This report has been prepared under Section 6 of the National Audit Act, 1983 for presentation to the House of Commons in accordance with Section 9 of the Act.

John Bourn  
Comptroller and Auditor General

National Audit Office  
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The picture shows the third development aircraft - DA3 - during its successful first flight in Italy on 4 June 1995. DA3 is the first prototype to be flown with the EJ200 engine. On the programme as a whole a total of 35 development flights have now been successfully undertaken and the second development aircraft - DA2 - has flown supersonically from BAe Warton.
Part 1: Introduction

1.1 Eurofighter 2000 is a single seat agile combat aircraft. It will form the keystone of the Royal Air Force's future capability in both the air-to-air combat role, where it will supersede the United Kingdom's existing Tornado F3 fighters, and the air-to-ground and tactical reconnaissance roles, where it will replace the ageing Jaguar fleet. It is the most expensive equipment procurement currently being undertaken by Ministry of Defence (the Department) with development costs estimated at £3.9 billion and production and Integrated Logistics Support, of 250 aircraft, expected to cost £10.6 billion, giving total United Kingdom programme costs of some £14.5 billion (all figures at 1993/94 constant prices). Eurofighter 2000 is being developed collaboratively by the United Kingdom, Germany, Italy and Spain. The history of the project is summarised at Figure 1.

Figure 1: Project history

1. In December 1985 the governments of Germany, Italy, Spain and the United Kingdom agreed a common requirement for an aircraft optimised for air-to-air combat but also with an air-to-ground capability. From the outset an important feature of the programme has been the requirement to minimise the life cycle cost of the aircraft and for this reason the programme has been the first in Europe to fully embrace the concept of Integrated Logistics Support.

2. Early development work on the aircraft, then known as the European Fighter Aircraft (EFA), was undertaken in each participating country by defence contractors working under contract to their national governments and was co-ordinated under an official agreement between the partner nations. A collaborative programme of work was only established when full development commenced in 1988. At this time the objective was to have production aircraft, with maximum commonality, in operational service with the Air Forces by the late 1990s.

3. Governmental oversight of the programme is exercised through the NATO European Fighter Aircraft Development, Production and Logistics Management Organisation (NEFMO) supported by a jointly staffed project office (NEFMA). On the industry side the development is being undertaken by two consortia each with industrial representation from all four participating nations. Eurofighter GmbH (Eurofighter) are developing the airframe, avionics and other systems and are responsible for the integration of the EJ200 engine, being developed by Eurojet GmbH (Eurojet), to form the overall weapons system. Development work and costs are being shared on the basis of nations' planned production offtakes, as declared in 1987, giving the United Kingdom and Germany 33 percent shares, Italy 21 percent and Spain 13 percent with work being allocated with due regard to the technological benefits.

4. By 1991, rising estimates of the cost of the programme and slower than expected technical progress were causing concern to nations. In an attempt to constrain costs nations instituted a campaign to remove or reduce excessive provision for test facilities and cancelled one prototype aircraft. In addition, Germany opted out of aspects of the common requirement (such as EFA's air-to-ground capability). This situation reached a head in 1992 when, following an unacceptably high industry quotation for the future phases of the programme, Germany announced its intention to withdraw from production, and possibly from the remainder of the development programme, on the grounds that the aircraft exceeded Germany's military requirements in the post Cold War environment, and was likely to be unaffordable.

continued
5. To address the German concerns, in December 1992, nations agreed the principles of a 're-orientated' approach to the development programme. This recognised that an aircraft with the basic characteristics of the existing EFA was still required in the new security environment, but that nations should be able to select variants of the basic aircraft to match their individual budgetary and operational needs. It was also agreed that the procurement programme would be extended to relax the in-year budgetary pressures faced by some nations and to accommodate the slippage which had already occurred on the programme. Negotiations over the detail of 're-orientation' have been protracted. In July 1995 nations reached formal agreement on the re-orientated programme and are therefore in a position to place revised development contracts with industry. These were originally expected to be placed during the first quarter of 1995.

6. Following the formal agreement of re-orientation the key dates on the programme will relate to the signature of intergovernmental Memoranda of Understanding covering the Production Investment/Production, Integrated Logistic Support and Aircrew Training Aids aspects of the programme. These are due to be concluded in January 1996. Following these agreements nations will then be in a position to place contracts with industry. Eurofighter 2000 is expected to enter service with the Royal Air Force early in the next century.

Previous Parliamentary coverage

1.2 The Committee of Public Accounts reported on the European Fighter Aircraft, on the basis of a confidential Memorandum submitted by the Comptroller and Auditor General, in their 14th Report, Session 1990-91. The Report, whilst noting the Department's assurance that the programme was proceeding well, concluded that they may not have been fully successful in transferring all technical risk to industry, and noted in particular that there was no absolute ceiling on the Department's financial liability for United Kingdom development work. The Treasury Minute response (Cmnd 1582) recognised the need to introduce measures to limit the United Kingdom's financial liability and to promote contractors' efficiency, so far as this was possible under the existing contractual arrangements.

1.3 The House of Commons Defence Committee have also reported on the Eurofighter 2000 programme on several occasions, most recently in their Third Report of Session 1993-94. This highlighted the possibility of further cost increases and timescale slippages, and noted that significant technical risks remained in the development phase.

Objectives and methodology

1.4 The National Audit Office have considered:

(a) the status of the programme and reasons for the cost growth and schedule slippage experienced on the development phase (Part 2);

(b) the contractual arrangements on the programme and assessed whether the shortcomings apparent with these have been adequately addressed in re-orientation (Part 3); and

(c) the factors underlying the problems experienced with the industrial and governmental management of the programme and whether the remedial actions being taken have placed the programme on a sound footing to commit to future phases (Part 4).
1.5 The principal sources of information for the study have been file reviews and discussions with key personnel in both the national and international Project Offices. The National Audit Office have also held extensive discussions with the key United Kingdom industry players; British Aerospace, Rolls Royce and GEC Marconi, and also with the Eurofighter and Eurojet consortia.
Part 2: The status of the programme

Introduction

2.1 Since it commenced in 1988, the cost of the Eurofighter 2000 development programme to the United Kingdom has risen by some 23 percent (£662 million at 1993-94 constant prices) and the timescale has been rescheduled by three years. As Figure 2 shows the intention is now to place contracts covering the future phases of the programme in early 1996. This part of the report considers the reasons behind these cost and timescale difficulties, reviews the technical status of the programme and highlights a number of the challenges still faced by nations and industry if they are to be in a position to sign contracts for the future phases as intended. This analysis provides a backdrop for the detailed consideration of the commercial and management arrangements on the programme in Parts 3 and 4 of the Report.

Figure 2: Comparison of Original and Re-oriented Development Programmes

Source: Ministry of Defence

Note: The original Initial Operational Clearance (IOC) most closely corresponds with what is now IOC Phase 1.
When the development phase of the Eurofighter 2000 programme began in January 1988 it was scheduled for completion in September 1999. The re-orientated programme now shows completion of development as October 2002. Although many aspects of the programme have fallen behind schedule, delays to the overall timescale are dictated by a number of critical items, with one of the most important delays relating to the Flight Control System. This has been the main reason underlying the three year delay in first flight of the prototype aircraft. Case Study 1 describes the Flight Control System and provides a good illustration of two of the main drivers behind the timescale slippage on the programme; the commercial and the managerial arrangements for a workshared programme. The effect of these, together with a third factor, political and financial uncertainty, are considered in the following paragraphs.

**Case study 1: The Flight Control System (FCS)**

EF2000 is designed to be an aerodynamically unstable aircraft. This means that the pilot can only fly it with the support of a computer controlled system. The FCS provides this support and operates through four identical computers which act in parallel to provide the necessary system integrity given the safety critical nature of this system. Overall system design of the FCS was, until recently, the responsibility of DASA, the German partner in the Eurofighter consortium. The sub-contracts for the supply of the four main computers and their software has been let to a four-nation consortium, in which GEC Marconi Avionics play the leading role.

The formal relationship between DASA and GEC Marconi Avionics, as defined in the consortium subcontract, has been a principal cause of delay on the programme since it meant that GEC Marconi Avionics were only informed of design changes through a lengthy change approval process. In 1994, following pressure from nations, the companies acted to resolve this problem and established a joint venture comprising DASA, British Aerospace and GEC Marconi Avionics with a senior management team, collocated at DASA, sharing the risk of integration and directing FCS development activities as a single entity.

The other main contributor to the delays on the FCS development has been the worksharing arrangements. The details of these were proposed by industry within nations' overall requirement that work should be shared in accordance with proposed production offtakes. For hardware development, the worksharing plan implemented by industry has meant that work has in some cases been placed with companies with little experience of the components they are expected to develop. An example of this is the decision to allocate development of the electronic boards of the Stick Sensor and Interface Control Assembly to two separate companies in different countries. There are four identical boards on each assembly and each of the two companies has to manufacture, to drawings and test sets provided by GEC Marconi Avionics, half the required number of boards, before delivering them to GEC Marconi for final assembly.
The software for the Flight Control Computer is extremely complex, but to comply with workshare requirements the software development was split into modules and divided between the four consortium members. Until recently the software was written separately by the companies involved in four different countries. This meant that when the modules were brought together at GEC Marconi Avionics and interface problems were identified, the relevant modules had to be returned to the other partner companies for rework.

The delays caused by this process were exacerbated by the fact that, for economy reasons, GEC Marconi were funded to build only a single lane test rig since a four lane test rig was already provisioned at DASA. Consequently, GEC Marconi could only test the computers as separate units and not running together in parallel. This has resulted in further delays, as faults were often only found when the software was integrated at DASA. The software then had to be returned to GEC Marconi, and in turn the other companies, before going through the testing loop again. This process has caused resource problems within the companies and resulted in the development of individual modules running out of phase when modifications have fallen more heavily on one company than another. The cost effect of these arrangements is illustrated by the fact that GEC Marconi consider a technically compliant solo bid would have been a third cheaper than the consortium bid. However, the workshare requirements and the aspirations of partner nations meant such a bid would not have been possible. In the event that a solo bid had been acceptable, all costs would have fallen to the United Kingdom, as opposed to 42 per cent of the costs of the consortium bid.

In 1993, nations instructed Eurofighter to address these inefficiencies. In response Eurofighter have made individual partner companies fully accountable for the failure of their equipment suppliers. As a consequence, industry established a joint software team for the Flight Control Computer, with design engineers from all four companies, at GEC Marconi Avionics in order to minimise future delays and provide resource flexibility to counter problems. In addition GEC Marconi have now been funded to develop a four lane test rig, which should minimise the prospect of inter-lane faults only coming to light at DASA in the final stages of integration.

(a) Delays arising from the worksharing arrangements on the programme

2.3 The rigid worksharing requirements specified by nations in the Main Development Contracts have been a prime cause of timescale slippage on the programme. They have contributed to delays in the selection of equipments and accessories (50 of the 285 aircraft equipments were selected in 1992 or early 1993 - some two years later than expected) and, in a number of cases, such as the gearbox, have led nations to refer proposals back to industry for their worksharing provisions to be revised.
2.4 Meeting the worksharing requirements has also led the equipment companies to create multinational consortia. In each of these consortia there are complex industrial interfaces to manage which have increased technical and programme risk. An example here is the electronics of the Head-Up Display (detailed at Case Study 2 on page 211, where drawings were produced in the United Kingdom and the items fabricated in three different locations before being returned to the United Kingdom for final assembly and testing. The development of equipments by consortia in this way puts a premium on the establishment by industry of suitable systems to co-ordinate the work of each company, and to ensure that responsibility for the rectification of emerging problems is clear. This has not always happened and has led to a number of delays such as those experienced with the Flight Control System.

(b) Delays arising from management arrangements on the programme

2.5 The main cause of delay under this heading relates to the integration of individual equipments into their overall systems. This is shown clearly by the difficulties with the Flight Control System but this is not an isolated example. On the Attack and Identification System, the nose radome was procured separately from the radar. When the equipments were first integrated certain aspects were found not to be compatible and the radar is unable to function to its full performance in all modes since the radome supplier, whilst producing a radome at the leading edge of technology, is unable to meet the performance specification. This mismatch will be time consuming for Eurofighter to resolve since they will have to manage extensive changes to the development sub-contract for the radar and reschedule the flight test programme to accommodate the delays.

(c) The effect of political and financial uncertainty

2.6 Although difficult to quantify, the uncertainties over whether, and in what form, the Eurofighter 2000 project should continue have affected progress on the programme. For example, political and financial uncertainties have delayed the formal agreement of the re-orientated programme by nations, principally Germany, by more than one year. If these uncertainties continue they are likely to have an impact on the achievement of the currently projected timescales for completion of both the development and later stages of the programme.

2.7 Industry have told the National Audit Office that they are optimistic they can achieve the current 2002 end date for the completion of the development phase. In reaching this judgement industry have pointed out that, despite the delays in signing the re-orientated development contracts, they are willing to stand by the schedule of work originally agreed which assumed the contracts would be signed by August 1994. Industry are confident that they can recover this misalignment if nations make decisions, principally relating to the placement of contracts for future phases of the programme, in early 1996, in accordance with the current timetable.
2.8 A key factor in these future decisions will be the worksharing agreement for the production phase. The intergovernmental Memorandum of Understanding governing the programme states that workshares for the production phase should reflect nations' production offtakes. These have not yet been formally declared by any of the four nations. It is expected that, compared to the 1987 figures, the German offtake will reduce substantially (current estimate 140 instead of 250 aircraft) and the Italian (130 rather than 165 aircraft) and Spanish (87 rather than 100 aircraft) offtakes will also reduce. The United Kingdom has maintained its planned offtake figure at 250 aircraft. These changes in offtake plans could have serious implications for the production programme since they would require a new production worksharing agreement with substantial re-allocation of work, particularly to the United Kingdom (share increased to 41 percent) and from Germany (share reduced to 23 percent).

2.9 Given the costs associated with the transfer of technology between partners within the industrial consortia after seven years of development, and the industrial re-structuring which this would cause, a large re-allocation of tasks for the production phase is likely to prove difficult to achieve at an acceptable cost without causing some delay on the programme. This is highlighted by the indicative prices for future phases provided by industry in late 1994. These were requested by nations on the basis of the most economic programme of work (assuming a German production offtake of 200 rather than the current estimate of 140 aircraft) and resulted in a United Kingdom share of 37.5 per cent.

Key points

2.10 The National Audit Office consider that the following key points can be identified concerning the timescales of the Eurofighter 2000 programme:

(i) The development programme has slipped by three years. One reason for this has been the industrial management of the programme, in particular difficulties in co-ordinating the development of equipments between equipment suppliers and their subsequent integration into parent systems, within the rigid worksharing arrangements placed on industry by nations. The principal areas of slippage are connected with avionic equipments and engine accessories, which include the most critical dependencies - in particular the Flight Control System - on the overall development programme (paragraphs 2.2-2.5);

(ii) A second reason for delay has been political and financial uncertainty. Industry has identified the continuation of such uncertainties as the factor most likely to delay key decisions for the future of the programme and hence the achievement of the revised programme timescale. In particular, nations' production offtake numbers and the resulting worksharing requirements are pre-requisites for industry to be able to provide binding quotations for future phases against which prices can be negotiated (paragraphs 2.6-2.9).
The cost of the programme

(a) Development cost growth

2.11 In January 1995 the Treasury approved funding for the United Kingdom contribution to the development phase of the programme of £3,919 million. Figure 3 highlights the principal differences between this and the original 1987 approval figure of £2,880 million and provides brief explanations for these.

2.12 Figure 3 includes a £377 million entry for "nominal cost increases". These relate to items which were not covered by the original approval such as equipments and facilities provided by the government (which were not

Figure 3: Comparison of original and currently approved development costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost (£million)*</th>
<th>Cost Increase*</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1987</td>
<td>1994</td>
<td>£million</td>
</tr>
<tr>
<td>Airframe Development</td>
<td>1192</td>
<td>1338</td>
<td>146</td>
</tr>
<tr>
<td>Aircraft Equipments</td>
<td>489</td>
<td>765</td>
<td>276</td>
</tr>
<tr>
<td>Engine Development</td>
<td>864</td>
<td>902 **</td>
<td>38</td>
</tr>
<tr>
<td>Engine Accessories</td>
<td>58</td>
<td>96</td>
<td>38</td>
</tr>
<tr>
<td>Integrated Logistic Support</td>
<td>35</td>
<td>72</td>
<td>37</td>
</tr>
<tr>
<td>Pre-Development and Admin.</td>
<td>242</td>
<td>186</td>
<td>(56)</td>
</tr>
<tr>
<td></td>
<td>2880</td>
<td>3356</td>
<td>479</td>
</tr>
<tr>
<td>Additional Tasks</td>
<td>183</td>
<td>183</td>
<td></td>
</tr>
</tbody>
</table>

Comparative approval figures: 2880 3542 652 23

*Nominal* cost increases: 377 377

Total approval figures: 2880 3919 1039

NOTE: These figures do not accord with those contained in the 1994 Major Projects Report since they reflect more recent estimates of the current cost of the development programme and have been uprated using MOD indices to ensure consistency with the figures approved by Treasury (rather than the GDP deflator as used in the Major Projects Report).

* All figures are at 1993/94 prices and reflect the position at the time of Treasury Approval.

** Industry have now agreed a fixed price of £901 million for the engine and accessories taken together. This is £97 million lower than estimated at the time of Treasury Approval and £21 million lower than the maximum price agreed at the outset of development.
accounted for as project costs in 1987), integration tasks which could not then be fully defined, and the transfer to the development phase of work originally classed as Production Investment. Discounting these costs, a like for like comparison of the 1987 and 1994 figures shows a cost increase of £662 million or 23 percent on the originally approved figure. The following paragraphs analyse the two largest areas of cost escalation - the airframe development and aircraft equipments - in more detail.

Airframe development

2.13 Airframe development costs, including those of Eurofighter, have increased by 12 percent (£146 million). There are two main factors underlying this increase. The first relates to the three year extension of the development programme and reflects the resulting increase in Eurofighter's own management costs and the fact that the fixed price covers the completion, within the revised timescale, of the whole of the programme of work specified in the original development contract, taking due account of the cost saving measures agreed, notably the deletion of one prototype aircraft.

2.14 The second reason for the cost increase to the United Kingdom concerns the transfer of industrial responsibilities on the programme. This has resulted from individual nations opting out of elements of the originally agreed common requirement (for example the deletion of the German requirement for an air-to-ground capability and their limited involvement in the development of the Defensive Aids Sub-System) and from British Aerospace assuming responsibility for additional elements of the development task. Action has also been taken to improve the industrial management of the programme, most notably the joint venture established by DASA, GEC Marconi and British Aerospace to manage the development of the Flight Control System.

Aircraft equipments

2.15 Aircraft equipment costs have increased by 56 percent (£276 million). The original development contract contained a "pegged" element (effectively a budgetary allocation based on the result of a market survey of potential equipment suppliers conducted by Eurofighter before the Main Development Contracts were placed) to cover the cost of equipments. These were to be selected competitively by Eurofighter once development was underway. Selection was made against criteria which included technical compliance, value for money and achieving the workshare requirements. The latter requirement stemmed from the intergovernmental arrangements underpinning the programme. In some cases, meeting these criteria led to more expensive development bids than had been expected. The cost increases have been concentrated on high value equipments such as the Defensive Aids Sub-System (101 percent higher than the original estimate) and Forward-Looking Infra-Red (292 percent higher than the original estimate).

2.16 The equipment cost increase to the United Kingdom has also been affected by the higher than expected development workshare achieved by United Kingdom industry. This is illustrated graphically at Figure 4 opposite and has led to United Kingdom government costs being £152 million higher than they might
Figure 4: Planned and actual equipment costshares

Source: Ministry of Defence

Comment: The United Kingdom has borne a higher than expected share of total costs on the development programme as a result of United Kingdom industry winning a larger than planned share of work and German withdrawal from several major equipments.

otherwise have been. This has been caused by two factors. Firstly, British industry has won, competitively, a larger-than-planned share of work (with the jobs this represents) on equipments common to all four nations’ requirements. Secondly, Germany has withdrawn from several major equipments and funding liability for these has fallen to the remaining nations alone. The largest equipment affected in this way is the Defensive Aids Sub-System where the United Kingdom will pay £70 million more than if the equipment had been developed by all four nations. The Defensive Aids Sub-System is considered in more detail in Case Study 3 on page 22. The international agreements governing the programme make no provision to correct these imbalances during either the current or future phases of the programme.
(b) The cost of future phases

2.17 At present the Department only have indicative costs for future phases of the programme. Nations intended to issue a formal request to industry for quotations covering the Production Investment, Production and Integrated Logistics Support stages of the programme in Summer 1995 with responses due in Autumn 1995. The intention is to place contracts to cover all future phases of the programme following the signature of intergovernmental Memoranda of Understanding covering these phases which is expected to take place early in 1996. There are risks that this timetable will not be met if the prices quoted prove unaffordable to one or more nations and are subject to lengthy negotiations. Furthermore, there is a risk that national funding approvals may not be obtained to schedule in all four countries, who may not therefore be in a position to commit to future phases even if prices are agreed in time. This latter scenario is a real possibility given past experience obtaining agreement for both the original and re-orientated development funding.

2.18 The position on the Aircrew Synthetic Training Aids (ASTA) element of the programme is less clear. The ASTA programme will provide the equipment necessary to train Eurofighter 2000 aircrew to ensure the aircraft can be operated effectively.

2.19 The intention is that a contract for ASTA should be placed at the same time as those for the rest of the programme, in early 1996. However, whilst the Department have undertaken a full Training Needs Analysis and Risk Assessment to define United Kingdom requirements, progress on the collaborative programme has been limited and nations have not yet agreed a procurement strategy. The Department's preference is for a full and open competition, including companies from outside the four partner nations. However, this may not be acceptable to some nations who may wish competition to be limited to United Kingdom, German, Italian and Spanish companies. In this case, nations could be faced with complex worksharing and managerial arrangements as on the main development programme.

2.20 Allied to these uncertainties is the fact that funds for the facilities to house ASTA lie not with the project office but with Strike Command, who are planning the capital works programme, in conjunction with the project office, who are responsible for procuring the Training Aids.

(c) the cost of programme delays

2.21 The re-scheduling of the development programme has increased costs as elements of the programme have become mis-aligned. The most obvious example is the mismatch between the airframe and engine programmes with the majority of the £38 million increase in engine development costs, and £6 million of the increase in engine accessory costs, caused by the need to reschedule work to take account of the revised airframe programme. An illustration of this is the inclusion in the Eurojet re-orientation proposal of an extra 900 hours of benchtesting to allow for fundamental rework which may be
necessary to ensure progress given the tight testing timescales envisaged under the re-orientated programme.

2.22 The slippage in the Eurofighter 2000 programme will also have a wider impact on the defence budget since it means that the Department will be required to retain their Tornado F3 and Jaguar fleets, which Eurofighter 2000 is expected to replace, in operation for longer than expected. In 1995 the Department, on the basis of an internal risk assessment, calculated the additional cost to the defence budget of retaining the Tornado F3s and Jaguars in service until their revised Out-of-Service Date as some £104 million. This reflects the costs resulting from the heavier maintenance requirements on the older aircraft and, in the case of Tornado, the need to continue with two-man crew operations.

Key points

2.23 The National Audit Office consider that the following points can be identified concerning the cost of the Eurofighter 2000 programme:

(i) The total funding required by the Department for the development programme (at constant 1993/94 prices) has increased by £1,029 million since 1987. However, this figure reflects a number of requirements not fully defined and costed in 1987, and changes to accounting conventions. A like for like comparison shows an increase of £662 million or 23 percent on the figure originally approved by the Treasury (paragraphs 2.11-2.12).

(ii) Most of the cost escalation relates to the avionics systems rather than the engine. The main area of cost increase has been on the procurement of aircraft equipments, and has been caused by under-estimation of industry's bid prices, and of the funding required for equipment integration. This has been exacerbated by a higher than expected United Kingdom workshare caused by British industry winning more work than expected, and by Germany withdrawing from a number of equipments. These imbalances are not subject to adjustment later in the programme. Overall equipment costs have increased by 56 percent (paragraphs 2.15-2.16).

(iii) Programme slippage has also affected costs, notably the funding required by industry to undertake the management of the programme over the extended development period and the transfer of industrial responsibilities. The revised funding figures reflect the need to accommodate these factors (paragraph 2.13-2.14).

(iv) The increase in the level of funding required also reflects the Department's greater realism, building on their recent risk analysis work, in recognising the outstanding risk on the programme, particularly relating to integration (Figure 3).
(v) At present nations have only indicative figures for the costs of the future phases of the programme. Past experience on the programme, of both the time taken to agree prices with industry and for nations to obtain funding approval, suggests that there are significant challenges to be met if the intergovernmental Memoranda of Understanding covering the Production Investment/Production and Integrated Logistics Support phases are to be signed early in 1996 and contracts subsequently placed with industry as intended (paragraph 2.17).

(vi) The situation is also unclear for ASTA where nations have yet to agree a procurement strategy against which to invite bids. This, combined with the separate funding and management of the works and equipment elements of the United Kingdom programme, means that the total costs for ASTA are still uncertain (paragraphs 2.18-2.20).

(vii) Delays in the entry into service of Eurofighter 2000 will have wider cost implications for the Department as they will be required to continue to operate and maintain older aircraft. The Department have estimated that the cost of retaining these aircraft in service is approximately £104 million (paragraph 2.22).

Technical status

2.24 In April 1994, the Department asked their Chief Scientist to report on the technical status of the Eurofighter 2000 project in advance of a commitment being made to the Production and Production Investment phases of the programme. His report, produced in December 1994 following extensive consultation with technical experts within both the Department and industry, concluded that the Eurofighter 2000 design was well balanced and closely matched to the requirement, and that the aircraft would be more effective in its primary air combat role than all other alternatives, with the exception of the United States F-22 which would be significantly more expensive.

2.25 The Chief Scientist concluded that the greatest risk to the programme was from further timescale slippages. His Report recommends the implementation of the revised development arrangements, and that - subject to satisfactory progress in risk management, management practices, and on the technical programme - commitment to the Production and Production Investment phases be made in accordance with the proposed timescales to minimise the risk.

2.26 Contractual commitment to future phases will be conditional upon industry demonstrating technical achievements on the development programme which prove that the aircraft design is stable and capable of achieving its major performance objectives without fundamental re-design. To achieve this, industry must meet a number of technical maturity criteria laid down by nations. These include successful results from flight testing by the first four development aircraft and the successful integration of a number of equipments. Both the Department and industry consider that these criteria will not now be achieved in the timescales planned for starting the future phases (early 1996) and that the last of the criteria may not be met until mid-1996.
Key points

2.27 The National Audit Office consider that the following key points can be identified concerning the technical status of the Eurofighter 2000 programme:

(i) A review carried out in 1994 by the Chief Scientist concluded that Eurofighter 2000 was well designed and closely matched to the requirement. The review concluded that the greatest risks were to timescale achievement (paragraphs 2.24 2.25).

(ii) Before nations place contracts with industry for future phases of the programme, industry must demonstrate that they have achieved a sufficient level of maturity on the development programme. Nations have defined a number of maturity criteria which must be met to demonstrate this. Both industry and the Department consider that the criteria may not be achieved until mid-1996 (paragraph 2.26).
Part 3: The commercial arrangements on the programme

Introduction

3.1 The range of technologies involved in the development of an aircraft to meet the Eurofighter 2000 specification is wide, including advanced aerodynamics and avionics, new materials and a completely new engine. Together with the cost risks involved in a complex collaborative programme, these technical risks meant that industry would not accept a fixed price contract at the outset of the development phase and that separate prime contractors were appointed for the airframe and engine aspects of the programme. Nations therefore agreed to appoint separate prime contractors responsible for the engine (Eurojet) and for the airframe, avionics and integration of the engine into the airframe (Eurofighter). The two Main Development Contracts were placed in November 1988.

3.2 The National Audit Office reviewed the commercial arrangements on the programme to assess the extent to which they have incentivised industry and minimised the risks faced by nations. They also considered how the shortcomings which have emerged in these arrangements have been addressed during re-orientation of the programme and have drawn out a number of lessons learned which have wider application for future collaborative programmes. These lessons are summarised at Annex A.

(a) Pricing

3.3 The Eurojet contract was let with a maximum price. The Eurofighter contract was let with 85 per cent of the development covered by a maximum price and the remainder, covering items which could only be fully defined as development proceeded, set as a budgetary price (ie an indicative price not subject to any overall limit). The contracts also defined “pegged” price elements (ie a budgetary allocation) to cover equipments/accessories, such as the radar, the prices for which were to be fixed when the equipments were selected competitively. The “pegged” elements covered 26 engine accessories and 285 airframe/avionics equipments.

3.4 The pricing scheme required that, within the overall maximum prices, fixed prices would progressively be agreed for individual packages of work as the risks specific to these packages became more clearly defined and, at worst, before one third of the work on that package had been completed. For the airframe contract each package price was to be agreed independently by each nation with its own member of the Eurofighter consortium. On the engine side, it was agreed, that for all four members of the Eurojet consortium, prices would be agreed simultaneously for each package. The intention was that as technical
risks were progressively clarified the financial risk of achievement would be passed from nations to the companies who would therefore have a greater incentive to efficient performance. Figure 5 illustrates the way this transfer of risk was intended to work.

**Figure 5: Eurofighter 2000 - 1988 pricing mechanism**

![Diagram showing overall maximum price and how it shifts to fixed price with technical risk and industry exposure to commercial risk.

Source: National Audit Office analysis

Comment: As technical risk reduces, prices are converted to fixed prices and commercial risk is transferred to industry.

3.5 The slower than expected technical progress on the programme has meant that this strategy has not been implemented. On the airframe side only four of the United Kingdom's 19 packages have been converted to fixed prices with the earliest after 50-55 percent of the work was complete and the latest when it was 90-95 percent complete. Spain have agreed two fixed price packages and Germany and Italy none. On the engine side the requirement for the entire consortium to be in agreement before a package could be converted has meant progress has been even slower (1 out of 18 packages priced). As a result there has been little reduction in nations' exposure to commercial risk and a lower incentive to industry efficiency.

3.6 In recognition of the failure of the initial arrangements, the re-orientated contracts will both be fixed price and cover all work to achieve the development specifications. These prices will also include all of the airframe equipments and engine accessories, previously covered by the "pegged" elements where prices had already been fixed through competitions run by Eurofighter and Eurojet.

3.7 The re-orientated Eurofighter contract also includes an Equipment Integration Contingency. This will be subject to a target cost arrangement with each national airframe company responsible for the integration of equipments within its allocation. This approach was chosen in recognition of the difficulty of
estimating in this area and to provide an incentive for industry to minimise the costs incurred.

3.8 In line with the rest of the development programme the Equipment Integration Contingency will be funded territorially. Since United Kingdom industry has a large share of the more complex equipment likely to be affected by high risk integration work (such as the Defensive Aids Sub-System and Forward Looking Infra-Red sensor) it is likely that the United Kingdom could end up paying more than its intended 33 percent cost share of the Integration Contingency. To mitigate this risk nations have agreed with Eurofighter that, as far as practical, contingency funds will be allocated in line with existing workshares and that, for high value items where price or programme difficulties are expected in allocating on the basis of existing workshare, the matter will be the subject of consultation between the partners.

(b) Limiting contractors' liability to cost overruns

3.9 As part of the original pricing scheme a Limit of Contractor's Liability was agreed, with the requirement that for each fixed price subsequently agreed no such limit would apply. The Limit of Contractor's Liability meant that if industry did not satisfactorily complete development within the maximum price they would be liable to continue funding development work until they had spent 75 percent of their intended profit. Once this ceiling was reached nations could require industry to continue to work on a cost reimbursement only basis (ie without profit) until development was satisfactorily completed. This agreement meant that there was no ceiling on nations' cost liability on the programme and also reduced the incentive placed on industry since breaching the maximum price would still result in industry making a notional profit. From industry's point of view the Limit provided a necessary degree of assurance that they had not entered into an agreement which could potentially bankrupt them.

3.10 Under the re-orientated contracts both consortia have agreed to an increase in their Limits of Liability to 140 percent of profit provided a production order for at least 200 aircraft is placed. If no production order is placed the Limit will reduce to 120 percent for Eurofighter and 100 percent for Eurojet. Although this increase is an improvement on the original contract and provides a considerable financial incentive to industry, the fact that a Limit remains is indicative of the residual risk to both parties. It is for this reason that it has not proved possible to remove the Limit entirely as intended when the original contracts were let.

(c) Payment and milestones

3.11 Under the current maximum price arrangements industry are paid 93 percent of costs incurred each month regardless of technical achievement. Payment of the remaining 7 percent of costs and all profit is linked to the achievement of two categories of milestones. Package milestones are set at partner company level for Eurofighter and consortium level for Eurojet with approximately two each year. Achievement of these milestones releases a further 4 percent.
payment of costs incurred. Major milestones are set approximately annually at
the overall consortium level. Achieving these results in 100 percent of costs
being paid together with 50 percent of profit. The remaining 50 percent of profit
was to be paid upon the completion of individual work packages.

3.12 The effectiveness of this milestone scheme has been limited by the fact that
package and major milestones are not directly linked and have not always been
representative of key measures of technical achievement. This has undermined
the incentive which linking the payment of 7 percent of cost and all profits to
achievement should have had on industry. There are two aspects to this. Firstly,
in the case of Eurofighter, it has meant that a large proportion of the extra
payment due at a major milestone can be claimed even if package milestones
have not been achieved, whilst, in the case of Eurojet, the entire payment may
be claimed. Secondly, since achievement of package milestones is related to the
performance of individual partner companies rather than the consortia as a
whole, the incentive has not been effective at the consortium level.

3.13 Under the re-orientated contracts the payment system and use of milestones
will be substantially reformed. With the agreement of a fixed price, payment
will be made against an agreed plan under which each partner company will be
paid 93 percent of price (covering both cost and profit) monthly against a
schedule agreed at the outset. A further 5 percent of the price will be paid upon
the achievement of annual milestones set at the consortia level and reflecting
major system and integration events intended to better represent real technical
progress. The remaining 2 percent will be held as a retention to be released in
two stages, the achievement of Initial Operating Clearance 1 and completion of
the development contract.

3.14 Under the revised milestone arrangements failure to achieve a milestone will
result in payments being progressively reduced until after 4 months industry
will receive only 75 percent of the agreed payment schedule. After 6 months
there will be a formal review of the situation with the prospect that nations
could stop payment completely until satisfactory progress is made.

3.15 The original contracts also gave nations the capability to suspend payment
across the contract if progress was not satisfactory. This remedy has never been
applied because of the complexity of the collaborative and contractual
arrangements which made it difficult to establish which party was at fault in
any particular circumstance.

(d) Worksharing

3.16 Nations agreed in 1987 that work and costs on the Eurofighter 2000
development programme should be shared in proportion to each nation’s then
declared production offtake (ie United Kingdom and Germany 33 percent each,
Italy 21 percent and Spain 13 percent) whilst providing a balanced spread of
technology and a cost effective distribution of work between the partners.
3.17 For the airframe and engine, the distribution of work between nations was detailed in the Main Development Contracts. This is illustrated at Figure 6. The Contracts also laid down the criteria for selection and worksharing for avionics/armaments, other aircraft equipments and engine accessories. In these cases the intention of the nations was that the actual allocation of work to the four national defence industries should be decided in the most competitive way possible, within the constraints imposed by the need to conform to the overall workshares. As a result, collaborative bids were encouraged in order to minimise the likelihood of contracts having to be awarded purely for worksharing purposes.

Figure 6: Eurofighter 2000 Airframe Development Workshares

Source: Ministry of Defence
Comment: Workshare on the airframe is shared between all four nations. In addition the engine and the majority of the 285 airframe equipment and 57 engine accessories are also workshared.

3.18 In practice, overly rigid adherence to the worksharing requirements has compromised the price benefits that would have been expected to accrue from competition for the equipments and engine accessories. In particular, the preference to select bids from specially created consortia rather than single companies has led to proposals being constructed to meet worksharing requirements rather than to match technical expertise and achieve best value for money. This has impacted on timescales and costs since the consortia arrangements have necessarily been far more complex, and management far more unwieldy than would have been the case if contracts had been awarded to single companies. The effect on United Kingdom costs is illustrated by the fixed prices for the equipments and accessories included in the revised contracts which are £308 million (55 percent) higher than the "pegged" items originally intended to cover these elements. The worksharing requirements on the
programme have contributed significantly to this. On the other hand, if there had been no worksharing requirement and United Kingdom companies had been selected as sole bidders to supply the equipment then the United Kingdom would have had to meet 100 per cent of the costs.

3.19 The National Audit Office have selected two equipments which highlight the worksharing arrangements on the programme. These are the Head-Up Display (Case Study 2) which provides an example of the difficulties associated with implementing the worksharing requirements in a demanding technological environment, and the Defensive Aids Sub-System (Case Study 3), which shows how worksharing has been tackled more effectively on some parts of the programme than others.

Case study 2: The Head-Up Display (HUD)

The HUD superimposes information on a range of factors such as the aircraft’s attitude, navigation, weapon release parameters, and housekeeping data, onto the pilot’s forward field of view. It reduces the need for him to look down at the instrument panel during critical manoeuvres. The contract to develop the HUD, worth some £8 million, was placed by Eurofighter on a consortium led by GEC Marconi Avionics and including Alenia (Italy), Teldix (Germany), and ENOSA (Spain). The contract is managed by British Aerospace who have overall responsibility for integrating the HUD into the cockpit.

Worksharing on the HUD was agreed between the suppliers concerned at a very detailed component level in order to achieve the required ratios. This has resulted in artificial worksharing with GEC Marconi Avionics, as the only member of the consortium to have developed this type of display previously, designing electronic cards for another company to produce in order to meet the workshare requirement.

The work sharing requirements have also led to complex management arrangements and increased development timescales and technical risk. This is most clearly illustrated by the testing arrangements on the programme with no formal provision made by the consortium for modular testing. The correct functioning of the equipment cannot therefore be established until final testing takes place at GEC Marconi Avionics. This means that when faults are identified, the component must be returned to the originating company for rectification before entering the testing loop again. This requirement to transport components back and forth across Europe is likely to take up a significant amount of time towards the end of the development programme with potentially adverse affects on the integration of the cockpit as a whole by British Aerospace.

The same consortium has won two other major contracts for the cockpit assembly. However, despite the similarities in the technology involved, the detailed worksharing split agreed by the consortium, whilst ensuring a spread of technology between the consortium members on the three contracts, is not consistent. For example, a different member of the consortium is responsible for the power supply unit on each equipment.
The HUD development programme is currently running some 24 months behind the original contract date, although this is partially a reflection of delays elsewhere on the development programme.

**Case study 3: The Defensive Aids Sub-System (DASS)**

The DASS is an electronic warfare suite which provides protection for Eurofighter 2000 when it operates in a hostile environment. Its main components are Electronic Support Measures, Electronic Counter Measures, Missile Approach Warner and Laser Warner devices. At the outset, the United Kingdom was the only nation procuring the full DASS capability. Italy does not have a requirement for the Laser Warner, whilst Germany and initially Spain decided to join only in the development of the Defensive Aids Computer and the chaff and flares.

A contract, worth approximately £240 million (at 1994 economic conditions), for the development of the first three components was placed by Eurofighter on the EuroDass consortium which is led by GEC Marconi Defence Systems with the Italian company Elettronica as their partner. A separate contract was placed on GEC Marconi Avionics for the development of the Laser Warner. Both contracts are managed by British Aerospace who have overall responsibility for integrating the DASS onto the aircraft.

Since Germany had withdrawn its requirement for the DASS, and Spain reserved its position, the worksharing was initially between the United Kingdom and Italy in accordance with offtake ratios but in this case worksharing has been applied at the major assembly level (i.e. for 24 separate assemblies) only and has been divided to match the respective strengths of the companies involved. These principles have been applied following Spain's recent decision to rejoin the EuroDass development and 2 assemblies will be re-allocated to Spanish industry once they have acquired the expertise necessary to produce them.

Integration of the Electronic Support Measures and Electronic Counter Measures Assemblies will take place on a single site by a joint team based at GEC Marconi Defence Systems. These arrangements will reduce the supplier consortium management burden and the time spent moving components between companies.

The DASS programme is currently on schedule.

3.20 The existing worksharing arrangements for development will be largely unchanged by the re-orientation of the programme. This is a reflection of the costs and time delays likely to be caused by the widespread transfer of technology between partners within the industrial consortia after 7 years of development and the industrial re-structuring which this would cause. However, Eurofighter has acted to make its partner companies more accountable for the performance of their suppliers. This should help to address some of the earlier difficulties.
(e) The provision of Government Furnished Equipments

3.21 Under the original Development Contracts nations are responsible for the supply of a number of items of equipment to Eurofighter as Government Furnished Equipment. The principal items are the engine and the Multi-Functional Information Distribution System.

3.22 The nations have undertaken to supply the engine to Eurofighter as Government Furnished Equipment. The nations sought to mitigate the risks this posed by including an engine/airframe Interface Control Document and an Associate Contractors Agreement in the Main Development Contracts which required both consortia to be responsible jointly for arrangements related to standard and delivery of development engines.

3.23 Whilst these agreements have sought to address the technical risks associated with the interface there remains a cost risk to nations if either the Eurofighter or Eurojet programmes run out of phase causing one consortium to submit claims for the cost of delays. The possible effects of such timing differences are already evident with most of the £38 million increase in the engine programme attributable to the extension of the development phase.

3.24 The Department intend to procure the Multi-Functional Information Distribution System Low Volume Terminal (MIDS) currently being developed collaboratively by the United States, France, Germany, Spain and Italy. At the outset of the development programme this was agreed by the nations as the only MIDS terminal suitable and available for Eurofighter 2000. The terminal will be supplied as Government Furnished Equipment to the Eurofighter 2000 development programme.

3.25 The Eurofighter 2000 specification includes a requirement for the aircraft to interface with the MIDS, however the MIDS specification has changed since the Eurofighter 2000 development contract was let. Nations have tried to limit the impact of this by making provision for the transfer of information to NEFMA relating to specification changes on the MIDS. However, risks remain since nations will bear not only the cost of any changes but also of any delays in the supply of MIDS to Eurofighter (the MIDS programme has slipped and the current timetable is regarded as high risk by the Department).

3.26 The re-orientation of the development programme will not affect the existing arrangements for the provision of Government Furnished Equipment.
Key points

3.27 The National Audit Office consider that the following key points can be identified concerning the commercial arrangements on the Eurofighter 2000 programme:

(i) The original contracts on the Eurofighter 2000 programme were not as taut as would now be expected on a comparable national programme. This was a reflection of the technical risks present on the programme when the commitment to development was made and also the collaborative arrangements agreed between the nations (paragraph 3.1).

(ii) The agreement of a pricing scheme facilitating the progressive transfer of commercial risk from nations to industry as the technical risks on the programme became better understood was a pragmatic and innovative solution to a difficult situation. However, its implementation was predicated on successful progress on the programme. When this did not prove to be the case the agreement of fixed prices was compromised and nations were exposed to a higher degree of commercial risk than anticipated (paragraphs 3.3-3.5).

(iii) Six years into development, there is still a significant level of technical risk remaining which is reflected in the substantial increase in the fixed price now agreed for completion of the development programme. This fixed price will still leave nations with a potentially uncapped cost liability for some aspects of the programme (paragraphs 3.6-3.8 and 3.10).

(iv) The original contracts did not provide sufficient incentive to efficient consortia performance. The re-orientated contracts are an improvement and address a number of the shortcomings apparent on the programme. Specifically:

- the failure to agree fixed prices, combined with the low level at which the Limit on Contractors Liability was set, meant that under the original contracts industry were effectively working in a cost re-imbursement environment. The move to fixed prices and the increase in the Limit of Contractors Liability under the revised contracts are significant improvements (paragraphs 3.5-3.6 and 3.9-3.10); and

- the original milestone payment arrangements provided a limited incentive to efficient consortia performance. The revised milestone arrangements are also a major improvement, and, provided nations have the collective will to enforce the sanctions they have under the contract, will provide a significantly greater incentive to efficient management and focus effort onto the programme as a whole (paragraphs 3.11-3.15).

continued
(v) The re-orientated contracts reduce the cost risks faced by nations. However a number of cost risks do remain the responsibility of nations and cannot be passed to industry:

- the territorial payment arrangements on the programme mean that the United Kingdom could potentially pay a greater share of the Equipment Integration Contingency than its cost share percentage on the rest of the programme (paragraphs 3.7-3.8); and

- the provision of Government Furnished Equipment leaves the Department open to risks should the required equipments not be delivered on time or to specification. For the main items of Government Furnished Equipment on the development programme nations have recognised the technical risks and taken steps to minimise these. However the cost risks remain, and, in the case of the engine, have already resulted in Eurojet making a provision for extra testing in their fixed price quotation as a result of delays on the Eurofighter 2000 programme (paragraphs 3.21-3.26).

(vi) The rigid application of the worksharing arrangements set out in the intergovernmental Memorandum of Understanding for the programme, and the requirement to provide a balanced spread of technology between the participating nations, have often resulted in industry placing work with specially formed consortia with complex managerial and working structures and variable levels of technical expertise rather than on the grounds of value for money. This has been a key factor behind the cost increases on the programme and has also impacted on timescales and value for money overall. Re-orientation does not overcome these development problems because it is difficult to reallocate work between partners (eg technology transfer difficulties), would take too long and would add to the cost of the programme (paragraphs 3.16-3.20).
Part 4: The management arrangements on the Eurofighter 2000 programme

Introduction

4.1 Whilst nations retain overall control of the Eurofighter 2000 programme, the prime contracts place responsibility for the management and achievement of the development programme with the Eurofighter and Eurojet consortia, with nations monitoring progress and achievement on the technical and financial aspects of the project and ensuring industry fulfil their contractual obligations. The principal contractual relationships and management structures are shown in Figure 7.

![Figure 7: Principal contractual relationships and management structures](image)

Source: Ministry of Defence
Comment: The bold lines show the formal contractual relationships and management structures involving nations and industry. The dotted lines show the extensive informal contacts between nations' governments and their partner companies.

4.2 In this part of the Report the National Audit Office consider the systems put in place by industry and nations to meet their obligations and the approach being adopted to the management of Integrated Logistics Support on the programme. The National Audit Office have also drawn out a number of lessons learned which may have wider application for future collaborative programmes. These lessons are summarised at Annex A.
Industrial management

(a) Eurofighter

4.3 The Eurofighter consortium is responsible for the design and development of the aircraft, excluding the engine, stores and Government Furnished Equipment, and for the integration of the aircraft and these items to fully meet the Weapon System Development Performance Specification. This is a highly complex and technically challenging task. By December 1993, the continuing slippage in the project time schedule and inadequate management of equipment suppliers meant that the nations had lost confidence in the ability of the Eurofighter consortium and the partner companies to manage the development phase to a successful conclusion. They argued that radical changes must be introduced to the operating procedures, commercial and management arrangements within the consortium very quickly to restore the nations' confidence in the prime contractor. Eurofighter responded to these concerns by introducing a number of initiatives to improve its performance. The following paragraphs consider the reasons underlying Eurofighter's past performance and outline the new measures being put in place to improve this.

Accountability

4.4 Eurofighter are responsible for the overall management and co-ordination of the development programme. However, responsibility for day to day management of major parts of the airframe development has been delegated to partner companies each of whom have a number of System Design Responsibilities.

4.5 Each system comprises a number of equipments for which suppliers are selected through competition. In each case one of the partner companies places the contract in Eurofighter's name, and manages the contract on behalf of Eurofighter. This is known as Equipment Design Responsibility. This arrangement means that the partner company with System Design Responsibility may not always be responsible for the supply of all the equipments which make up the system. For example, British Aerospace held Equipment Design Responsibility for the Missile Eject Launcher but System Design Responsibility was held by DASA.

4.6 As part of their restructuring, Eurofighter have recognised the difficulties caused by these blurred lines of accountability and have initiated a system known as Eurofighter Partner Company Accountability. This has resulted in the re-alignment of most of the previous System and Equipment Design Responsibility mismatches, for instance, DASA now hold both Equipment and System Design Responsibility for the Missile Eject Launcher. The new system of accountability gives each partner company full financial and technical responsibility for all of the equipment and software which comprise the systems for which it has procurement responsibility.

4.7 This re-alignment should ensure responsibility for the solution of individual problems is clearly defined. In the event of disputes the Managing Director of Eurofighter will act as a final arbiter. However, all industrial partners have agreed that work will not be held up pending resolution of any dispute.
The management of equipment suppliers

4.8 The management of equipment suppliers and the Equipment Design Responsibility process was specifically identified by nations as a cause for concern. The main reasons for this were the complexity of many of the equipments being developed, and the need to procure them from international consortia to meet the worksharing requirements on the programme, which meant that this has not proved a straightforward task. In particular, partner companies have not always made provision to ensure adequate visibility of progress and have been unable to ensure that difficulties are resolved in a timely manner.

4.9 Eurofighter have introduced a number of measures to improve supplier management by improving both their own and partner companies' visibility of the performance of individual suppliers, ensuring advance warning of problems which may affect the overall programme, and encouraging suppliers to afford the Eurofighter programme a high priority. The measures introduced include designating individuals at Director level within each partner company responsible for each major supplier in their country; introducing regular board-to-board meetings; and extending the activities of established teams to monitor progress on specific critical equipments.

The effectiveness of the Eurofighter organisation

4.10 Contractually, Eurofighter are the focal point of contact between nations and industry on the programme. Eurofighter are therefore responsible for centrally monitoring and co-ordinating the activities of the four partner companies across the whole of the development programme. To fulfil these roles Eurofighter has a permanent staff supplemented by a large network of meetings (indicatively, in 1994, 585 Eurofighter meetings were planned with 796 actually being held between Eurofighter and partner companies with an average of 16 attendees) which draw on the technical expertise available in the partner companies. A particular concern has been that these arrangements were not sufficiently pro-active and did not identify problems early enough or ensure solutions were implemented in a timely manner.

4.11 Eurofighter has responded to these criticisms by introducing a full scale re-assessment of its role, functions and tools, known as "the Phoenix Initiative". Action is in hand to address criticisms from nations, partner companies and within Eurofighter itself, to eliminate bureaucracy and improve Eurofighter's ability to manage and co-ordinate the programme and to make it much more responsive to nations requirements. This process is on-going and, at present, it is too early to conclude on the long term impact which the reforms being introduced will have on the programme. However, progress has been made with, for example, staff numbers reduced from 170 to 159 (including 10 new posts to strengthen the organisation in key areas) and a Business Plan produced.

Cohesion of the Eurofighter consortium

4.12 The unclear lines of accountability on the programme, arrangements for the management of equipment suppliers and the shortcomings in the effectiveness of the Eurofighter organisation have all meant that the consortium's approach to the
development programme has lacked cohesion. This has been aggravated by the milestone payment arrangements in the original contracts which did not encourage partner companies to focus on overall programme achievement (paragraph 3.12).

4.13 A good illustration of the overall effect of these difficulties is the way changes to equipments have been handled with a tendency for the partner companies to avoid responsibility for technical problems. This is in order to avoid the associated costs, rather than for the consortium to act cohesively and solve the problem for the benefit of the overall programme.

4.14 The lack of cohesion is being tackled in a number of ways. Lines of technical and, more importantly, financial accountability have been clarified and the milestone payment plan has been revised to place the emphasis on collective rather than individual achievement. Moreover, the joint risk sharing venture established by DASA, British Aerospace and GEC-Marconi Avionics to overcome the problems on the Flight Control System provides an indication that what Eurofighter has called “the natural commercial barriers” on the programme can be overcome. They are currently examining the potential application of this type of arrangement to other areas of the programme.

(b) Eurojet

4.15 The Eurojet consortium is responsible for the development of the EJ200 engine. This is a highly challenging technical task, albeit a less complex one than that faced by Eurofighter. The following paragraphs consider Eurojet's role in managing the engine programme and how well the partner companies have worked together.

4.16 Eurojet does not seek to undertake a full managerial role on the programme itself. Rather it has a small core of approximately 40 staff who chair a series of working groups which comprise the relevant technical experts from the partner companies. These working groups feed an executive chain once again comprising members of the partner companies but chaired and supported by Eurojet staff. This means that Eurojet, rather than mirroring the roles of the consortium members, draw together the key players in the partner companies to facilitate timely decision making.

4.17 In general these arrangements have worked well, although there are indications that, where difficulties have occurred, it has not always been possible to resolve them in a timely and effective manner. An example of where the arrangements have not worked well is the Digital Engine Control Unit where difficulties with the development of the hardware were only addressed and resolved some two years after nations first began pressing for remedial action to be taken, when Eurojet adopted a more pro-active role than had previously been the case.
4.18 The Eurojet partner companies have also functioned well together at the consortium level. There are three factors which have influenced this:

- with the exception of the Spanish partner, ITP, all the companies worked together as part of the TurboUnion consortium which developed and manufactured the RB199 engine for the Tornado programme. The basis of their collaborative relationship was therefore well established and, for Eurojet, they sought to retain a similar simple structure with clear responsibility for each partner company's part of the development task including the procurement of specific accessories;

- the engine is a highly integrated equipment and very close co-operation was required to ensure it functioned effectively. The United Kingdom funded XG-40 Technical Demonstrator Programme made a significant contribution in the early stages of this process; and

- the commercial prospects for the EJ200 engine (for example it is being considered for use on the Swedish Gripen) have also acted as a driver for the consortium.

**Key points**

4.19 The National Audit Office consider that the following key points can be identified concerning the industrial management arrangements on the Eurofighter 2000 programme:

(i) Eurofighter has been unable to impose its authority to ensure the resolution of problems on the programme since the lines of accountability between Eurofighter and its partner companies and also between the partner companies themselves have been blurred, for both overall systems and the procurement of the equipments which comprise these. This has meant that industry's approach to the development programme lacked cohesion and leadership from Eurofighter and that, by the end of 1993, nations had lost confidence in the consortium's ability to manage the development phase to a successful conclusion (paragraphs 4.3, 4.5, 4.8, 4.10 and 4.12-4.13).

(ii) Following an ultimatum from the nations in December 1993, Eurofighter have introduced a range of initiatives to improve their management performance and regain the confidence of nations. These include aligning responsibility for equipment and system design more clearly for each partner company, improving the management of equipment suppliers and improving Eurofighter's performance in providing effective leadership. Although these initiatives are still in their early stages, there are already some signs that they are improving the cohesion of the consortium, for example the risk sharing arrangements introduced for the Flight Control System. The steps taken should result in both the identification and resolution of problems and better management of the highly complex development task (paragraphs 4.6-4.7, 4.9, 4.11 and 4.14).

*continued*
(iii) For the engine, Eurojet have managed the programme with a small central organisation supporting decision making by partner companies through a series of Committees. This approach has worked reasonably well. In addition, there are a number of other factors which have promoted harmony within the Eurojet consortium. The consortium members have previous experience of joint working on the Tornado RB199 engine and have prospective customers for the EJ200 engine (paragraphs 4.15 4.18).

Government management 4.20 Figure 8 outlines the structures that nations put in place to enable them to exercise overall control of, and to monitor progress on, the Eurofighter 2000 programme. There are two main features of the approach adopted: the use, typical to collaborative programmes, of committees to make key decisions on the programme and the establishment of an Agency (NEFMA) to undertake the

Figure 8: NEFMA organisational chart

Source: NEFMA

Note: * STORM = Senior Technical and Operational Representatives Meeting.

Comments: Figure 8 shows how the nations manage the project through a complex hierarchy of meetings, groups and committees.
day to day management task on behalf of nations. The following paragraphs assess how well this approach has worked and whether it has enabled nations to make timely and effective decisions on the basis of adequate information from the programme monitoring systems.

(a) The collaborative decision making process

4.21 Collaborative decisions are reached through a four level hierarchy of Committees with a Steering Committee providing overall guidance. These are attended by national officials, NEFMA and, in many cases, industry representatives. They involve an extensive commitment in both time and manpower terms. Indicatively, in 1994 over 500 meetings were held, some with large numbers of attendees (the Integrated Logistic Support meetings had up to 60 attendees). This committee approach seeking consensus at every level meant that nations have not always made decisions in an efficient and timely manner and that the expected benefits from the extensive programme monitoring systems installed have not been fully realised. There are three main reasons for this:

(a) lower-level committees have lacked the authority to resolve technical, financial or contractual issues themselves but have referred them upwards to the Board of Directors who have become over burdened. An example of this is the Senior Technical and Operations Representatives Meeting (STORM) which has had unresolved disputes from over 50 lower level meetings referred up to it each year relating to the Eurofighter consortium alone and who, in turn, have referred many of these up to the Board of Directors;

(b) policy issues, such as those relating to the re-orientation of the development phase affect the conduct of every aspect of the programme, and can only be decided by the most senior committees or even ministers. This has resulted in delays in the decision making process; and

(c) the complexity of the Committee structure itself has also led to inefficiencies. Originally 39 committees were established. This number has increased as the programme has progressed with six new lower level meetings introduced to deal with emerging risk areas. However, this has not been matched by committees whose usefulness is no longer apparent being disbanded.

4.22 The effect of these shortcomings is well illustrated by the attempts to update the meeting structure itself in light of the re-orientation of the programme. Proposals for revising the structure were first circulated early in 1993 and agreement between nations finally reached a year later in January 1994. However the details are still being discussed with industry. Furthermore, the agreement reached by nations makes only limited provision to amend the terms of reference for lower level meetings and hence the pressure on senior committees is likely to remain.
(b) The role of NEFMA

4.23 NEFMA was established in February 1987. It is responsible for the day to day management and control of the programme on behalf of nations, letting the prime contracts, and co-ordinating the working methods of the four participating countries. NEFMA is based in Munich and has 174 staff (including 54 provided by the United Kingdom). It also calls on national expertise to assist it where necessary, for example with tasks involving close contact with national industries such as pricing.

4.24 NEFMA's ability to fulfil its intended task has been constrained by a lack of clearly delegated authority and responsibility. In practice, a succession of major issues such as the selection of the radar and re-orientation of the development contracts have required significant effort on the part of the Agency but, in the end, have had to be resolved by the national governments usually led by the United Kingdom project office. The result of this has been that, in some areas, NEFMA has not been an effective focus for the management of the programme as it lacked a clear mandate.

4.25 To discharge each national defence ministry's responsibility to their parliament for their shares of expenditure on the project, each nation has established its own national project office. The United Kingdom project office has some 45 staff (with a further 45 staff working on ILS issues) with additional resources available to assist in tasks such as pricing. The United Kingdom Project Office has often been pro-active in identifying problems and solutions before the Agency. Other national project offices have similar roles in their own nation. This was a deliberate aim at the outset of the programme to minimise the size of the Agency. However, in practice there has been a tendency for the Agency to await directions from nations. This perception is reinforced by the strength within the Eurofighter and Eurojet consortia of the national partner companies, with whom national project offices negotiate directly without recourse to the formal contractual interface between NEFMA and Eurofighter or Eurojet.

4.26 NEFMA's role is defined in general terms in a NATO Charter and in the General Memorandum of Understanding. The Charter is based on a NATO Standard drawn up over 30 years ago which is rather imprecise and ambiguous in its delegation of authority and responsibility to the Agency. It is not sufficiently in line with modern management practices and does not require NEFMA to have a management plan with performance requirements or indicators by which nations could judge its effectiveness.

4.27 NEFMA is also constrained by the rigidity of its staffing arrangements with specific posts designated to be filled by each nation in line with the cost sharing arrangements on the programme. This means that NEFMA has relatively little flexibility to decide on the skills mix they require or where resources should best be focused.

4.28 Nations are currently undertaking a full review of NEFMA staffing in anticipation of the planned merger with the Tornado NATO Management Agency, which is also located in Munich, in January 1996. The nations have
taken the opportunity to rectify many of the existing shortcomings, not just by making the Agency more cost-effective but also by defining NEFMA's role and clarifying the responsibilities of senior committees. These measures will be reflected in a new Charter.

(c) Monitoring and programme control

4.29 Nations' visibility of progress on the programme is achieved through the regular meeting structure, together with the submission of regular progress reports by industry and access to industry's databases. In practice, these measures have not provided the required degree of visibility or reassurance on the status of the programme. The following paragraphs analyse the reasons for this and highlight two initiatives being taken by the Department to improve this situation.

Access to the Eurofighter database

4.30 Eurofighter are contractually required to maintain a computer database showing progress on each element of the programme. NEFMA have access to this and nations are each provided with copies of the data by NEFMA. The database is based on a breakdown of the development programme known as the Master Control Network and consists of around 10,000 interrelated activities. Establishing the network was a lengthy process and was not completed until 1991 (3 years after development started) until which time all information was received on paper. The network was designed primarily for project management and represents a powerful tool for industry to co-ordinate work across the four nations. But it has several shortcomings for nations in terms of project monitoring. These relate to the timeliness and completeness of the data held and its utility in helping nations to monitor achievement on the programme.

4.31 The database is updated monthly. However, before it is released to nations the Eurofighter partner companies amend the raw data to include recovery actions in respect of slippages on individual activities. This means that the network presents an optimistic picture of the status of the programme and data can be up to five weeks old by the time it is available to nations. The Department have sought to improve both the accuracy and timeliness of the updates to the network. Eurofighter have agreed, as part of re-orientation, to reduce the time lag to 22 days, and have accepted the need to improve the accuracy of the data used for all project planning by both Eurofighter itself and its four partner companies.

4.32 As originally structured, the database did not specifically relate activities to payment milestones. This made it difficult for nations to assess overall progress against payment milestones on the programme. This is being rectified as part of the re-oriented development programme and, for future phases, industry will be contractually required to link network activities to milestones. Furthermore, whilst it was available to industry, nations did not interrogate the network by using its "what if" capability to make projections of the effect of delays or the advancement of specific activities on the programme as they lacked confidence in the quality of the database.
Progress reporting

4.33 The Main Development Contracts require each consortium to submit quarterly progress reports detailing timescale and cost performance on the programme and explaining the reasons for technical problems and divergences from planned timescales and costs. In practice, as both nations and industry recognise, these reports proved inadequate monitoring tools. They were based on data which was out of date, included cost information for the current year only and contained uninformative explanations of cost overruns, programme slippages and technical difficulties. In 1994, industry re-designed the reports. However, their utility has remained limited with the Eurofighter report containing narrative only, and the Eurojet report only high level cost and programme information. Instead nations have relied on obtaining data from national partner companies to provide a more up to date picture than the formal reports, and a working level indication of progress and the realism of forecasts.

(d) Improvements to nations' programme monitoring arrangements

4.34 The Department have recognised the deficiencies with the monitoring information currently provided by industry and nations' consequent poor visibility of programme progress and have championed the introduction of two initiatives - Earned Value Analysis and risk management - to improve this. These are described in the following paragraphs.

Earned Value Analysis

4.35 Earned Value Analysis compares actual expenditure on work carried out on a programme with the originally estimated cost of that work. It allows customers to assess whether suppliers are performing according to plan and whether the expenditure that is being incurred each month is producing value for money. Earned Value Analysis can also be used to forecast the likely cost to complete a programme and its end date. The technique has been widely used in other countries, most notably in the United States where it has been a mandatory requirement for contractors undertaking defence equipment programmes for the past thirty years. United States experience has shown the forecasts produced to be accurate.

4.36 At the outset of the Eurofighter 2000 programme NEFMA sought to place similar cost reporting obligations on both Eurofighter and Eurojet. Both consortia rejected these requests on similar grounds, arguing that their partner companies did not use these techniques for their normal business with governments. Figure 9 overleaf uses the data available to nations under the existing industry reporting arrangements to show the current status of the programme and United Kingdom expenditure. At first sight it suggests that the United Kingdom have spent some 25 percent more than expected whilst the programme has slipped by three years. However, this analysis does not take account of the fact that many activities are following the planned programme of work whilst others may be lagging behind. Reflecting this balance is a particularly challenging task on a programme as complex as Eurofighter 2000 and one to which Earned Value Analysis would be well suited since it requires work to be broken down into small units with costs assigned to each. Rolls Royce have already recognised this and have applied
4.37 To address the existing deficiencies nations are seeking to include earned value reporting as a contract deliverable from industry on future phases of the programme. However, although industry are being encouraged to apply the technique to the remaining development work they have rejected that this should be a contractual obligation. Nations’ ability to correlate costs and progress on the development phase of the programme will not therefore be improved as much as might have been the case. To counter this the Department have reached an understanding with British Aerospace and Rolls Royce to allow access to their Earned Value Analysis data.

**Risk management**

4.38 The Main Development Contracts do not require industry to report on risk in a formally structured way. Thus, although both consortia have risk management plans and address risk at regular reviews, no mechanism exists to provide visibility of this to nations. Rather, difficulties are reported to national officials at technical meetings as they occur.

4.39 At the international level, the views of partner nations differ on the value of risk management techniques. As a result, some have argued that a passive approach to risk management was all that was necessary since, within a taut contractual arrangement, responsibility for the management of the programme lies with the contractor and that any attempt by nations to minimise “risk” could lead industry to blame nations for delays caused by that interference.
4.40 Hitherto, NEFMA's approach to risk has been based on traditional methods of progress monitoring. This is based on their general monitoring of progress through meetings with Eurofighter and Eurojet, industry generated technical reports, receiving and preparing briefings and through national dialogue. Thereafter, they rely on their technical experts' accumulated knowledge to produce a judgement on the level of technical and timescale risk in their area of the programme. NEFMA have not produced a risk management plan nor have they compiled the risks identified into a risk register covering technical, timescale, commercial and cost risks on the programme.

4.41 The absence of a structured approach to risk management, which would enable NEFMA to comprehensively report risk to nations, became clear during the early negotiations with industry over the re-orientation of the programme. Nations therefore tasked NEFMA to produce a one-off qualitative risk assessment of industry's proposed programme timetable to inform their negotiations. This assessment was built on the personal judgements of the technical experts without any standardised approach to what constituted materiality or definition of different levels of risk. However, the results were useful in highlighting the lack of realism in the proposed programme, confirming the concerns of nations and providing a basis to request new proposals from industry.

4.42 Building on this exercise, and following the Department's lead, nations proposed, in February 1994, an expansion of the existing informal system to include an assessment of financial, schedule and technical risks within a standardised structure and for their consolidation into a formalised register. NEFMA have produced a proposal to fulfil these requirements which is currently being assessed by nations. NEFMA have also instituted an informal dialogue with Eurofighter and Eurojet giving greater visibility of industry's risk management procedures, and nations are now pressing industry to include risk reports as a contract deliverable on future phases of the programme.

4.43 On a national level, and in line with the requirement for risk management to be viewed as an essential part of the project manager's remit, the Department introduced their own formal risk management procedures. A risk register was compiled in 1993 with the help of external consultants and the system has since been progressively enhanced. This risk assessment has confirmed the results of the review undertaken by the Chief Scientist (see Paragraphs 2.24 - 2.26) and showed that there is currently no indication of any significant shortfall in achieving the specification, but that both completion schedules and cost will require careful management.

4.44 The Department's more robust approach to risk management has been supported by the introduction of a suite of software tools to enable them to interrogate the industry project management database more rigorously to quickly identify trends, slippages, critical tasks and interdependencies to these. An early example of the use of these tools has been to analyse the programme currently proposed by industry, which they argue is realistic. The Department's analysis suggests that, whilst the rate of slippage is reducing, the current programme is likely to slip further. These differing views are the subject of
on-going discussions with industry with the Department better informed to argue their point than would previously have been the case.

Key points

4.45 The National Audit Office consider that the following key points can be identified concerning nations' monitoring and control of the Eurofighter 2000 programme:

(i) The requirement for nations to provide overall direction on the programme through a complex Committee structure has kept nations informed of events, but is not the most efficient use of resources in the nations or in the Agency. Lack of delegated authority to lower level committees has often led to decisions being referred upwards to senior committees, unduly increasing the burden placed on them. This is to some extent a reflection of the political nature of some of the decisions (eg those affecting re-orientation) and the complexity of the committee structure which itself reflects the perception by nations of the need for specialists to be involved in a wide range of management tasks (paragraphs 4.21-4.22).

(ii) These problems have been compounded by NEFMA's lack of a clearly defined role. In practice, the Agency have come to depend on the national project offices to an increasing extent to identify problems and propose solutions. The problems of collaborative oversight and the decision making process have meant that the approach of nations to programme monitoring, in common with that of the Eurofighter consortium, has lacked both cohesion and strong central leadership (paragraphs 4.23-4.28).

(iii) The deficiencies in the information available to NEFMA and nations have reduced their capability to assess the status of the programme in terms of progress made compared to the costs incurred. The initiatives being introduced by nations to improve their own monitoring procedures, and the contract deliverables they will request from industry on future phases, should improve this situation. These arrangements should provide nations with a more robust basis upon which to take decisions and exercise overall control of the programme. Specifically:

(a) Earned Value monitoring potentially offers nations a solid basis upon which to assess industry's performance and the value for money they are achieving. It will also provide early warning of both slippages and cost escalation on the programme and allow nations to take action to minimise these. In addition to these arrangements the Department have done well to reach an understanding with British Aerospace and Rolls Royce to provide separate analysis covering the United Kingdom elements of the re-orientated development programme. This will help to ensure that the Department is better placed to judge future achievement on the programme for which it has funding responsibility (paragraphs 4.35-4.37); and

continued
(b) the introduction of formalised risk management techniques by both the Department and NEFMA, and the more open dialogue with industry, should mean nations are better informed. Potential difficulties affecting cost, schedule and technical achievement should be identified earlier and action taken to minimise these. The potential benefits are illustrated by the discussions over the realism of timescales proposed by industry which have followed both NEFMA's initial qualitative assessment and the recent analysis of the industry database by the Department using their newly developed software tools (paragraphs 4.38-4.44).

4.46 Typically, well over half of the overall cost of an equipment is incurred after it has entered service. A key factor in the Eurofighter 2000 procurement strategy has therefore been to minimise costs across the whole life cycle of the aircraft and not just in the procurement phase. The use of Integrated Logistics Support (ILS) techniques has been a major plank in this strategy. ILS is intended to reduce equipment ownership costs by considering, during the design of the equipment, through life support aspects and ensuring they are given due weight against performance, cost and timescale considerations.

4.47 Eurofighter 2000 is the first major programme in Europe fully to embrace the concept of ILS. The National Audit Office have therefore considered the approach being adopted to the management of ILS during the development programme and the procurement strategy being adopted for the main ILS contracts.

(a) The approach adopted to ILS

4.48 All partner companies are contractually required to deliver logistics data throughout the development programme. This data is fed into two databases administered by industry covering Logistic Support Analysis and the Support Analysis of Software. These are interlinked and compiled to common data standards (based on established American military standards).

4.49 The benefits of the ILS approach are already becoming apparent from the analysis carried out using the available data. For hardware, examples are emerging of design changes being made to reduce support costs as a result of the modelling undertaken. For example, the addition of de-humidification in the avionics bays, although increasing the initial acquisition cost, is expected to produce savings of £30 million over the aircraft’s service life.

4.50 Analysis of the software database has shown that, in some cases, industry have deviated from the common software standards defined by nations. If nations accept these deviations, rather than insist industry re-write the non compliant software at their own expense (leading to a further delay on the programme), the increased maintenance times and costs when the aircraft enters service could be serious, with inadequate documentation and a proliferation of software tools requiring additional resources to diagnose faults and maintain the software. Nations are currently considering how best to deal with this problem.
4.51 At the outset of the development programme funding of £35 million was included for initial ILS tasks up to the end of 1992. As a result of the slippage on the development programme, which has delayed the transition to the future phases and the availability of data, additional ILS work will be undertaken under the Main Development Contract. Work on ILS has now virtually ceased within some of the partner companies because of the delays in agreeing the re-oriented programme and difficulties faced by some nations in obtaining sufficient funding to meet the proposed programme. The initial funding has, therefore, been spent largely on the establishment of the necessary procedures and infrastructure to undertake and manage the work although the databases have not reached the level of maturity expected. For the United Kingdom, completion of the necessary work through to the end of 1995 is expected to cost an extra £37 million.

(b) Procurement strategy

4.52 There will be four separate contracts let for ILS (two each to Eurofighter and Eurojet) covering services and hardware. The contracts will be incentivised and the intention is that they should be let with fixed prices. Firm bids for ILS will be invited at the same time as those for Production Investment/Production.

4.53 The key factor underlying nations’ procurement strategy for ILS is how to provide the necessary logistic support for the weapons system to underpin operational effectiveness and to minimise lifecycle costs. There are two alternatives. The traditional route, favoured by the Royal Air Force, would be for them to undertake all maintenance themselves. In this case the ILS contracts would require the Air Force to decide what support they wish to procure for every repairable item on the aircraft, and for industry to supply the necessary equipments, tools and parts, as specified by the Air Force, to enable service tradesmen to fulfil this task.

4.54 The second route would be for the Air Force to undertake on-aircraft support only. The prime contractor would undertake all other support, including defining the equipments, tools and levels of spares required to achieve a contractually specified level of availability. The Department have chosen to follow this prime contractor support route on a number of recent procurements, most notably for Trident missiles and the Hercules transport aircraft replacement. From an industry perspective British Aerospace have experience of such arrangements from their role as prime contractor on a number of major overseas sales.

4.55 The Department recognise that adopting the prime contractor support route would address many of the risks posed by the 6 year overlap between the start of production and end of development. They also consider that it would reduce the risks which the three different standards of aircraft entering service (two levels of interim capability and full operational capability) will cause industry in identifying, and the Services in defining, their requirements for production equipments, long lead logistic support materiel and Aerospace Ground Equipment requirements (likely to run to some 3,000 items). There are also issues concerning the provision of software facilities under the services contract. At present each nation intends to maintain its own facility staffed by Service and civilian personnel. However, there are concerns within the
Department over the availability of sufficient skilled personnel and the cost of maintaining four separate facilities. Deciding how best to meet these requirements would become industry's responsibility under a prime contractor support arrangement which would allow them to explore more radical options to meet the software support requirements.

4.56 To assess the relative merits of the two approaches nations have tasked NEFMA to undertake an investment appraisal. This will be based on quotations to be supplied by Eurofighter and Eurojet in Autumn 1995. The Department are also undertaking their own investment appraisal to address United Kingdom specific requirements. Whatever the results of this work, the Department expect binding quotations to be sought from industry covering both routes to enable nations to determine the optimal procurement strategy.

Key points

4.57 The National Audit Office consider that the following key points can be identified concerning the approach being adopted to Integrated Logistics Support on the Eurofighter 2000 programme:

(i) the approach adopted to ILS on the programme has been well planned with the benefits already starting to become apparent. However, progress has been slower than expected, largely due to the funding constraints faced by some nations and the slower than expected rate of achievement on the main development programme which has resulted in data not becoming available as expected. This has led to more of the original ILS funding being spent on procedures and infrastructure than expected. As a result, the cost of funding the ILS tasks prior to the commencement of the full ILS phase has more than doubled (paragraphs 4.49-4.51).

(ii) The Department face a number of significant challenges if the main ILS contracts are to be placed in early 1996 as currently planned. In particular the lack of an agreed procurement strategy between nations means that, even when industry quotations are received in July 1995, the basic commercial strategy will still have to be agreed before prices can be negotiated and national funding approvals obtained (paragraphs 4.52 and 4.56).

(iii) The Department believe that prime contractor support offers a number of potential commercial attractions over the conventional Air Force Support provision. This is particularly the case given the development and production overlap and the intention to introduce successive iterations of the aircraft into service which would make defining requirements and aligning timescales on the ILS and production programmes a challenging task. Prime contractor support would place this responsibility on industry and would be a logical extension of the existing procurement strategy. However, there will be costs associated with tasking industry to bear these risks and the Department are right to undertake detailed appraisals of the options to assess which offers the best value for money relative to the level of risk they will be required to accept (paragraphs 4.53-4.56).
5.1 The roots of much of the cost escalation and schedule slippage on the Eurofighter 2000 development can be traced back to the commercial and managerial arrangements on the programme, particularly the rigid worksharing requirements, rather than to major technical difficulties. At the time these were thought to be the best way forward but both nations and industry have since recognised there are shortcomings and have taken a number of steps to rectify these. These have placed the programme on a much firmer footing and should mean that nations and industry can now have greater confidence in taking the programme forward.

5.2 However, risks do remain, principally to the achievement of programme timescales, with a number of major hurdles to be overcome if the current timetable for commitment to future phases is to be achieved. In particular, past experience on the programme suggests that agreeing prices and obtaining national funding approvals will be time consuming. This, taken together with the requirement for industry to demonstrate a sufficient level of technical maturity on the development programme, means that, as nations and industry recognise, there are a number of significant challenges to be met if the contracts for future phases of the programme are to be placed early in 1996 as intended.
Annex A

Lessons applicable to any future programmes

The National Audit Office have identified a number of lessons from their analysis of the Eurofighter 2000 programme which may be applicable both to the remaining phases of this programme and to future collaborative programmes.

1. On programme costs and timescales

1.1 Estimates of likely costs of future collaborative programmes should reflect the need to include realistic contingencies in contracts and reserves in Treasury Funding Approval figures to take account of the complexity in which collaborative working arrangements usually result (paragraph 2.23(iv)).

1.2 Reaching agreement between partners throughout collaborative programmes is inevitably a time consuming process. The Department should ensure that future planning timescales, at both a national and international level, adequately reflect this (paragraphs 2.17 and 2.23(v)).

2. On the commercial arrangements

2.1 On future collaborative programmes there should be well structured and comprehensive, collaborative project definition work supported by a robust appraisal of alternative commercial strategies, to ensure risks are better understood before substantive funds are committed to full development.

2.2 When innovative contractual and managerial arrangements are adopted on programmes there should be scope included in the contract to allow a review of these in the light of experience and the instigation of corrective actions where necessary (paragraph 3.27(ii)).

2.3 Fixed prices potentially offer the lowest cost risk to the customer and should usually be the preferred form of pricing. However, if there is a high degree of risk in the programme which makes this unrealistic there may be scope to make greater use of Target Cost Incentive pricing arrangements (as with the Equipment Integration Contingency). These offer an incentive to efficient industry performance whilst sharing the risk burden more equitably with nations (paragraphs 3.7 and 3.27(iv)).
2.4 The agreement of Limits of Contractor’s Liability increases cost risk to nations. Where a Limit is included on a programme nations should look progressively to increase this at each stage of the programme as risk is better understood. (paragraphs 3.9-3.10).

2.5 Milestones and payment plans should provide a clear incentive to industry by effectively linking payment to real technical progress. This is particularly important where industrial management structures are complex as is often the case on collaborative programmes (paragraphs 3.12-3.13 and 3.27(iv)).

2.6 Where contractual remedies are included in contracts nations must be prepared collectively to use them to reinforce the incentive of linking payment to achievement (paragraphs 3.15 and 3.27 (iv)).

2.7 If contingencies are included in future programmes the Department should ensure that the Memorandum of Understanding covering the programme clearly lays down mechanisms to ensure the equitable sharing of these costs by partner nations (paragraph 3.8).

2.8 Including items of Government Furnished Equipment, Facilities or Information on programmes increases the risks faced by the Department since failure to deliver items on time or to specification will reduce the incentive placed on a prime contractor to manage the overall programme and may leave the Department open to claims from the prime contractor. It should be avoided where it is both practicable and cost effective (paragraph 3.27(v)).

2.9 If formal work sharing is a necessity it should be defined at the broadest possible level and priority should be given to the achievement of value for money (paragraph 3.27(vi)).

3. On the management of collaborative programmes

On collaborative programmes both government and industrial management tends to follow similar principles. The following four lessons apply equally to both.

3.1 Collaborative programmes often include complex managerial structures. Greater emphasis should be given at the outset to the consideration of these arrangements as well as to technical issues.

3.2 There must be a clear focus of authority on the programme on both government and industry sides. These bodies should form the main point of contact between customer and supplier and have sufficient authority to make decisions in a timely manner and ensure that partners implement these (paragraphs 4.19(i) and 4.45(i), (ii)).
3.3 Effective management of collaborative programmes is more difficult where there are many partners each with an equal say in decision making. On the industry side this could be overcome by a single company from one nation taking the lead role with other nations’ companies acting as sub-contractors. On the government level, majority voting linked to each nation’s financial commitment would provide a robust basis for decision making and would make it more difficult for a single nation to delay actions agreed by other partners (paragraphs 4.19(i) and 4.45(i), (ii)).

3.4 Lower level management of complex programmes will inevitably involve partner companies/nations taking responsibility for the monitoring of progress on specific aspects of the programme and taking action to minimise difficulties in a timely and effective manner. Such responsibilities must be clearly defined at the outset with the main managing body retaining the capability to impose solutions if necessary. One approach, to ensure that the technical and specialist skills of all of the partners are fully utilised could be to establish integrated teams similar to that on the Flight Control System on the Eurofighter 2000 programme (paragraphs 4.12-4.14 and 4.24-4.26).

The National Audit Office also suggest three lessons relating specifically to nations’ monitoring of programme progress.

3.5 Where nations pass responsibility for the management of programmes to industry they should clearly specify their reporting requirements in the contract. These should cover cost, timescale and performance aspects of the programme and include full risk reporting. Nations should also ensure that industry’s proposed reports, and the systems used to generate these, are suitable in terms of accuracy, timeliness and completeness and, wherever possible, that they have access to industry databases to provide a common basis for discussion and negotiation (paragraph 4.45(iii)).

3.6 On highly complex programmes the Department should seek to introduce risk management procedures which accord with best United Kingdom practice. The availability of such analyses is key to enable nations to identify emerging difficulties and institute remedial actions in a timely and effective manner (paragraph 4.45(iii)b).

3.7 Earned Value Analysis is a useful monitoring tool on complex programmes. It provides a solid basis upon which to assess industrial performance, the value for money being achieved and gives early warning of both slippages and cost escalation on the programme. The Department should consider its application not just on collaborative programmes but also on national procurements (paragraphs 4.36-4.38 and 4.45(iii)a).

3.8 Adopting Integrated Logistics Support techniques requires funding to be committed during development to enable databases of mature design and operational information to be compiled. This data can only be generated once development is underway. Expenditure profiles should reflect this and ensure that ILS funding is not committed too early in the development programme (paragraph 4.51).