is likely to be insufficient because most of it was consumed before technology development started on the project. This was due to extended negotiations with the contractor and concurrent delay to signature of the Memorandum of Understanding between the Partner Nations, a potential source of delay that was recognised at Main Gate but not adequately allowed for in its time and cost risk differentials.

2.13 Early and realistic acknowledgement of external factors that impact on the choice of procurement strategy is likely to be extremely beneficial. It should allow the creation of appropriate time and cost risk differential to give the project team flexibility to deal with outstanding risks and for the front line user to have a more realistic view of when they will get the required capability. For example, MARS support ships is attempting to build industrial and political factors into its cost estimates at an early stage by acknowledging the history of large cost overruns on naval projects and the political dimension to the decision of where the ships may be built.

There is further to go in developing robust cost estimates

2.14 The projected delivery costs of a project that are submitted for approval are the product of an estimating and budgeting process that begins before the start of the Assessment Phase. Project teams further evolve these cost estimates during the Assessment Phase by populating detailed cost models using data generated internally and sourced from industry at different stages. There are difficulties with this as, across our case studies and Departmental and industrial interviews, there was a consensus that cost estimates provided by industry are not always robust.[9] Interviewees recognised that this can be for different reasons such as the diversity of defence projects, the length of time that may have passed since a similar project was undertaken, lack of relevant knowledge or data or to the constraints imposed by a competitive environment.

2.15 The costing process developed by project teams during the Assessment Phase is produced in parallel with the strategic budgeting process undertaken by central planners in the Department. Interviewees found a tendency for cost estimates generated before the Assessment Phase to inform the subsequent equipment planning and budgeting process; this was illustrated by case studies of IFPA artillery weapons and MARS support ships. Interviewees noted that these very early estimates not only created expectations of how much a project is likely to cost but also crystallised into firm budgets that did not necessarily match the results of the bottom-up costing exercise done subsequently by project teams.

2.16 The Department recognises the difficulties in generating robust cost forecasts and now requires historic cost data analysis to be included in Main Gate business cases. It has also put in place a strand of work to bring together cost data sources across the Department. Currently, this work is focused on better use of industrial knowledge and modelling techniques during the Concept and Assessment Phases and on providing expertise and support to assist the strategic equipment planning and budgeting process. The Department has an aspiration to roll out the first phase of a master cost and pricing database in mid 2007.

There is an emerging consensus on the need to identify project trade space early as a key de-risking and scoping activity during the Assessment Phase

2.17 Evidence of the scope for cost versus capability trade-off is required at Main Gate and we found a general consensus that projects must identify the minimum and maximum equipment performance specifications, costs and in-service dates, also known as the 'trade space', as early as possible. Implicit in the requirement for evidence of future trade space at Main Gate is an assumption that a project may have already traded during the Assessment Phase to reach the specified performance, cost and time delivery targets sought for approval at Main Gate and the experience of Watchkeeper's extended Assessment Phase is a practical example of this. The successful trading of performance against time on Watchkeeper was attributed in part to the Director Capability Integration structure within the Army. This structure provided a central point for looking across the Army's acquisition programme and dealing with trade-offs on behalf of the front line user. This is also an example of the importance of involving the Customer community in both identifying the trade space and making trade-offs across all the Lines of Development that make up military capability.

2.18 We found that some projects may have varying scope for trade-offs after Main Gate. One of the limiting factors of international collaboration is that participating nations are often reluctant to trade what they see as a vital capability of the programme against either cost or time. Meteor found that, once the design was fixed, future trade space became limited to changing the required number of missiles. The trading options on MARS support ships (specifically Fleet Tankers) may also be limited as funding constraints have led to an already 'bare bones' capability being taken forward into the Assessment Phase, although further options for building in future capability will be considered as the project goes forward.

9 See also our report on 'Driving successful delivery of major defence projects: drawing on wider practice in tracking the progress of major projects', published in March 2004.

The Department recognises the importance of constructive engagement with industry during the Assessment Phase

2.19 There was widespread recognition that projects need to build relationships with industry during the Assessment Phase but that these relationships require careful management. The experience of earlier projects such as Nimrod MRA4 aircraft and Astute submarine show the difficulties of managing what can be a highly competitive environment offering significant commercial opportunities. These competitions drove keen pricing and may have encouraged the bidding companies to take on more risk than was genuinely manageable. However, three of our case studies illustrate the variety of ways in which projects are now building constructive relationships with industry, tapping into knowledge and expertise and identifying those best placed to go forward into Demonstration and Manufacture, which are detailed below:

- Watchkeeper engaged with industry widely and early as part of pre-Assessment Phase market research as there was no established solution to provide the required capability. Over 100 responses were received when initial expressions of interest were sought, which comprised a wide range of potential platforms and technologies. Four were taken forward into the Assessment Phase and the key challenge for the project team was to ensure industry understood and accepted the planned approach to optimise military capability by integrating the best or most appropriate sensor onto the best or most appropriate platform, rather than proceed with a single solution. The relationships were characterised as open and honest, particularly after the preferred bidder Thales was selected when final affordability issues had to be resolved. The military Customer acknowledged the contribution the Watchkeeper Project Team made in driving the contractor to deliver the scope for performance and cost trade-off, and also acknowledged Thales for its open approach in costing the resulting options.
- IFPA artillery weapons departed from the more traditional competitive Assessment Phase by contracting an industry partner to undertake the assessment of options and produce a recommended munitions mix and route map for developing and procuring them. The project team ran a competition for this role and evaluated candidates on the competence of their proposed approach rather than on price alone. A consortium led by BAE Systems Future Systems was appointed and brought into a joint project team with the Department. The key benefit of partnering in this way was the application of methodologies, skills and commercial experience that the Departmental project team would not have been able to provide themselves. A key challenge was ensuring the industrial partner did not favour their own potential solutions and that potential suppliers were content to share the details of their own products.
- MARS support ships reviewed previous naval programmes to identify potential lessons that could be applied to the project. Poor industry relations, in particular problems with the prime contractor model on previous naval programmes, were identified as a key lesson and the project team actively sought to investigate fresh approaches to engaging with industry. In particular, it benchmarked contracting models with other industries and its proposed procurement strategy is based on the alliance model demonstrated in the oil and gas industry. The project team also held seminars for Small and Medium-sized Enterprises that may be well placed to drive innovation and savings into the project and also for the major defence contractors to keep the sector informed about the programme.

APPENDIX 1

Summary of Pre-Main Gate projects as of 31 March 2005

Project	Description	Forecast of Assessment Phase Spend (millions)	Forecast Demonstration and Manufacture costs (millions)	Assessment Phase spend as a proportion of total procurement costs	Target date for Main Gate approval	Internal planning assumption for entry into service
Advanced Jet Training	Training system	74	667	10.1%	October 2005	February 2010
Falcon	Communication system	59	387	13.2%	May 2009	October 2011
Frigates and Destroyers Programme	Improving situational awareness	52	248	17.3%	July 2010	April 2012
Future Aircraft Carrier	Aircraft Carrier	300	Commercially sensitive	Commercially sensitive	TBA	Commercially sensitive
Future Integrated Soldier Technology	Fighting system for dismounted close combat	33	773	4.1%	November 2006	September 2010
Future Strategic Tanker Aircraft	Tanker aircraft providing air-to-air refuelling capability	24	Commercially sensitive	Commercially sensitive	September 2005	Commercially sensitive
Land Environment Air Picture Provision	Integration and update of Air Defence systems	110	135	44.9%	August 2007	June 2010
Indirect Fire Precision Attack	Munitions	18	1286	1.4%[10]	January 2006	December 2008
UK Military Flying Training System	Training System	29	6679	0.4%	November 2006	April 2007
Watchkeeper	Unmanned air vehicles, sensors and ground stations	65	907	6.5%	May 2005	April 2010

10 Indirect Fire Precision Attack Assessment funding will continue beyond Main Gate as part of the incremental acquisition process which will result in a spend of 12 per cent of total procurement costs.

APPENDIX 2

The Smart Acquisition approval process

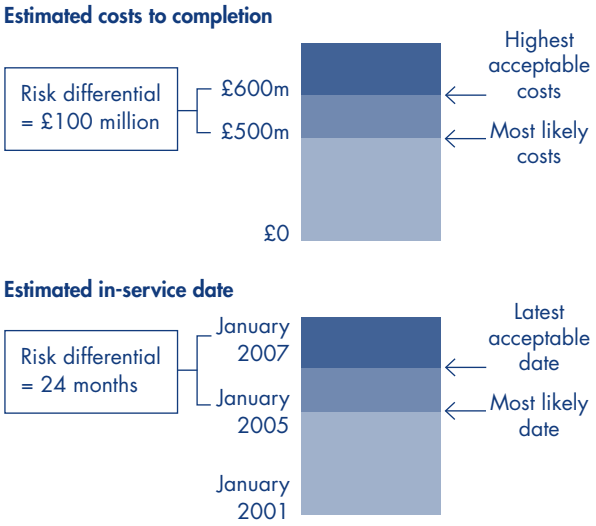
1 Under the Smart Acquisition lifecycle, there are two key approval points, Initial Gate, at which parameters for the Assessment Phase are set, and Main Gate, at which performance, time and cost targets for the Demonstration and Manufacture Phase are set.

2 In Smart Acquisition, projects are required to submit three-point estimates as part of their Main Gate business cases (seeking approval for demonstration and manufacture). These three-point estimates provide an estimate of costs and in-service dates at 10, 50 and 90 per cent confidence levels based on the likelihood of identified risks materialising and represent the lowest achievable, most likely, and highest estimate of costs (or most optimistic, most likely, and most pessimistic). Similarly for time, the three point estimates represent the earliest achievable, most likely, and latest estimate of in-service dates. Smart projects are approved on the basis of their 90 per cent estimates, but are managed and driven to meet their 50 per cent estimates. The 90 per cent estimates represent the manifestation of most of the identified risks and are the highest level of costs and latest in-service dates which the Department are prepared to accept – projects which exceed these parameters are required to seek re-approval from the Investment and Approvals Board. The Department budgets against the 'most likely' estimates of time and cost in its equipment programme.

3 The Department has recently introduced a new measure, whereby the 90 per cent estimates set previously as highest acceptable levels are actually set elsewhere on the three-point estimate scale. This is known as the 'not to exceed' level and the actual percentage is calculated on a case by case basis based on the risks identified. The Major Projects Report post-Main Gate population does not currently include any projects with this new level of 'not to exceed' applied.

4 The difference between the forecast (50 per cent) for cost and time and highest acceptable (90 per cent) for cost and time at Main Gate is reported in the Major Projects Report as the Risk Differential. This is illustrated in **Figure 14**. If risk identification is performed effectively, there should be a similar number of projects delivered within, as projects delivered beyond, their most likely forecasts. The vast majority of projects should not exceed their highest, or latest, acceptable parameters but theoretically around one in ten could be expected to exceed these.

14 Cost and time approvals under Smart Acquisition



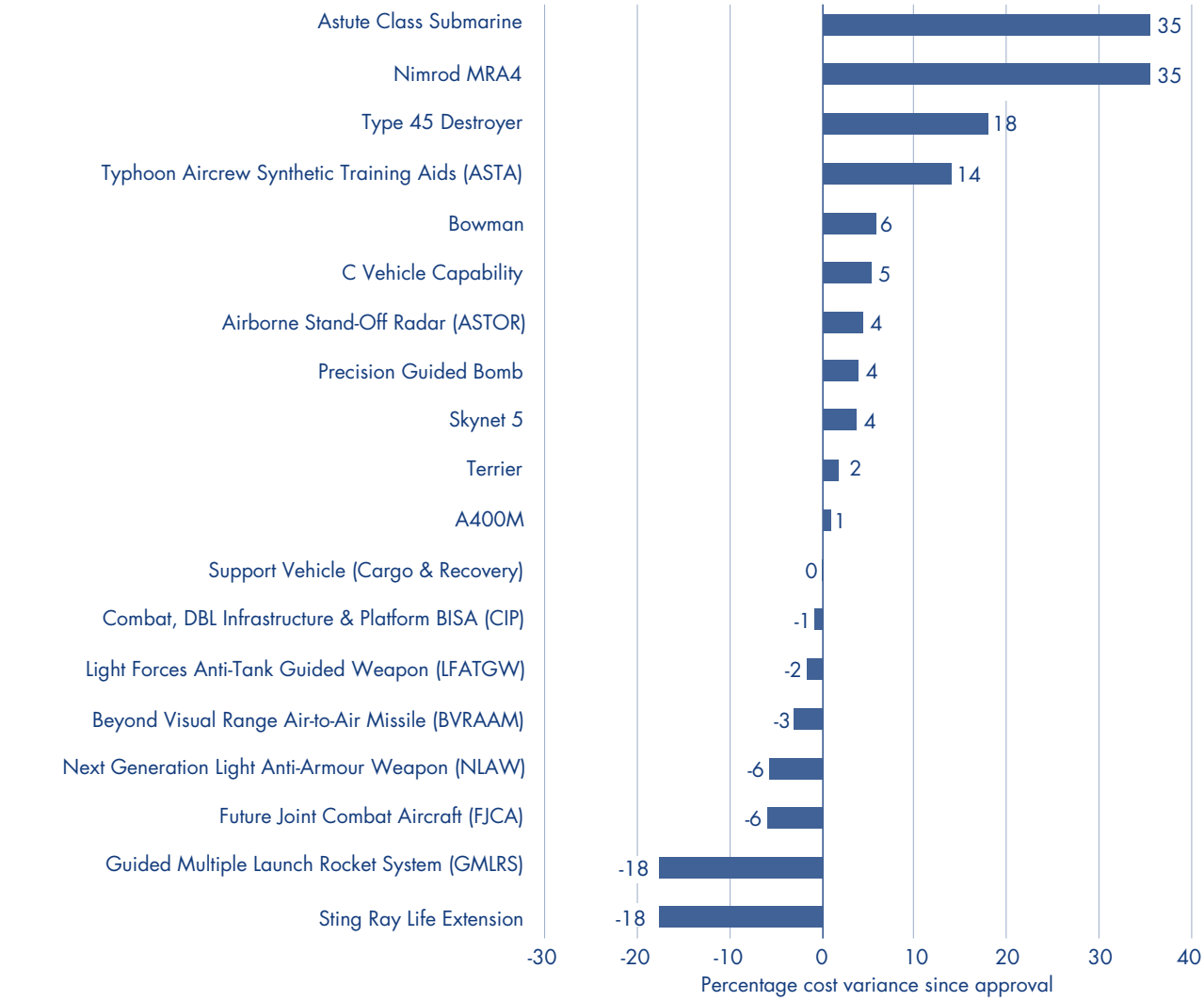
Source: National Audit Office

APPENDIX 3

Cost and time performance since Main Gate approval

15 Cost variation since Approval

11 projects are forecasting overruns against their forecast of budgeted costs at approval. Of these, four are also forecasting overruns against their highest acceptable cost estimates at approval.



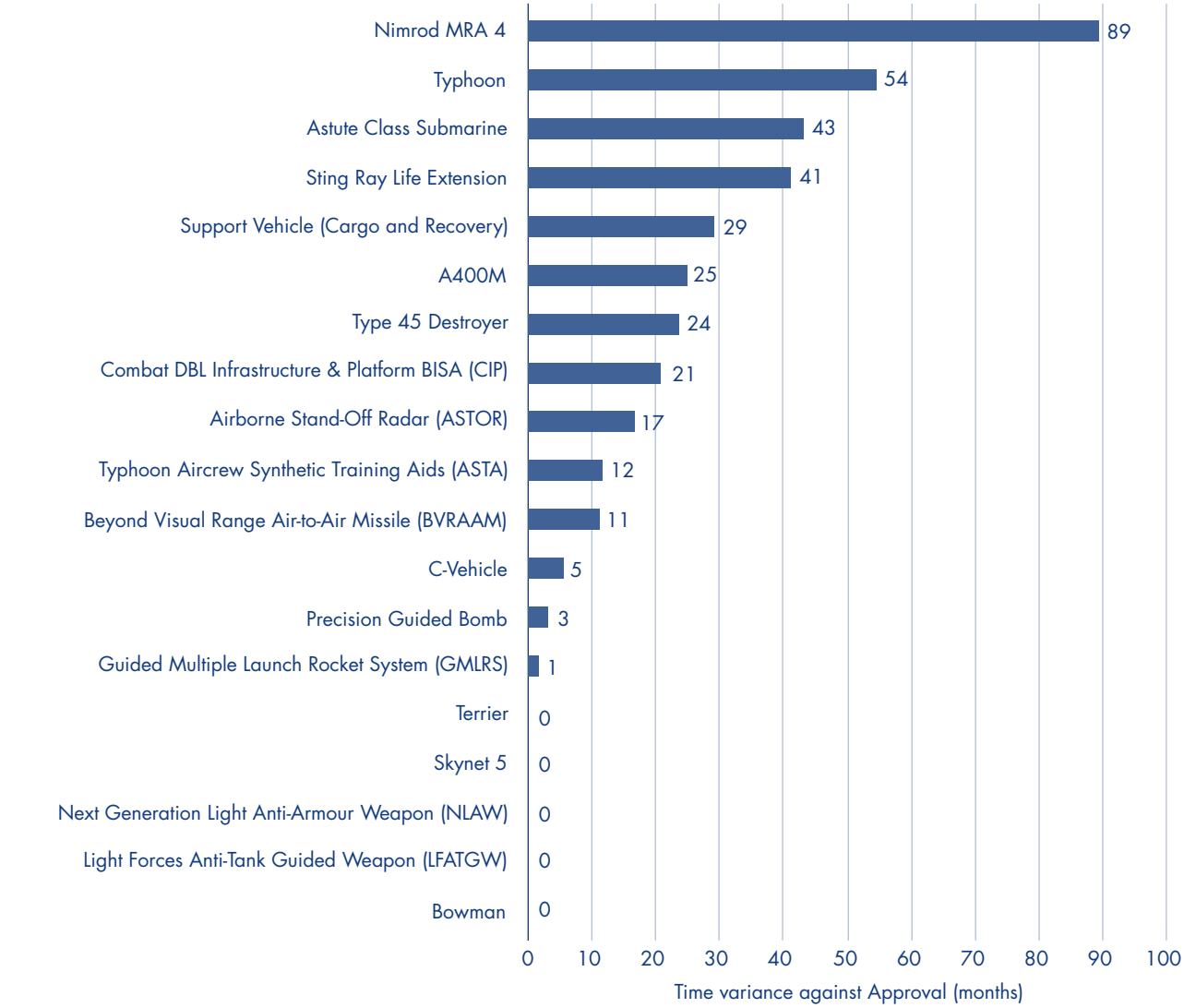
Source: National Audit Office

NOTE

Typhoon is excluded from this analysis as the information is commercially sensitive.

16 Time variation since Approval

Compared against their forecasts of expected in-service dates at approval, 14 projects are forecasting delays.



Source: National Audit Office

NOTE

Future Joint Combat Aircraft is excluded as it does not yet have an approved in-service date.

APPENDIX 4

Case studies

Airborne Stand-Off Radar (ASTOR)

ASTOR is a surveillance and target acquisition radar capability intended to detect moving, fixed and static targets on the battlefield from a distance. Radar data from the aircraft is fed to ground stations for processing, from where it is passed to Army and RAF commanders.

Key characteristics of the project

ASTOR is a new capability utilising developing technology

The use of radar technology for battlefield surveillance was an emerging concept in the 1980s and was successfully used by US forces in the first Gulf War. ASTOR will be the first capability of this kind for use by United Kingdom Forces and draws on subsequent advances in radar technology.

ASTOR is a pre-Smart Acquisition project

The assessment processes that led up to ASTOR's approval at Main Gate took place within a framework that predated smart acquisition. Activities broadly equivalent to what is now defined as the Assessment Phase took place in what was known as Project Definition.

Key characteristics of the Assessment Phase

ASTOR underwent an early technology demonstration programme on its radar concepts and there was no further practical demonstration of the competing solutions during the assessment phase

During the Concept Phase for ASTOR, a technology demonstration programme was run to assess whether emerging radar technology had the potential to meet the developing requirement. This used representative radar units in flight to assess if it was feasible to collect both radar imagery and Moving Target Indicator returns satisfactorily from a single antenna. This programme was deemed successful and enabled the programme to move into Feasibility/Project Definition activities.

Assessment activities centred on a competitive Project Definition Study followed by an evaluation of initially two, later expanded to three, competitive bid proposals. All proposals identified that the air-platform would be based on the modification of existing commercial aircraft and that many of the key sub-systems, such as the data links, were based on items that were already in-service with the US Armed Forces.

The Project Team's assessment of the bids did not draw on further technical demonstration. Instead the analysis was largely an assessment of commercial, managerial and technical data submitted as part of the bidders' proposals to establish compliance against requirements, identify risks and select a preferred solution.

The work undertaken prior to the main investment decision was successful in identifying the key risks on candidate systems but did not mitigate them to the extent that is expected now prior to Main Gate

While the emphasis was on bid analysis over practical demonstration, the Project Team is confident that the level of scrutiny, in particular that by the Defence Evaluation and Research Agency (now Defence Science and Technology Laboratory and QinetiQ) was sufficient to identify the key technical risks to the project. Concerns that the level of radar power proposed in Raytheon's winning bid might be insufficient to enable the radar to meet specification requirements were raised ahead of Main Gate, although the Project Team and the scrutiny community eventually judged that this risk was manageable after Raytheon's late introduction of an amendment to the design that would double the power available to the antenna. The Raytheon bid was selected on the basis that it offered the lowest technological risk, best all round package and value for money.

The Team accepts, in retrospect, that the activities undertaken did not wholly mitigate all the risks identified before Main Gate. The Project Team note that the greater expectation of demonstrable maturity now expected at Main Gate would probably have demanded further work

Airborne Stand-Off Radar (ASTOR) continued

to underpin assessments of technology readiness and could have provided a fuller understanding of the areas of concern prior to committing to contract.

Project Maturity at Main Gate

ASTOR's radar technology, although mature at the main investment decision had not been demonstrated against the contract requirements

The Project Team recognises that the understanding of how well the radar solution would meet the overall ASTOR system requirements had not been subject to demonstration ahead of Main Gate, although the technology demonstration programme had shown that this kind of solution was possible and the proposed radar solution was a derivative of products in service with the United States Air Force.

Problems emerged with the radar technology after Main Gate

In order to meet the testing target set for ASTOR of going into service in 2005, the contractor proposed to run developmental and manufacturing work in parallel. Early work on the aircraft flying qualities was particularly successful in de-risking the programme. This permitted the design, flight test and confirmation of the effectiveness of a range of aerodynamic features to eliminate low speed stability issues before the first ASTOR aircraft flight.

Design work on the radar, however, hit problems within six months of Main Gate. The initial radar design was unable to provide the levels of power required to meet the specification requirement. As a result, the contractor reviewed its radar antenna design concept deciding ultimately that the requirement could only be met with a more technically advanced antenna rather than through the power doubling solution identified by the company during the competitive phase. This new design raised sensitivities over the transfer of this more advanced technology from the United States. This created further challenges for the Project Team to manage.

Further problems with the radar occurred during integration testing in 2004. This was put down to a breakdown in quality between design and manufacture of components, introduced as a result of the re-design activity, embedded within the antenna sub-array assemblies. The problem was not of a nature that was likely to have been de-risked by technology demonstration prior to the main investment. There is now confidence that the contractor has addressed the problem but a 12 month delay to ASTOR's in-service date has ensued.

The need for appropriate and flexible resources

£13 million was spent ahead of the main investment decision, in addition to the £10 million spent on the Concept Phase technology demonstration programme. The activities prior to the main investment decision were driven hard against a target of zero or minimal cost growth, and this increased pressure on project teams to get to Main Gate on budget and to time.

Identifying trade space within the project

Cost and capability trading within the ASTOR project has been limited

Trading, as such, prior to the main investment decision was largely achieved through iterative tendering processes. There has been significant risk-based trading since, the principal trade involving deletion of the Air-to-Air refuelling requirement. The cost implications of the technical problems experienced have not forced any trade-offs as they have to be met by the contractor under the Firm Price terms of the contract.

Constructive engagement with industry

The competitive nature of the project may have led to over optimistic cost and time estimates

The competition for this new capability was intense. Three US-based companies were battling for a contract which offered a significant commercial opportunity in the United Kingdom with potential access to a wider European market. This competition drove keen pricing and may have encouraged the bidding companies to take on more risk than was genuinely manageable.

The Project Team and the military Customer believe that both they and the contractor were probably too optimistic in terms of the demonstration and manufacture schedule. The challenges inherent in the programme were increased by a four month delay to the signature of the contract, and the problems emerging on the radar shortly after, neither of which led to a revision of the planned completion date. Deeper analysis of the competing proposals and the level of risk being carried into the demonstration and manufacture phase, and a fundamental baseline review when the company changed its choice of radar, could have balanced over-optimism and assisted adherence to the demanding schedule.

Beyond Visual Range Air-to-Air Missile (BVRAAM)

Beyond Visual Range Air-to-Air Missile (BVRAAM) is a missile programme intended to provide the RAF's Typhoon aircraft with its long range air-to-air combat capability. The project involves development of the new "Meteor" missile plus the acquisition of off-the-shelf air-to-air missiles (AMRAAM) to meet the interim capability gap.

Key characteristics of the project

The BVRAAM requirement represents a step change in air-to-air missile technology

The missile range and guidance requirements for Meteor mean it will be significantly more capable than air-to-air missiles currently in service. The technology required to meet this requirement was in its infancy throughout the assessment phase and no equivalent capability was available off-the-shelf.

BVRAAM is an international collaborative programme

Meteor is intended to equip Typhoon, and the final project structure for procuring Meteor involves the four Typhoon partner nations led by the United Kingdom, plus France and Sweden which are procuring the missile for their respective Rafale and Gripen fighter aircraft programmes.

Key characteristics of the Assessment Phase

The nature of the assessment phase made discrimination between the candidate systems difficult

The Assessment Phase comprised a competition between two candidate systems. A European consortium led by Matra BAe Dynamics (now MBDA) proposed Meteor, while a United States-led bid offered the option of either an entirely new missile to meet the requirement, or a modified version of an existing medium range air-to-air missile which could meet the requirement through incremental development over time. This bid was seen as being the cheaper and lower risk option while Meteor was seen as being the best bid in terms of meeting the requirement.

Due to the developmental nature of the candidate technology no actual demonstration of the candidate missiles was possible during Assessment Phase. The assessment was in essence a paper-based process and one which the military Customer found to be complex and technically very demanding. Assessment was further hampered by classification issues on the more sensitive aspects of the American bid. Ultimately the Main Gate submission did not make a firm recommendation, presenting instead the options for the main investment.

The assessment phase was successful in identifying the key risks on candidate systems but did not mitigate them to the extent that is expected now prior to Main Gate

The technological risks of the Meteor option were set out in the Main Gate submission. The dependency of the project on Typhoon aircraft being available for integration testing and having the appropriate technology upgrades in time for Meteor going into service was also identified, along with the acknowledgment that international collaboration was necessary to make the project affordable.

These major risks were identified by the Assessment Phase and were presented in the Main Gate Business Case along with proposed mitigation measures. Technology milestones and refund clauses were proposed to manage the key technological risks. A Statement of Intent had also already been agreed with European collaborators along with the opening of negotiations over a draft Memorandum of Understanding. In addition, contractual negotiations were proposed with Typhoon authorities to mitigate the risk of scheduling and interface difficulties between the two programmes.

While the technology milestones were subsequently written into the contract and remain active, mitigation attempts on the collaborative and integration side proved less successful. The extent of negotiations required over the Memorandum of Understanding was underestimated, while the Department's failure after Main Gate to secure the contractual agreements it required with Typhoon authorities left the integration risk exposed.

Beyond Visual Range Air-to-Air Missile (BVRAAM) continued

Project Maturity at Main Gate

The Meteor missile was not mature at Main Gate

There is an acceptance that the BVRAAM Main Gate submission would almost certainly not stand up to the higher expectations of project maturity that characterise Main Gate now. For example, the Meteor missile passed through Main Gate at an estimated Technology Readiness Level of five rather than the current expectation of around seven. However, the costs of the technological development required to achieve such maturity on a missile project like Meteor are very high and the Project Team does not believe this could have been delivered within a competitive Assessment Phase. More recent approaches such as down-selection during Assessment Phase and continued development with a preferred contractor before Main Gate may have delivered a more mature project before the main investment decision was made.

Foreseen and unforeseen risks have emerged since Main Gate for which insufficient allowance may have been made in assessment phase

The risk differential agreed at Main Gate set the cost and time parameters within which the remaining developmental uncertainty on Meteor had to be managed. On a developmental project such as Meteor, unforeseeable technical problems are almost certain to arise, and the Project Team has had to react to a range of difficulties. These have included problems with export licenses for earmarked supplies and unforeseen ambiguities in Typhoon, Rafale and Gripen's interpretations of Military Standard system communication protocols. The risk differential enables the Project Team to absorb the cost increases arising as a result of such problems without having to seek approval to exceed the original budget.

A major difficulty for BVRAAM, however, is that almost the entire risk differential approved at Main Gate was consumed by cost and time over-runs that took place before the Demonstration and Manufacture contract was signed. These were mostly due to delays in the post-Main Gate contract negotiations with MBDA and further delays in obtaining signatures from all Partner Nations to the Memorandum of Understanding that underpinned the collaborative structure of the project. More recently, delays to the Typhoon programme are threatening Meteor's integration plans. This could add further delay to the project. These risks were all foreseen at Main Gate but the Project Team believes that the full extent of their impact, in particular the impact of the collaboration risks, was underestimated and insufficiently provided for.

The need for appropriate and flexible resources

With hindsight the assessment phase may not have been adequately resourced

The military Customer expressed concern that the volume and complexity of the two bids, in particular the information regarding the technical aspects of the missiles, was considerably in excess of the resources available to assess it. While Defence Evaluation and Research Agency (now Defence Science and Technology Laboratory) experts were involved in the assessment the military Customer lacked an understanding of technical aspects of the bids and therefore had less confidence to discriminate between candidate systems at Main Gate. The military Customer also felt that time pressure was pushing the assessment towards a Main Gate decision.

Identifying trade space within the project

Trade space is limited within the BVRAAM project

No capability trading took place during the Assessment Phase, and it is the military Customer's belief that the requirement may have become more complex in this period, with the Meteor missile developing capabilities in excess of what was originally needed. Since Main Gate the maturity of the Meteor design progressed to the extent that scope for remaining capability trade-off is more limited.

In the absence of early trading, reduction of missile numbers is one option that remains. This option has already been executed by the Departmental savings measures in 2005. Any further reductions would have severe capability and commercial implications, and would in any event be unlikely to generate proportionate savings due to the nature of missile production line costs. The other option would be to save money by limiting the extent of integration of Meteor's capability onto Typhoon.

In addition, scope for trade-off options is further limited by the project's collaborative nature. All Partner Nations would have to agree to the adjustments in capability.

Light Forces Anti-Tank Guided Weapon (LFATGW)

The LFATGW requirement is for a man-portable guided missile system capable of destroying tanks and other armoured vehicles out to a range of 2.5km to be operated by the United Kingdom Armed Forces. The requirement will be met by the United States-made Javelin missile system, modified to meet specific elements of the UK requirement.

Key characteristics of the project

LFATGW is a replacement capability

Light forces currently use the MILAN anti-tank missile which was developed in the late 1970s and has become increasingly less effective due to advances in modern tank armour. MILAN is due to go out of service in 2007 with Javelin as a direct replacement.

Failure of an existing development project led to the need to find a quick solution

In 1999 it was decided that the Medium Range TRIGAT anti-tank weapon that was in collaborative development with France and Germany to replace MILAN would not be suitable for Light Forces use. The military Customer requested that the Project Team look for options to replace the capability through buying or modifying an existing system that was on the market. A bespoke development programme was ruled out. A challenging in-service deadline of late 2005 was set which demanded the Assessment Phase be conducted within a 12 month timescale.

Key characteristics of the Assessment Phase

Candidate systems were demonstrably mature

With no developmental candidate deemed capable of reaching sufficient maturity within the Assessment Phase timetable, two off-the-shelf systems were considered during a competitive Assessment Phase. Javelin was already in service with the US Army and the Spike system was in service in Israel. Consequently, notwithstanding the requirement still to develop the UK specific modifications, and conduct UK specific qualification tests and trials, both systems entered the Assessment Phase with Technology Readiness Levels generally in excess of 8 with most significant technological de-risking already completed.

The customer was fully involved in assessment

The Infantry Trials Development Unit and the anti-tank division of the Infantry Training Centre were involved in the live trials for both systems during the Assessment Phase, enabling end users to gain practical experience of how the systems worked, along with an understanding of the relative effectiveness of the two systems in different environments. This experience was crucial and was fed back to the Project Team and used to propose modifications to Javelin which will improve its suitability to the United Kingdom requirement.

Project Maturity at Main Gate

Enhanced off-the-shelf procurement can greatly increase the maturity of the system approved at Main Gate

The Javelin system was technically mature at Main Gate having been in service with the US armed forces since 1996. This high level of maturity is seen as one of the key benefits of off-the-shelf procurement. However, the Project Team still had to manage a number of new system elements, notably modifications to the Command Launch Unit, training and safety issues, and United Kingdom industrial participation within a relatively short Demonstration Phase.

The need for appropriate and flexible resources in assessment phase

A relatively low proportion of assessment phase spend proved sufficient for assessing off-the-shelf weapons systems

The project recognised the guidelines for investing a proportionate level of funding prior to Main Gate, and felt that spend of around three per cent of overall procurement costs was sufficient to take the essentially off-the-shelf project to Main Gate in a mature state. This comparatively low level of investment was in large part dependent on access to the competitors extant performance data.

Light Forces Anti-Tank Guided Weapon (LFATGW) continued

Developing Cost Estimates

Off-the-shelf solutions can offer higher degrees of certainty in the cost estimates approved at Main Gate

The Project Team conducted parallel contract negotiations with the potential suppliers during the Assessment Phase, reducing risk, maintaining the Department's negotiating position and accelerating the process. The off-the-shelf nature of the assessment phase meant that cost estimating could draw to an extent on known pricing, notwithstanding the unique elements of the UK system, allowing greater confidence in indicative pricing and improving cost certainty in the estimates approved at Main Gate.

Identifying trade space within the project

There is limited scope for trade-off once an off-the-shelf solution is selected

An off-the-shelf procurement approach like that undertaken for LFATGW imposes limitations on the ability to trade performance against cost. As Javelin and Spike were already existing products, there was no real possibility of trading the capability that was already designed into the systems. However, trade space can be developed in comparing the performance of candidate systems against the endorsed requirement. Beyond this, once the customer has determined the relative performance of competing systems, the only trade space remaining in the project is missile numbers.

Constructive engagement with industry

Off-the-shelf procurements often involve overseas contractors which can be an additional challenge to industry relationships

The timing constraints on the project resulted in only two systems being taken into the Assessment Phase. The challenge for the Project Team was to engage successfully with the American and Israeli suppliers in order to maintain their commitment to the competition. The Project Team felt they worked hard at these relationships and cited open communications as the key success factor in managing the sensitivities that can arise on international competition and keeping both suppliers engaged until the point of down-selection.

The Project Team stressed the importance of maintaining and developing this approach into the Demonstration and Manufacture phase. The team was proactive in its relationship with the Javelin contractor, in particular choosing to resolve issues face to face as they arose.

The involvement of the Guided Weapon System Support project team during the contract negotiations, which will procure the support of the equipment in service, was also appreciated by the Javelin contractor. It enabled them to bottom out sustainability issues and form relationships that assisted the handover of the project to achieve the in-service date on schedule.

Watchkeeper

Watchkeeper is an unmanned aerial vehicle (UAV) equipped with a range of photographic and radar sensors. It will fly over the battlefield transmitting surveillance, reconnaissance and target identification information to Army commanders on the ground.

Key characteristics of the project

Watchkeeper will provide a step change in capability

Watchkeeper draws on many of the rapid advances in UAV technology since the Army's existing Phoenix unmanned vehicles came into service. In particular it offers much greater range and time in the air along with greater battlefield versatility and readiness. The sensor technology is also significantly more advanced.

The capability will be provided largely by off-the-shelf technology

Watchkeeper will integrate the best (or most appropriate) sensor technology onto the best (or most appropriate) existing unmanned aerial vehicle available on the market. The result will be a bespoke product rather than a straight off-the-shelf purchase, but the use of proven technologies and components significantly lessens the risk of full scale technological development. Technological challenges remain, however, on integrating the off-the-shelf components and enabling them to operate together.

Key characteristics of the Assessment Phase

The Project Team ran a competitive assessment process to appoint a prime contractor

The Assessment Phase comprised a competition to select a contractor to manage and deliver the manufacture and integration of the Watchkeeper capability. Four contractors were selected at the start of the Assessment Phase and over 29 months developed their proposed candidate systems. There was then a further down-select to two contractors who continued to work on their bids before a preferred contractor and candidate solution was chosen.

The assessment phase involved live demonstration of candidate systems

During the later stages of the Assessment Phase, representative simulated or actual systems were demonstrated in order to allow the military users to understand the solutions being offered by both contractors. This also gave an indication of the technical risk inherent in either system solution.

Project Maturity at Main Gate

The assessment phase was extended in order to ensure greater project maturity at Main Gate

While the competitive Assessment Phase provided the team with sufficient confidence to select Thales as preferred contractor on both capability and cost, procurement costs overall were still too high. The team therefore requested approval to appoint Thales as preferred bidder and extend the Assessment Phase to work with them to identify options to trade off and carry out additional risk reduction work at a cost of £7.5 million. Main Gate was deferred while the trade-offs and risk reduction activity were completed. The extended Assessment Phase gave the military Customer a greater level of confidence that the equipment and other lines of development were deliverable to the agreed timetable. This additional work and overall programme affordability dictated a later in-service date.

Some uncertainty remains as further development work is required after Main Gate

Despite the additional work before Main Gate, some uncertainty remains within the project. This principally relates to the ongoing technical challenge of integrating all of Watchkeeper's sensor and software components into the air vehicle. Airworthiness and security certifications also need to be attained. These risks will be addressed in the Demonstration Phase. Both the Project Team and the contractor assess that these risks are manageable within the approved budget.

The need for appropriate and flexible resources

The Watchkeeper Project Team was able to secure approval to extend assessment phase in order to ensure greater maturity at Main Gate

The £65 million spent on the Assessment Phase was approximately seven per cent of the total procurement costs. The Project Team felt this was appropriate given the largely off-the-shelf nature of Watchkeeper's technology.

The Project Team welcomed the openness shown by the Approval and Scrutiny community in granting approval to fund additional risk reduction activity to achieve the maturity required for Main Gate.

Watchkeeper continued

Developing Cost Estimates

There are challenges managing the relationship between bottom-up estimates and top-down budgetary pressures

Work conducted during the Concept Phase into existing reconnaissance and target acquisition systems allowed the Project Team to construct estimates of cost. These estimates were fed into the departmental equipment planning and budgeting process. The Project Team accepts that these early estimates remained outline in nature until industry began formally pricing their bids during the Assessment Phase. However, by this time the departmental budgets binding the costs of the project were largely set and the Project Team had to manage the emerging industrial estimates within that profile.

Identifying trade space within the project

Watchkeeper was forced to trade off capability in assessment phase in order to address affordability constraints

As the final Assessment Phase bids from industry were in excess of the available funding, capability had to be traded off to reduce cost before the project could proceed. The Project Team and Thales worked in partnership to identify cost drivers within the project across all lines of development, trading out those that did not compromise the Customer's Key User Requirements.

The number of Royal Artillery batteries which will be equipped with Watchkeeper was reduced from four to three and the option for a single air vehicle type was selected giving greater flying time and requiring fewer air vehicles to be procured. Together with a range of smaller trade-offs these unlocked approximately £100 million of equipment savings.

The military Customer acknowledged the approach of both the Project Team and the contractor in this process. The military Customer also attributed some of this success to the existence of the Director Capability Integration (Army) structure within the Army. This provides a central point for looking across the Army's acquisition programme to identify the trade space and deal with trade-offs across the lines of development on behalf of the front-line user.

Messages on the remaining trade space are mixed

The extent to which there is any remaining trade space on performance is less clear. The Project Team is confident that scope remains to trade off capability further after Main Gate should project difficulties arise. The military Customer meanwhile feels that this scope is limited to a few small areas.

Constructive engagement with industry

An environment of trust and openness was crucial to Watchkeeper achieving Main Gate

The Assessment Phase hit difficulties when both the final industry bids turned out to be considerably in excess of the project budget. The Project Team requested to extend the Assessment Phase and work with Thales as the preferred contractor to identify cost savings. The award of preferred bidder status, from Thales's perspective, was essential to enabling them to continue to work on the project, as the company had already taken on significant financial risk through investing in its bid and this was something the company feels it could not have sustained indefinitely in a continuing competitive environment. In addition, preferred bidder status gave the company greater confidence to plan fully to undertake the task.

The subsequent period of partnership working tested the relationship the Project Team had built with Thales. A strong shared understanding of the requirement between the Project Team and the military Customer and a commitment to keep the requirement at a sufficiently high level enabled Thales to be creative in looking across all lines of development to identify potential trades. Thales in turn shared its price forecasting models with the Project Team so both sides had full visibility of the cost implications of the trades. The Project Team and the contractor also worked together to ensure the scrutiny community and the Investment Appraisals Board were provided with the information required to approve the Main Gate submission. The view of Thales is that without the commitment shown by the Department to the partnership with industry the project would have failed.

Indirect Fire Precision Attack (IFPA)

Indirect Fire Precision Attack (IFPA) will provide a number of enhanced and new capabilities to the mortar, gun and rocket weaponry that comprises the indirect fire system, delivering significant improvements to the precision and range at which targets can be attacked from land based platforms. This will enable a more effective land based contribution to the wider joint fires capability that also includes air- and sea launched attacks against land targets.

Key characteristics of the project

IFPA requires procurement of a suite of munitions expected to be, initially, a range of off-the-shelf products and then by insertion of new technology as it develops over time

Early market research undertaken by the Project Team in the Concept Phase indicated that no single product existed which would meet the IFPA requirement. Analysis therefore assumed a range of munitions would need to be procured. The aim of the Assessment Phase was to identify candidate solutions, the best product mix available and a timetable for procuring the technologies over a 15 to 20 year timeframe. The capability will be met through a mixture of existing and emerging technologies.

IFPA will be procured on an incremental basis

The current anticipated product mix includes munitions at different levels of maturity ranging from Technology Readiness Levels of four through to eight. These products will be procured on an incremental basis in order to ensure sufficient maturity of each product before committing to contract, to spread the cost of the procurement, and to take advantage of any technological developments, such as new products coming to market, in the interim.

Key characteristics of the Assessment Phase

The aim of the assessment phase was the identification of the optimal mix of weapons that are or are likely to be available off-the-shelf

The Assessment Phase centred on the narrowing down of almost 300 potential weapon options on the market to a planned procurement of five – a 155mm shell with a sensor fused sub-munition, a guided sensor fused shell, an extended range rocket for the Guided Multiple Launch Rocket System (GMLRS), a large long range rocket, then subsequently an airborne loiterer munition. An IFPA Capability Route map has been developed which illustrates procurement paths for each increment of capability.

The assessment phase was undertaken in partnership with industry

Early dialogue with industry indicated that the procurement of the IFPA capability was not going to be met through a traditional competitive Assessment Phase structure and it was decided to contract an industry partner to undertake the assessment. The Project Team ran a competition to appoint this partner using a competency based approach. A consortium led by BAE Systems Future Systems won the competition and a Joint Integrated Project Team (JIPT) partnership structure was formed with the Project Team and other Departmental stakeholders. The JIPT was tasked with delivering the Assessment Phase in parallel with the Defence Science and Technology Laboratory, the recommendations of which are examined by the Department's scrutiny community prior to Main Gate.

Assessment phase activity will continue beyond Main Gate

Due to the incremental nature of the acquisition, the Project Team plans to de-risk each individual weapon in turn before bringing them to Main Gate. This further de-risking is planned to include a Capability Demonstrator programme for the loiterer munition which is a new capability.

Project Maturity at Main Gate

The Project Team will make submissions for approval on a maturity-driven timetable

The Project Team intends to submit a Main Gate Business Case when the 155mm Ballistic Sensor-Fused Munition (BSFM), the first element of the incremental procurement, is considered mature enough to enter a Demonstration and Manufacture phase. The four remaining weapons will be submitted for approval on an individual basis after further de-risking has taken place and they meet the maturity milestones as set out on the Project Team's procurement plans.

An incremental approach may increase uncertainty at Main Gate but also brings benefits

The incremental nature of the IFPA procurement creates a higher level of uncertainty at Main Gate compared to what would normally be expected for an off-the-shelf procurement. Only the 155mm BSFM will be approved for procurement at Main Gate with the remaining elements yet to be de-risked, put out to tender and ultimately contracted against each individual procurement plan as shown in the Capability Route map. While this creates

Indirect Fire Precision Attack (IFPA) continued

some uncertainty regarding the nature of the eventual solutions and their costs, the flexibility in this approach has benefits in respect of the military Customer being able to adapt the procurement to changing needs or emerging technologies over time.

The need for appropriate and flexible resources

The Project Team is satisfied sufficient resources are available for de-risking

The Project Team was aware of the guidelines for spending a proportionate level of procurement spend on the Assessment Phase. Assessment spend will be spread throughout the life of the programme, de-risking each tranche of equipment in turn ahead of the associated major investment decision. The total incremental assessment expenditure is currently expected to reach around 12 per cent of total procurement costs.

Developing Cost Estimates

Both the Customer and the Project Team accept that cost estimates are necessarily approximate in the pre-Assessment Phase period. Initial approaches to estimating costs include market research of potential solutions and comparable products but there is always an element of predicting what the costs of future technologies may be. The Departmental equipment budget line was built on the basis of these estimates roughly a year before Assessment Phase began. The Project Team felt that these initial budgets could cost-cap projects unrealistically early but they acknowledged also that the military Customer could increase these provisions by trading off elsewhere if justified.

In the Project Team's experience industry only begins to fully engage in the provision of robust cost estimates once invitations to tender are issued. The Project Team felt that industry generally was improving in the quality of its estimating and has an improved appreciation of the funding constraints in operation within the departmental equipment budget.

Identifying trade space within the project

Trade space on off-the-shelf procurements can be limited

Once mature in the market place, each of the IFPA munitions are assumed to be off-the-shelf procurements and, as such, both military Customer and Project Team are aware that there will be very little trade space other than weapon numbers once candidate systems are selected. However, the incremental nature of assessment and procurement means that the customer will be able to keep reviewing the proposed weapon mix, deferring, reducing or replacing individual elements in order to trade off capability across the whole procurement.

Constructive engagement with industry

Partnering with industry in undertaking the assessment phase can bring additional skills to the process

The key benefit of partnering with industry in the Assessment Phase was the co-option of industry methodologies and skills into the assessment process which the Project Team would not have been able to provide themselves. The "Spiral" process for down-selecting the munitions mix was seen as instrumental in delivering the Assessment Phase to time and budget. The Project Team also highlighted the commercial edge that industry partners brought to the Assessment Phase. The industry partners have first hand experience of how contractors operate in competition and are able to apply this commercial experience for the benefit of the project.

Selecting the assessment phase partner on competence rather than price was seen as key to getting the best out of the relationship

The Project Team also felt their innovative approach in selecting the contractor on competence rather than price helped deliver a successful Assessment Phase. In particular the format of the competency based questionnaire that was used in the selection forced the candidates to think creatively about how assessment of the programme should be approached. This enabled the Project Team to discriminate between bidders while also feeding into the quality of the programme itself. In order to keep the winning bidder focussed on quality the runner-up was retained on stand-by until the contract was finalised.

There were risks that had to be managed

Robust confidentiality agreements and structures were required in order to enable candidate manufacturers to feel secure submitting their product details to a contracted assessor who may also be an industrial competitor. The candidates bidding to run the Assessment Phase were required to evidence these structures before the contract was signed. The Project Team also obtained contractual guarantees regarding the calibre of staff posted to the Assessment Phase team to prevent the capacity of the team being weakened once assessment was underway.

Military Afloat Reach and Sustainability (MARS)

MARS intends to provide a fleet of ships which will deliver logistic support to maritime, amphibious and land based forces engaged in expeditionary activity. The requirement reflects the changing strategic role of the future Navy (including Carrier Strike) and is intended to reduce United Kingdom Forces' reliance on logistic and infrastructure support from other nations within the theatre of operations.

Key characteristics of the project

Some elements of the MARS project are replacement capabilities while other aspects offer new capabilities

MARS will replace the old, increasingly legislatively non-compliant, Royal Fleet Auxiliary (RFA) ships supplying fuel, food, ammunition and other stores to the Navy's warships. The project is also intended to provide logistic and aviation (in particular helicopter) support capabilities to Carrier Strike and other expeditionary forces. This aspect of the project will be an enhanced capability to that already provided.

The MARS requirement is expected to be met by a range of ships procured on an incremental basis

Concept Phase work concluded that the requirement would best be met by a range of ships with different capabilities rather than by a single class of vessel. This range is likely to comprise both highly capable ships for the Joint Sea Based Logistics (JSBL) requirement and more basic designs for the Fleet Tankers (fuel) and Fleet Solid Support (other supplies) ships. A full range of solutions will be considered to the various classes of ships required from bespoke military design through to modified commercial. The programme is regarded as technologically low risk with only the proposed heavy replenishment at sea (HRAS) lifting equipment for the supply ships representing technology that is not already at or beyond Technology Readiness Level seven. The MARS ships are expected to be procured in discrete phases beginning with the Fleet Tankers where the need to bring new ships into service is most pressing, each subsequent class being approved by separate submissions to the Investment Approvals Board.

The ships are expected to be designed and built by an alliance of contractors

The Departmental Project Team is intending to appoint a Project Integrator to assemble and manage an alliance of contractors for the design, manufacture and support of each class of ship. This structure is intended to engage a wider range of contractors than might participate in a traditional Prime Contractor-led procurement, with the aim of bringing new ideas and efficiencies into the programme from Small and Medium-sized Enterprises in a wider industrial base than the traditional defence suppliers.

Key characteristics of the Assessment Phase

Alliance building will begin in the assessment phase

The early period of the Assessment Phase will comprise a competition to down-select a contractor for the Project Integrator role. Three candidates from an initial field of nine will be assessed on their project management competence and corporate culture, while working in parallel on the alliance strategy over a period of nine months. A candidate will then be appointed as the MARS Integrator on the basis of their performance during the assessment period. The Project Integrator along with the Project Team will then form an initial alliance to acquire the first class of ship following approval at Main Gate.

The Project and its assessment will be phased

Only the first class of ship – the Fleet Tankers – will be significantly de-risked in advance of Main Gate. The Project Team intends to have a sufficiently mature design for the tankers at Main Gate which, following a period of more detailed design post Main Gate approval, can then proceed into manufacture. Subsequent classes will be designed, de-risked and approved for demonstration and manufacture sequentially after Main Gate.

Military Afloat Reach and Sustainability (MARS) continued

Project Maturity at Main Gate

The incremental approach to procurement delivers varying levels of maturity at Main Gate

The Project Team believes maturity of design and build strategy are the key de-risking factors in ship programmes and is intending to have the Fleet Tankers largely designed before going forward for Main Gate. The Project Team acknowledges this to be a greater level of maturity than is usually required for Main Gate approval, but the more standard commercial nature of the Fleet Tanker requirement means this level of design maturity is attainable within the resources available before Main Gate. This approach may not always be possible or indeed desirable with more complex ship projects.

While the Fleet Tanker solution will therefore be very mature (to enable accurate costing at Main Gate), the incremental nature of the programme means the designs and likely costs of the remaining ship classes will be for budgetary purposes only at Main Gate. Each will be de-risked and designed sequentially after Main Gate with subsequent Review Note approvals required to proceed to manufacture.

The need for appropriate and flexible resources

The Project Team is satisfied with its anticipated resources for assessment phase

The Project Team acknowledges the guidelines for spending a proportionate amount of procurement costs on the Assessment Phase, and they are confident that the eight per cent provided for on MARS is appropriate for a programme which, while being large and complex, carries low technological risk. Due to the planned phased nature of the procurement, the majority of this funding will be spent on de-risking activities taking place via separate Business Case submissions.

Developing Cost Estimates

Cost estimates for the MARS ships will only become more accurate when the industrial aspects of the procurement are more clear

The Project Team developed outline cost estimates for MARS during the Concept Phase. The process involves using operational analysis to identify the proposed mix of ship classes and numbers required. The proposed classes are then evaluated by the department's Price Forecasting Group (PFG) which uses models based on size and complexity to generate outline estimates of cost. The Project Team then added contingency to these estimates to account for specific risks not covered in PFG's modelling. Informal industry soundings were also taken to give the Project Team additional assurance on the quality of the estimates they were generating.

The estimates remain outline figures until industry starts formally bidding prices. One of the major challenges for the Project Team is these prices may vary considerably depending on the impact of any industrial strategy decision regarding where the ships may be built. Until this becomes more certain the Project Team is basing its cost estimates on the most expensive scenarios, but that is putting significant pressure on the Departmental budget for MARS. While the industrial scenarios driving cost remain uncertain, the military Customer and the Project Team are identifying scope for trading performance and driving cost down.

Military Afloat Reach and Sustainability (MARS) continued

Identifying trade space within the project

MARS has begun trading cost and capability early in order to keep within budgetary constraints

Budgetary pressures on the Department's shipbuilding programme as a whole have meant that there is significant pressure to cost-cap MARS as far as possible. The early identification of trade space to enable subsequent cost-capability trading within the programme was seen as crucial to achieving this.

The military Customer and the Project Team worked iteratively on the MARS requirement, developing a hierarchical approach to demonstrate how lower capabilities feed into the overall Key User Requirements for the capability and as such how trading individual capabilities may affect the key requirement. As capabilities are added and removed the Project Team will adjust its estimated costs accordingly.

As a result of budgetary savings taken in January 2005, the Department has traded the initial operating capability of the MARS Fleet Tanker down to an identified lower bound of expectation. The incremental nature of the wider programme also gives scope for trading capability across the other ship classes in the run up to the progressive investment decision points.

Constructive engagement with industry

The project is looking at new structures for engaging industry

During Concept Phase the Project Team conducted a review of previous naval programmes to identify potential learning from experience that could be drawn on for MARS. Poor industry relations and project management – in particular historic problems with the Prime Contractor model on naval programmes – were identified as a key problems. Fresh approaches were considered including:

- Consultation across similar industries to identify other potential contracting models. The oil and gas industry use of contractor Alliances under the management of project integrators helped shape the proposed procurement strategy.
- Hosting industry seminars for Small and Medium-sized Enterprises (SMEs). The Project Team feels that SMEs are well placed to drive innovation and savings into aspects of naval programmes but have traditionally been excluded from doing so by the nature of historic contracting arrangements.

The Project Team also held industry seminars for the major defence contractors to inform the sector about the programme. The main risk with this approach was preventing industry immediately pushing their own solutions to the requirement. This was managed by a combination of robustness in handling any unsolicited work offered by contractors in anticipation of the requirement, but equally by maintaining a spirit of openness with industry to keep them informed of project timetables and expectations.

APPENDIX 5

Glossary of contractual and acquisition terms

Acquisition Management System	The department's web-enabled system for accessing guidance on all aspects of the acquisition process: www.ams.mod.uk
Alliance	A procurement strategy in which the Department selects and contracts with a number of suppliers, the aim being to include those best placed to introduce innovation and mitigate recognised risks. The Department and the other Alliance partners share risks and benefits. The Department will typically appoint an Integrator to lead project management across the Alliance.
Approval	The formal decision by the Investment Approvals Board (IAB) at Main Gate to invest significantly in a project. Approval sets "Not to Exceed" parameters for the project's cost and In Service Date, which reflect the worst case scenario should all foreseen risks arise. The project cannot exceed these parameters without returning to the IAB for further approval. The Main Gate process also sets target "Most Likely Estimate" figures for cost and In Service Date. The difference between these targets and the approved Not to Exceed figures is known as a project's risk differential.
Assessment Phase	The second phase in the acquisition cycle after the Concept Phase and beginning with Initial Gate. The aim of Assessment Phase is to develop an understanding of options for meeting the requirement that is sufficiently mature to enable selection of a preferred solution and identification, quantification and mitigation of the risks associated with that solution. At the end of Assessment Phase a Business Case is submitted to the Investment Approvals Board for Main Gate Approval.
Business Case	The documentation submitted to the Investment Approvals Board at Initial Gate or Main Gate, making the case for proposed expenditure on the next phases of the project.
Cost of Ownership	An annualised representation of the resources consumed directly in the procurement, operation, training, support and maintenance of military equipment at all stages of its life. The Cost of Ownership statement is the costed element of the Through-Life Management Plan.
Customer	The communities within the Department that are responsible for initiating the acquisition of defence equipment. The Equipment Capability Customer (ECC) is the Departmental organisation responsible for developing and managing a balanced and affordable equipment programme; including requirements definition; equipment planning; seeking approvals; and authorising acceptance of equipment. The Customer community also includes the Armed Forces (also known as Customer Two) as the end users of the equipment.

Demonstration and Manufacture Phases	The third and fourth phases in the acquisition cycle, which begin after Main Gate approval, and continue until the equipment enters service. During the Demonstration and Manufacture Phases, development risk is progressively eliminated, the ability to produce integrated capability is demonstrated and the solution to the military requirement is delivered within time and cost limits appropriate to this stage.
Earned Value Management	Process of representing physical progress achieved in terms of a cost based measure and integration of the cost, schedule and technical aspects of a contract.
Equipment Programme (EP)	The Department's budgeting plan for expenditure on procurement of defence equipment, which runs across a 10-year planning cycle, and creates and balances options to match Defence priorities.
Firm Price	A contract price that is not subject to variation for inflation.
Fixed Price	A contract price that is subject to variation to take account of inflationary and/or exchange rate movements.
Gainsharing	Where the Department and industry work together to derive mutual beneficial advantage from reopening and renegotiating current contracts.
Incremental Acquisition	A procurement strategy which aims to reduce risk and spread costs by building up a required capability over time. This can involve approaches such as contracting to buy equipment sequentially, or acquiring an intermediate capability and inserting the features required to meet the full requirement over time.
Initial Gate	The approval point preceding the Assessment Phase. At Initial Gate, a Business Case is put to the Investment Approvals Board to confirm that there is a well-constructed plan for the Assessment Phase that gives reasonable confidence that there are flexible solutions within the time, cost and performance envelope the Customer has proposed.
In-Service Date	The definition varies from project to project, for example for the Typhoon aircraft the in-service date was defined as the date of delivery of first aircraft to the RAF, for Light Forces Anti-Tank Guided Weapon System it was defined as the date one Brigade is trained and equipped. It does not necessarily mean the capability is fully delivered and available for operational use.
Integrator	Also referred to as a Physical or System Integrator. Typically used as part of an Alliance procurement strategy to build, manage and lead project management across the Alliance partners and is often a project management specialist. See also **Alliance**.
Interest on Capital	The opportunity cost to the Government of employing money in capital expenditure instead of on alternative investment opportunities. For the public sector, Interest on Capital has been charged at 6 per cent of the average capital employed during each year. This changed from 1 April 2003 to 3.5 per cent.

Investment Approvals Board	The Departmental body responsible for the approval of investment in projects at Initial Gate and Main Gate. The Investment Approvals Board (IAB) comprises the Vice Chief of Defence Staff, the second Permanent Under Secretary, the Chief of Defence Procurement and the Chief of Defence Logistics and is chaired by the Chief Scientific Advisor. For projects with a value of less than £100 million, delegated representatives of IAB members may authorise approval.
Key Supplier Management	A co-ordinated approach to improving the Department's knowledge and understanding of the supplier base.
Key User Requirements	Requirements or constraints identified from within the wider set of user requirements, assessed as key to the achievement of the mission.
Liquidated Damages	A contractually pre-agreed sum payable by way of compensation in the event of a specific breach of contract (e.g. late delivery).
Lines of Development	The term used to describe the elements that must be brought together to deliver military capability to operational users. They include People, Force Structure and Estates, Sustainability, Training, Concepts and Doctrine, and Equipment.
Main Gate	The approval point between the Assessment Phase and the Demonstration and Manufacture Phases. At Main Gate, a Business Case is presented, which should recommend a single technical and procurement option. By Main Gate, risk should have been reduced to the extent that the Customer and IPT can, with a high degree of confidence, undertake to deliver the project to narrowly defined time, cost (procurement and whole-life) and performance parameters.
Network Enabled Capability	An approach to improve the flow of information from intelligence gathering activities, decision makers, weapons platforms and operatives in the field that are best placed to deliver the action required. Network Enabled Capability will involve new approaches across all the lines of development.
NAPNOC (No Acceptable Price No Contract)	The Department's policy for non-competitive pricing, which seeks to replicate the pressures of competitive procurement in which a price is secured at the outset through the tendering process. Under the NAPNOC policy, non-competitive contracts should only be placed when a price has been agreed that reflects what it would cost an efficient contractor to carry out the work. NAPNOC contracts should, therefore, be priced before a contract is placed.
OCCAR (Organisation Conjointe de Coopération en Matière d'Armement)	A multilateral agency for the management of European co-operative acquisition programmes such as the A400M heavy transport aircraft. The Member States are Belgium, France, Germany, Italy, Spain and the United Kingdom.
Operational Analysis	Scientific modelling and analysis undertaken during Concept and Assessment Phase to assess the cost effectiveness of procurement options. This is typically undertaken by experts from the Defence Science and Technology Laboratories (previously the Defence Research and Evaluation Agency).
Prime Contractor	A contractor having responsibility for co-ordinating and integrating the activities of a number of sub-systems contractors to meet the overall system specification efficiently, economically and to time.

Request for Proposals (RFP)	A request by the Department for the contractor to supply proposals on how it would meet the requirement.
Scrutiny Community	The bodies within the Department that review each project's progress towards Initial and Main Gate approval, and which advise the Investment Approvals Board on approval decisions. They include the Director General (Scrutiny and Analysis) who advises the IAB mainly on technical matters and the Director Capability Resources and Scrutiny who addresses affordability issues.
Synthetic Training	The use of simulators rather than live demonstration for training purposes.
System Readiness Levels	A means of assessing the readiness of the design, development and testing regime of systems or sub-systems to be integrated, and whether candidate systems or sub-systems represent a risk to timely integration.
Technology Demonstrator Programme	A programme designed to demonstrate unproven technology using practical demonstrations, prior to its incorporation into a defence equipment programme.
Technology Readiness Levels (TRL)	A structured means of measuring and communicating the maturity of technologies within acquisition programmes.
Through-Life Management Plan	The Through-Life Management Plan should bring together key themes of Integrated Project Teams, Systems Engineering and improved commercial practices. An outline Through-Life Management Plan should be produced in the concept stage and maintained throughout the procurement cycle. It will show the full resources needed to meet the objectives of the project and is recognised by all stakeholders.
Whole-Life Costs	The aggregation of the annual Cost of Ownership statements covering the total resource required to assemble, equip, sustain, operate, and dispose of a specified military capability at agreed levels of readiness, performance and safety.

REPORTS BY THE COMPTROLLER AND AUDITOR GENERAL, SESSION 2005-2006

The Comptroller and Auditor General has to date, in Session 2005-2006, presented to the House of Commons the following reports under Section 9 of the National Audit Act, 1983. The reports are listed by subject category.

		Publication date
Cross-Government		
Home Office: Working with the Third Sector	HC 75	29 June 2005
Joint Targets	HC 453	14 October 2005
Defence		
Driving the Successful Delivery of Major Defence Projects: Effective Project Control is a Key Factor in Successful Projects	HC 30	20 May 2005
Managing the Defence Estate	HC 25	25 May 2005
Assessing and Reporting Military Readiness	HC 72	15 June 2005
Major Projects Report 2005	HC 595	25 November 2005
Education		
Securing strategic leadership for the learning and skills sector in England	HC 29	18 May 2005
Extending access to learning through technology: Ufi and the learndirect service	HC 460	4 November 2005
Environment, Food and Rural Affairs		
Lost in Translation? Responding to the challenges of European law	HC 26	26 May 2005
Environment Agency: Efficiency in water resource management	HC 73	17 June 2005
Law, Order and Central		
Public Guardianship Office: Protecting and promoting the financial affairs of people who lose mental capacity	HC 27	8 June 2005
Home Office: National Asylum Support Service: The provision of accommodation for asylum seekers	HC 130	7 July 2005
Returning failed asylum applicants	HC 76	14 July 2005
National Offender Management Service: Dealing with increased numbers in custody	HC 458	27 October 2005
National Health Service		
Innovation in the NHS: Local Improvement Finance Trusts	HC 28	19 May 2005
The Refinancing of the Norfolk and Norwich PFI Hospital: how the deal can be viewed in the light of the refinancing	HC 78	10 June 2005
A Safer Place for Patients: Learning to improve patient safety	HC 456	3 November 2005
Reducing Brain Damage: Faster access to better stroke care	HC 452	16 November 2005
Overseas Affairs		
The Foreign and Commonwealth Office: Consular Services to British Nationals	HC 594	24 November 2005

		Publication date
Public Private Partnership		
Progress on the Channel Tunnel Rail Link	HC 77	21 July 2005
Regulation		
The Office of Fair Trading: Enforcing competition in markets	HC 593	17 November 2005
Revenue departments		
Filing of Income Tax Self Assessment Returns	HC 74	22 June 2005
Transport		
Maintaining and improving Britain's railway stations	HC 132	20 July 2005
Work and Pensions		
Gaining and retaining a job: the Department for Work and Pensions' support for disabled people	HC 455	13 October 2005
Department for Work and Pensions: Dealing with the complexity of the benefits system	HC 592	18 November 2005

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