NATO ARMAMENTS COOPERATION: THE CASE OF THE EUROPEAN FIGHTER AIRCRAFT

THESIS

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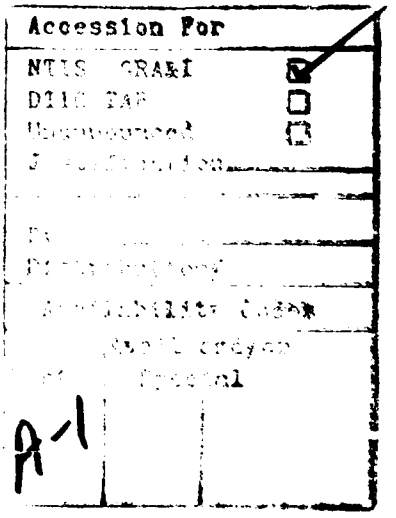

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THESIS

Presented to the Faculty of the School of Systems and Logistics

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Master of Science in Systems Management

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Preface

The purpose of the study was to find if the European Fighter Aircraft (EFA) program carried out in cooperation by Great Britain, Germany, Italy, and Spain, has faced the same difficulti s that have plagued almost all similar cooperative efforts undertaken by NATO countries in the past. These difficulties are commonly identified in the relevant literature as the main cause of failure of many of the past projects to survive or to achieve the expected results in terms of cost savings and standardization.

The study should be continued, since nations have still to agree on the actual production of the aircraft. Next phases of the program will show the actual effect of the difficulties, and if the EFA can be a useful experience for understanding the problems involved in multinational cooperation and in standardization efforts within NATO.

I would like to express my appreciation to my advisor, Dr Craig M. Brandt. His expertise, advice, and dedication made this effort successful.

Finally, I wish to thank my wife Carmen for her understanding and concern during the many days I was tied to my desk with work.

Carlos J. Sancho Gonzalez

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Abstract

Difficulties faced by cooperative acquisition programs are identified as the inability to agree on common requirements and the existence of economic or political interests of the partner nations which conflict with or impinge on the program. These are the causes of failure of many of the past cooperative projects undertaken by NATO countries for the purpose of standardization.

The study investigates the European Fighter Aircraft (EFA) program in order to find if the same holds true for the EFA and the impact that those difficulties had in the program.

The EFA has been subject to the same problems. All the nations involved have defended their internal economic interests within the program context. The difficulties in agreeing on common requirements caused France to withdraw, and Germany and Great Britain also had continuous problems in keeping an stable agreement. On the other hand, the collective economic interests of the remaining nations have had the effect of keeping the program alive despite the difficulties. Irrespective of standardization purposes, the EFA appears as both a military and industrial necessity to push the aerospace industries of the partner nations to a competitive level in the world marketplace.

NATO ARMAMENTS COOPERATION: THE CASE OF THE EUROPEAN FIGHTER AIRCRAFT

I. Introduction

General Issue

From almost the beginning of its history, the North Atlantic alliance has tried to foster cooperative efforts among the allies in the acquisition and operation of weapon systems, so that duplication of industrial effort can be avoided and the necessary interoperability among the NATO forces can be achieved.

Cooperation is a major concern within NATO, and it involves major issues for the allied countries regarding not only their national security policies, but also their economic and industrial interests, however important their commitment to the alliance goals may be. The reality is that history of NATO shows how, from the perspective of different national strategic and operational concepts, different sizes of budget and forces, and different industrial and technological development, each country may understand cooperation in a different way. As a result, the agreement on standardization and interoperability seems to become weaker when it must be translated into cooperative efforts to produce a weapon system.

Today, after so much effort by part of NATO leaders to promote cooperation, and after the numerous cooperative programs undertaken, there is still controversy on its benefits. Thomas Callaghan claims that the F-16 fighters produced in Belgium, Denmark, the Netherlands and Norway cost 35% more than the same F-16 bought directly from a U.S. factory, and he also claims that the kind of cooperation achieved in that case has no strategic effect related to standardization (41:29). Arguments of this nature can be found in reports and publications today, and seem to confirm the thesis of Richard Charles Fast, who in 1981 argued that most of the programs are bound to fail in achieving a significant degree of standardization, adducing political reasons as the main cause for that (29:viii).

Problem Background

Up to now, major drawbacks to cooperation have been identified as being of political or economic nature, as well as derived from differences in the requirements of the various forces. Although program management issues or the common difficulties of keeping an acquisition program within cost and schedule may become harder in a multinational environment, it appears that the burden of political and economic interests of the nations, and often the inability to set satisfactory requirements for all the partners, are by far the real problems to overcome.

"Defense decisions are also industry policy decisions" (3:8), and when governments make defense procurements they take into account parallel objectives such as (47:53):

- Limiting external sources for defense items;
- Lessening the balance of trade impact of non-domestic purchases;
- Increasing domestic employment, and
- Improving the high technology production base.

As a result, before any cooperative program may be put into operation, a range of issues need to be worked out (47:53):

- Agreement in common military requirements;
- Agreement on extent of collaboration;
- Resolution of problems arising from size differences in potential partners;
- Allaying fears of overspecialization in the assignment of work;
- Maintaining employment stability;
- Agreement on third-country sales;
- Development of a workable management structure; and
- Ending enforced offset purchases.

The consideration of so many issues is a true burden on any attempt to cooperate, no matter how important standardization is for the partners involved. On the other hand, in spite of the fact that the impact of a cooperative program in the national economies of the partners may be in some cases important enough to bring up those issues, they

help to complicate the whole process and bring confusion to the real purposes of the program.

One of the major cooperative programs undertaken up to now within NATO is the European Fighter Aircraft (EFA), with the participation of four European countries: Italy, Spain, Germany, and Great Britain. The management structure set up by the nations reflects the political commitment to cooperate and the attempt to manage the program in the most efficient and "joint" manner. The fact that the air staffs of the partner nations have worked together in a multitude of working groups throughout the definition phase, in a permanent team effort, also shows that commitment and the will to produce a "standard" weapon system.

Nevertheless, news in common media shows that the EFA program is apparently not free of disturbances. As an example, at the time this study was initiated, some sources reported that Germany was threatening to abandon the joint effort. On the other hand, one of the NATO members who has done the most significant effort to promote armaments standardization in NATO, the U.S., happens to be out of the one program intended to provide a high improvement in that level of standardization in year 2000. As its name indicates, the EFA will not be a NATO fighter, but a European fighter.

Specific Problem

After more than thirty five years of effort, the controversy about the benefits of cooperation among NATO members in the acquisition of weapon systems for their forces still remains. Despite the fact that NATO is a mature organization and that its members apparently agree on the commitment to standardization, the problems faced in increasing it through cooperative programs seem to be the political and economic interests of individual members, together with difficulties in agreeing on common military requirements.

Finding whether the EFA has been facing the same problems and what impact they had on the program will help clarify the controversy about cooperation benefits and will also help find solutions for the problems.

Research Objectives

The purpose of the study is to find whether the EFA program has faced up to now the problems mentioned above, and what impact they have had on the program.

Investigative questions

The study will try to answer the following questions:

1. Have the participating countries succeeded in formulating common requirements for the weapon system being acquired?
2. Have the process and the organizational arrangements that nations have followed to set up the program been

effective up to now in order to ensure that performance, schedule and costs requirements will be met?

3. Has any of the partners presented, at any stage of the program, any argument or claim which can be reasonably identified as based on individual economic or political interests that has caused, or could have caused, a major impact in the program?

Definition of terms

For the purpose of the study, the following definition of terms apply:

Cooperative Project

> One in which two or more NATO member countries agree to share the costs of research, development, testing, evaluation, and joint production of a weapon system in order to further the objectives of standardization and interoperability. (19:2-26)

Standardization

> The process by which member nations of NATO achieve the closest practicable cooperation among forces, the most efficient use of research, development and production resources, and agree to adopt on the widest possible basis the use of: a) Common or compatible operational, administrative and logistics procedures, b) Common or compatible technical procedures and criteria, c) common or compatible/interchangeable supplies, components, weapons or equipment, and d) common or compatible tactical doctrine with corresponding organizational compatibility. (18:1-4)

Interoperability

> The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them to operate effectively together. (18:1-5)

Major Impact

Inability to agree on common requirements, the establishment of an adequate program management structure or industrial arrangements for the program, a significant deviation from the initial agreement on requirements, or a cost increase or schedule slippage as high that the viability of the program as it was intended is in risk, or effect such as: a) one partner quitting the program, or b) breaking the existing agreement on common requirements to such extent that interoperability of the weapon system among the forces of the participating nations is not achieved.

Summary

After more than thirty five years of effort, and despite the cooperative programs undertaken up to now by NATO members, there is still controversy about the benefits of cooperation, and the main problems to cooperative acquisition programs are still political and economical, besides the difficulties to agree on common requirements.

The study analyzes the evolution of the EFA program to find whether it has faced the same kind of problems and what their impact has been up to now.

II. Methodology

Introduction

The general method has been a literature research covering the history of the EFA program relevant to the thesis topic, as well as a review of literature related to problems encountered in the past in cooperative major programs, problems to which the study on the EFA program is related.

The mentioned review has been based in existing reports and studies on past programs and cooperation issues within NATO, and has provided a reference point for the study. The research on the EFA program itself has covered its evolution from its first milestone, the Outline European Staff Target (OEST) of December 1983, and has been directed to identify the main decision points, requirements, organization, and political or economical issues to which the program has been subjected up to now.

On the basis of the above research the relevant information has been summarized and analyzed in an attempt to answer the research problem. Due to the nature of the study no quantitative measurement method has been found to be applicable for any of the investigated topics, and no statistical or quantitative type of analysis is made in the present study.

Justification of Method Selected

The methodology chosen has been considered appropriate due the fact that most of the relevant political, industrial or economic issues related to the EFA program have usually found echo in open professional publications and in most general media, and non-classified data on topics such as the program management organization structure, or the general common requirements for the EFA, have been also available.

The kind of information that can be gathered in such a way is then considered relevant to the research question and representative enough to get an indication of the existence of the kind of problems or issues on which the study is focused, as well as of the major impact that these may have had in the program.

Research Methodology

The particular method has been the following:

1. Review the available literature related to past programs, in an attempt to validate the conclusions found in most sources about the main problems encountered in cooperative programs, on which the study of the EFA program is focused.
2. Review the available literature about the EFA program in order to identify the key decisions and agreements that gave birth to the EFA program, the overall requirements and the management structure set

up by nations, and the key events related to the program progress.

3. Identify the issues relevant to the investigative questions that the nations have been facing up to now, and the impact they had in the program.
4. Classify them according to their nature in relation to the investigative questions (common requirements, economic, or political issue), and to the impact they had in the program, namely major impact, threat of major impact, and no major impact.
5. Summarize the results and draw conclusions.

Summary

The general method has been a literature research of the EFA program evolution up to its present stage. From the available data the main decisions and agreements that gave start to the program, the management structure, the issues of political or economical nature beyond the natural scope of the specific economic or technical aspects of the program, and those related to the agreement on common military requirements for the weapon system have been identified.

The analysis has been done by classifying the issues which caused, or could have caused, a major impact on the program according to their nature. No statistical methods have been used to perform the analysis.

Finally, the information obtained was summarized and the necessary conclusions drawn in an attempt to answer the stated research question.

III. Literature Review

Introduction

Collaborative programs are never easy. Some of the past experiences show how the initial number of partners in some programs went down significantly at the end, costs increased as much as 100% of the initial estimates, standardization goals turned out to be destandardization results, or programs were cancelled simply because the partners were unable to overcome the difficulties. Not surprisingly, feasibility of standardization in NATO and benefits of collaborative acquisition have often been negated by some authors because of so many examples of undesired results.

Collaborative efforts among NATO members still continue in spite of the obstacles. This chapter reviews some of the available literature in order to get a reference on the kind of problems commonly found in collaborative acquisition programs, as well as to provide justification for the problem statement made in Chapter I.

Standardization and the Need for Cooperation

Cooperative efforts in the acquisition or production of conventional weapons or equipment have been pursued by NATO members for more than thirty five years, but it was in the mid-1970s when true emphasis on equipment rationalization, standardization and interoperability (RSI) really came up, mainly by U.S. initiatives. By 1982, and under the RSI

policy, the U.S. and 11 NATO countries (Canada, Germany, Italy, the United Kingdom, Norway, the Netherlands, Portugal, Belgium, Denmark, France, and Turkey) had agreed to promote (75:2):

- Greater cooperation in research, development, acquisition and production;
- The most rational use of respective industrial, economic, and technological resources;
- The greatest attainable military capability at the lowest possible cost;
- Greater standardization and interoperability of their weapons systems.

Cooperation among all NATO members and sharing of R&D and production costs are viewed as "the most cost effective way possible to provide for the common defense" (57:150). Lack of cooperation, according to former U.S. Deputy Secretary of Defense William Howard Taft IV, has had negative results for the Alliance, like wasteful duplication of R&D and weapons production resources that have precluded the economies of scale that could drive down unit price of weapons, and overreliance on national resources, which has created problems in standardization and interoperability of equipment that "seriously hamper the NATO coalition warfare capability" (57:150). Thus, benefits of cooperation should be cost reductions because of economies of scale resulting from larger production runs and better use of available resources.

However, most multinational programs undertaken with standardization purposes have presented problems and many of them have failed not only in terms of cost and schedule, but also in terms of the standardization level achieved at the end of the program.

National policies and economies, difficulties in program management, and lack of agreement in military requirements seem to be the reasons. Apparently only the political will of the nations can overcome the problems, according to some authors.

Approaches to Standardization

Standardization may be pursued in different ways, but there are two main approaches: the first is the direct purchase from the producing country by other NATO members, and the second is any type of arrangement between countries to produce or acquire the weapon system or item in a cooperative way.

In general, a NATO cooperative project is defined as "a jointly managed arrangement which is undertaken to further the objectives of standardization and interoperability within NATO" (19:3-19). This definition is broader than the one stated in Chapter I, and it is used here because of its clear reference of the theoretical goal moving cooperative efforts among NATO members, though reference to cost reductions as another objective appears to be missing. Although different terminology and classifications may be

used, the basic approaches are direct purchase, competitive R&D with licensed production (coproduction or dual production), cooperative R&D with licensed production, and interdependent R&D with licensed production.

Direct Purchase. The direct purchase is considered the best approach in terms of military effectiveness and cost savings (29:25), one in which no duplication of R&D efforts exist and where economies of scale are possible, mainly if the producing firm gets contracts (from foreign countries and hopefully from its own national services) that allows for the production of large quantities of the system. It has disadvantages for the customer, as it is recognized in most sources, for it does not provide any benefit on national employment, impinges on the balance of payments, and causes customer forces to rely on foreign sources for logistic support (29:25).

The existence of direct offsets may classify a direct purchase as a "cooperative" effort. Offsets, either direct (those related directly to the purchase, in the form of licensed production or subcontracting in the customer country of some parts or components of the acquired weapon) or indirect (not directly related to the purchase, like countertrade or investment agreements), are usually employed as a compensating mean to address the indicated disadvantages, and have become almost a necessity for any military sale. As much as $34.8 billion were accounted in offset agreements concluded between 1980 and 1987 for U.S.

armament sales to other countries, as reported by a federal interagency group chaired by the White House Office of Management and Budget (65:45).

Offsets may, on the other hand, prevent economies of scale when coproduction is involved and lead to cost inefficiencies and a loss of quality (29:26).

Competitive R&D with Licensed Production. This is a compromise between the direct purchase and separate national programs (29:27). Production of the weapon system is undertaken in cooperation, either by coproduction (when each of the partners produces a part of the system and all of them cooperate in final assembly) or dual production (when each of the partners produces the whole system and assembles it independently of the others) after a selection among competitive systems (for which R&D has obviously been already made separately). The approach does not avoid duplication of R&D and, according to sources, is considered inefficient in terms of cost savings. That is probably the case for the criticism about the F-16 purchase and coproduction by some European countries. On the other hand, although it eliminates the problems associated with the direct purchase, coproduction does involve others, mainly technology transfer issues due to industrial and security concerns and possible restrictions on exports to other countries (29:27).

Both the direct purchase approach and the competitive R&D with licensed coproduction or dual production are

claimed to be the ones that yield better results in terms of the level of standardization achieved. However, standardization may be hampered in any case when the buyer undertakes changes in the system to fit the requirements of its own particular force, or when technology transfer issues prevent the customer force from keeping the same weapon system configuration.

Cooperative R&D with Licensed Production. In this approach two or more countries team up to design and develop a common weapon system. It is the kind of cooperation that has been most used among European countries, and according to Richard C. Fast it entails economic benefits, but it offers little promise of success (29:27). The problems that he mentions in his work are summarized in the following:

- The difficulties in achieving agreement on requirements and doctrine during the design phase
- The increases in cost and time associated with cooperative programs
- The practical limit in the number of participants
- From the U.S. perspective, the necessity for integration of the European industry before such cooperation is feasible

Interdependent R&D with Licensed Production. This one is directly related to the "family of weapons" concept. The concept calls for the NATO nations to split responsibilities for some particular family of weapons, and charge different members (or group of members) with the design and

development of a particular member of the family, making the product in each case available to all other NATO members. The classical example is the case of the air-to-air missiles, split into short, medium, and long range.

The advantages of this approach were thought to be the savings in R&D and the elimination of the problems associated with the cooperative R&D approach, though it does not avoid the inefficiencies of subsequent coproduction. It has, on the other hand, inherent problems due to the lack of competition implied in that kind of responsibility assignment, with direct effects on national industries, the need to reach an agreement on the requirements for the family of weapons, and uncertainty about the future desire of the forces involved to actually acquire a particular member of the family of weapons for their inventories. It also implies the agreement of NATO members to not compete in one particular area assigned to other members.

All of these approaches fall under the definition of Cooperative Project, and even the direct purchase may also be considered as such as long as it involves significant direct offsets, mainly subcontracting and coproduction of parts or components. However, in terms of the degree of collaboration, only the last three should probably qualify as "cooperative" in a proper sense and according to the definition in Chapter I. In reference to the focus of this study, as it will be seen in following chapters, the EFA

program falls within the third category: cooperative R&D and licensed production (dual or, better, multiple production).

Drawbacks to cooperation. A Survey of Past Experience

Because NATO has no powers over the members' governments, the building and supporting of forces is the responsibility of each and every nation. With the exception of some specific aspects of communications, airborne detection and warning systems, and infrastructure, NATO has no direct involvement in R&D or production of weapon systems (54:179).

Cooperation is then a process that need to be pushed jointly by all Nato members, as was pointed out by Jan Van Houwelingen, State Secretary for Defense of The Netherlands, at the ComDef exhibition in 1987: "Armaments cooperation can only work if there is the long term political and economical will to do so" (53:49). This was the conclusion reached in mid 1981 by Richard Charles Fast (29:588-599) in his study on NATO standardization, and both political and economic issues appear in most sources as the main reasons for the failure of cooperative programs in the mid '50s and '60s, as well as the difficulties to agree on common requirements.

Among other sources, several reports have been consulted related to past cooperative programs, in an attempt to validate in some degree those conclusions for the purpose of this study. The reports and other sources

covered programs like the European anti-submarine patrol aircraft Breguet 1150 Atlantic, initiated in 1956 with 14 countries interested, the French-German air transport Transall C-160 , the NATO main battle tank MBT-70 and the U.S. competition between the U.S. XM-1 and the German Leopard II tanks, the acquisition by the U.S. of the French-German Roland surface-to-air missile, the F-16 coproduction in Europe, and the purchase by Spain of the U.S. EF-18. References to the overall results of other cooperative programs like the MRCA Tornado built in cooperation by Germany, the United Kingdom and Italy, and the Alpha Jet between France and Germany have been also available.

Of all the cases included, a majority, according to the consulted sources, have been considered as a failure in terms of the standardization level provided. Some of them were cancelled for various reasons, and almost all of them did not meet the expected cost reductions. Others such as the F-16 coproduction, the procurement of the U.S. EF-18 by Spain or the Alpha Jet and Tornado programs are viewed as successes.

The Breguet 1150 Atlantic. This may be considered as a "quasi" cooperative R&D with licensed production case, in the sense that it was more a French driven program than a cooperative effort, despite the initial cooperative intentions of the partners. The program was plagued with political issues and industrial nationalism (48:28), and it is referred to as the "greatest achievement and the most

disturbing failure" by some sources (48:26), an indication of the difficulties it had to overcome to survive as a cooperative program, survival that may probably be viewed as a "success," even though the program eventually failed to achieve its objectives. From the beginning 14 nations, only 2 ended up buying the aircraft; cost overrun was estimated a 65% and schedule slippage at 17%.

The C-160 Transport Aircraft. An even worse result was that of the C-160 transport, another case of cooperative R&D that ended up with a 100% cost overrun and a delivery schedule twice as long as predicted. The burden of political and industrial factors was "overwhelming" (48:47), and the program was mostly driven by the lack of agreement on requirements, employment and industry policies, and management problems.

The F-16 Coproduction. In the F-16 case, the co-producing nations have accepted an extra cost around 34% to acquire the aircraft, according to almost all sources.

That figure cannot be used to disqualify the success of the program, since it is probably outweighed by the benefits that coproduction provided for the industries involved, level of employment, technology transfer, military capability and standardization (58:9), though these are difficult to measure. Increased monetary cost is a consequence of the differences of industrial settings at both sides of the Atlantic, different work force policies and manufacturing methods (58:4).

In any case, the coproduction involved a higher cost, and considerations about benefits to the countries involved are always of political or economic nature (benefits derived from the program and realized by industry or the general economy of the countries involved, but not by the acquisition program itself in terms of cost savings or better use of resources), and they might probably be applied to almost any program to counter-balance cost increases.

The Purchase of the EF-18 by Spain. The procurement of the EF-18 by Spain is a direct purchase with offsets. Even though other competitors were present, and that the direct offsets package involves subcontracting and coproduction of some components of the aircraft and support equipment, it is not viewed in this study as a case of competitive R&D with licensed production. The selection was driven by performance requirements and the negotiation of offsets, and as indicated, it is considered a success in terms of cost stability and schedule, and a model in terms of the offset package (50:1693).

The MBT-70 Battle Tank. The attempt to develop a common NATO main battle tank, the MTB-70, between U.S. and Germany was also a failure mainly due to impossibility to agree on common requirements. Further problems arose when differences in industrial practices and capabilities between U.S. and Germany began to impose a burden on the program, till it reached a point in which the effort was cancelled.

In the meantime, competition between the XM-1 and the Leopard II in the U.S. has been qualified as fiction by some sources (29:301). The competition was undertaken under the "two way street" philosophy, but it appears that the U.S. Army opposed the German tank from the beginning because it did not meet its requirements and because they did not want a foreign major system, like a tank, in its inventory. Both attempts, the first as a cooperative R&D case program and the latter as competitive R&D case were a failure.

The U.S. Roland. The procurement of the French - German short range air defense missile Roland by the U.S. is considered a success by some of the proponents of standardization (29:372), and a complete failure by others. As a case of competitive R&D and dual production, "the entire history of the system has been one of controversy, ranging from tremendous cost overruns to accusations that American industry and military interests have sought to sabotage the system" (29:372).

The U.S. Army began thinking in modifying the system from the very beginning, as soon as the decision to buy the Roland was made. The "americanization" of the system in the U.S. was not only in detriment of the supposed standardization, but also caused costs overruns and delays to field the systems. Because of the modifications undertaken and because of the subsequent intent to achieve again commonality with Europeans, more R&D dollars were spent in a system that had already been developed, making

the supposed savings in R&D unreal. Program costs rose from the January 1975 estimate of $1.3 billion to $2.4 billions in June 1979 (29:446). After the Army acquired the Rapier from U.K. and the authorization of funds for the improvement of the U.S. Chaparral was released, the Roland did not provide much standardization improvement.

The purchase itself is viewed more the result of the U.S. government will to demonstrate that the "two-way" street was really working in both directions, one in which the Army was forced to choose a foreign system against its will while simultaneously allowed to "redesign" it to meet its requirements. In the U.S., the problems faced by the Roland apparently "provided ammunition to opponents of further purchases of European equipment" (29:372).

The Alpha-Jet and the MRCA Tornado. Both programs are considered successful examples of cooperation among European NATO members, and they are also viewed more as an expression of one European strategy to consolidate the defense and aerospace industry (48:6-12) than a truly intent to achieve any greater standardization.

In the Tornado case, on the other hand, the program ended with fewer partners than it started with, and the aircraft, because of the broad requirements imposed to satisfy everybody, became much more complex and expensive than it was intended (29:28). A cost overrun of 17% and a program slippage of three and a half years have been reported (17:20), as well as shortages in supplies during

the initial operational stages. On the other hand, in 1986 the General Manager of NAMMA (NATO Agency for the development and manufacture of the Tornado fighter aircraft) claimed a unit price for the aircraft of DM43 million, instead of DM46.5 million, the predicted unit price at the early 70s (42:65).

Cooperation Between U.S. and the European NATO Countries.

The obstacles to cooperation have been experienced more in attempted collaboration between U.S. and European NATO members than among European members themselves. Greater differences in political views and in industrial capabilities, and the introduction of technology transfer issues pose a different dimension.

On both sides of the Atlantic proposals like that of Democratic Rep. Mary Rose Oakar of Ohio requiring that all weapons, parts, and components be made in the U.S. within five years of the legislation becoming law, and that of the European commission to collect tariffs on defense goods imported from outside the European block (41:29) show the traditional problems to the transatlantic collaboration.

The main obstacles found to cooperation between U.S. and its European NATO partners have been repeatedly expressed in many instances: The fact that all countries want to maintain their R&D base "as an integral part of their sovereignty" (4:107), the U.S. fear to lose first technological place through unavoidable technology

transfers, and European countries fear of being "dominated by U.S." in technological aspects, which is considered detrimental to European development (4:108). Export of U.S. items produced in Europe, if some sensitive transfer of technology has been made, may be limited because of U.S. restrictions. Technology transfer issues, though accepted in a general sense by partners, may cause major frictions because they may really hamper the achievement of a standard weapon system, and because restrictions may be viewed as lack of commitment to the program and to the allies (60:14), or as a commercial weapon (27:66).

It appears that under the particular problems there are some broader issues of entirely political and economic dimensions. It is worthy of noting them, so that the U.S. approach to the EFA and some of the reactions to that approach can be understood. These are what we may call European and U.S. concerns:

European Concerns. These are the European desires to balance the U.S. favorable armament trade balance and ensure the technological and industrial competitiveness in the international armament market and its own defense capabilities. It is good to remember at this point some of the recommendations made by the "NATO Independent Defense Study Team" appointed by the European defense ministers in 1985, in relation with the actions to be taken in order to reinforce the industrial and technological capabilities of the European countries (30:18):

- Create a common European arms market.
- Buy European, even if similar weapon systems are cheaper in the U.S.
- Buy the least costly bid. Open the defense industry to market laws.
- Form competitive consortia.
- Arrange fixed price contracts as a general rule to develop and produce armaments.
- Provide a common fund for R&D of $114 million.
- The Independent European Planning Group (IEPG) should establish a permanent Secretariat to oversee common programs and maintain a central register of all military procurements open to bids.

The recommendations were made in cooperation with the IEPG, a NATO group in which the U.S., Canada and Iceland are not present. For some analysts, "coproduction was only a one-way street, and U.S. offers to build U.S. developed systems didn't do any good" (17:20). In relation with the IEPG and the U.S. restrictions, the message was clear at that time: "the activity of the IEPG indicates that European are frustrated with some of the constraints..." (17:24).

Export of U.S. technology incorporated in a weapon system built by a European country to another European country within the Common European Market (CEM) gives another dimension to the issue, since there should be no export restrictions inside the CEM. The U.S. restrictions

on technology transfer would be in conflict with the CEM regulations, or they would cause a situation in which the free trade within the CEM would be distorted. This political dimension of the problem (or its purposely politization by the Europeans) is indicated by the resolution of the European Parliament in 1986 directing the European Commission to investigate whether "the last U.S. Export Administration Act eliminates the conflict...," threatening to rise the case to the European Court of Justice (27:66). Among other things, the resolution accused the U.S. of exceeding the provisions of the COCOM (Coordinating Committee on Multilateral Exports Controls) and stated that "the best insurance against unilateral restrictions on the transfer of technology is a Western Europe that also has a great deal to offer to the U.S.." The alternative (to a technologically independent and competitive Europe), is a European Community "that will become increasingly politically dependent and vulnerable because of its technical dependence" (27:66).

U.S. Concerns. The U.S. commitment to maintain an strong domestic industrial base to support their military forces and to avoid any significant dependency from foreign sources has direct implications on the U.S. acquisition policies (the one-way street). Of the same importance is their commitment to keep technological superiority over potential threats and the consideration of military sales as an integral part of its international policy (the fact that

an armament sale is a consequence or reflection of the receiving country being considered a "friendly" country, as opposed to the recommendation of the European group to open the arms industry to the market laws), which affects directly the U.S technology transfer policies.

The "buy - American" syndrome, as it is called by some authors, is only a reflection of the foregoing idea. Defense economics and national pride appear perfectly mixed in the so-called "syndrome," which has a genuine representative in the comments that Mr Stanley Sloan, U.S.-NATO relationship specialist within the U.S. Congressional Research Service, made in 1985 in relation to the possibility of the U.S. changing towards an actual "two-way" street:

> More European that will cut into U.S. European coproduction of U.S. American systems.....will be bought perhaps just for the sake of buying European, not necessarily because they are better than competing American products. (17:26)

The syndrome is not an exclusive U.S. property, as it is reflected by the IEPG recommendations, and the resulting consequences for the cooperation between the U.S. and Europe are reported in many sources. U.S. officials argue about the savings that NATO countries could have achieved by buying upgraded American fighters instead of building the EFA, but that method is clearly not preferred by European countries.

Conclusions

From the previous review, the current controversy about the benefits of cooperation seems supported in the same terms that is usually stated in most sources: If there are problems for multinational cooperation, it appears that political differences or national pride (like the leadership issue or resistance to procure a major weapon system from a foreign country), national interests in industrial or technological fields with a higher priority than the common objective of standardization, and difficulties to agree on common requirements, remain to be the real problems to overcome. Along with differences between industrial capabilities, they easily outweigh the benefits of cooperation and make standardization a debatable issue.

On the other hand, it appears that in successful programs, either those obstacles seem to be absent (or at least present at very low intensity), or there has been an strong political will to overcome the difficulties by all the parties involved.

This said, it is necessary to note that a "successful" program is always difficult to define. The term is used here to mean that the program actually went ahead and appeared to fulfill the intended standardization objectives. It also implies that it had no overwhelming cost overruns or schedule slippage. As it is pointed out by J. Ronald Fox referring to U.S. acquisitions:

> Notwithstanding the large budget increases in recent years, major defense programs have repeatedly experienced significant schedule delays and cost increases. Schedules have been extended by about 33 percent in approximately one-half of the programs. Again, more that nine in ten programs exceeded initial cost estimates, and the average increase in cost for the majority has been more than 50 percent, excluding the effects of quantity changes and inflation. (33:33)

Cost overruns and schedule slippage are not then any distinctive trait of cooperative programs, and they cannot be used as argument per se to disqualify a multinational acquisition program. On the other hand, it appears that only economies of scale resulting of large production runs remains as the ground behind the pretended cost savings, something that is not only becoming a memory of the past even with the U.S. services as customer, but that is violated as soon coproduction or dual production appears on the scene.

IV. The EFA Program

Antecedents and Major Milestones

The European Fighter Aircraft origins can be found back in the '70s and early '80s, when individual European air forces began planning replacements for their existing aircraft in the late 1980s and beyond. At that time, aeronautical industries were also planning for possible orders in the same timeframe, to provide work beyond the Tornado and Mirage 2000 (5:147). Services and industries were trying to develop concepts and designs, and projects like the British AST.396 and AST.403, intended to replace the RAF Jaguars in the offensive support role, the German TKF to replace the F-4C/RF-4E, or the ACT to replace the Jaguars in the French air force were undertaken.

The need of a future combat aircraft was first mentioned, as a European concept, at the "Colloquium on a European Armaments Policy" that took place in Brussels in October 1979 (71:475). In the late '70s, the British AST.403 was the base for conversations between Great Britain, France and Germany on what was called ECA (European Combat Aircraft), a joint project that ended without any agreement, mainly because of the impossibility of marrying the different requirements of the three Air Forces (5:147).

Industry had been also making its own efforts, and by 1980 Dassault-Breguet began the ACT-92 project (that lead to the ACX and later developments, and eventually to the

ACT/ACM Rafale), Messerschmitt-Bolkow-Blohm GmbH (MBB) the TKF-90 and British Aerospace (BAe) the P.110.

In April 1981, during the celebration of the 27th session of the Western European Union (WEU), the need of a combat aircraft to replace the inventories of the European air forces in the mid 1990s came up again, and a recommendation was made to Germany, Great Britain and France to study that possibility in a joint manner (71:476).

In the meantime, the industrial side had continued its own projects (and had pressed the governments for funding), and by 1982 BAe, MBB and Aeritalia (AIT) evolved a joint design, the Agile Combat Aircraft (ACA). The ACA project was not properly funded, and it never passed the mock-up stage. Eventually, in Great Britain, BAe succeeded in getting government support. In September 1982 the British MoD announced a jointly funded project, the Experimental Aircraft Programme (EAP) in which the MoD would bear half of the costs, and industry (BAe as the main contractor) the other half (5:148). The contract was signed in May 1983, when it was expected that Germany and Italy would join the program.

None of these two governments did that, but both MBB and AIT participated in the EAP through private arrangements. AIT completed its work share (wing leading edges and one wing), and MBB withdraw from the venture in 1984 mainly due to pressures from German government once the EFA program was on the road (52:120). At the end, the EAP

would become the experimental design for many of the concepts and technologies to be used in the EFA, and as such is now funded in part by the EFA partners. But at that time, the idea of a combat aircraft developed in cooperation among the nations was already in place, because of the costs and difficulties that governments and industry had realized while trying to accomplish individual projects.

From that time, the key milestones in the EFA program can be summarized in the following agreements and decisive events:

- Initial meeting by representatives of the air staffs' planning divisions of Germany, Great Britain, Italy, France and Spain in Paris in April 29 1983 "at colonel level" (5:147), in which they reached a first agreement on the idea of a multinational fighter development and paved the way for a further meeting at a higher level.
- Approval by the Chiefs of Staff of the five nations of the Outline European Staff Target (OEST), a first short statement of the operational requirements) for the Future European Fighter Aircraft (FEFA) (or Futur Avion de Combat Tactique for the French) in Cologne in December 1983. At that time, the basic idea that the aircraft had to respond to "common" requirements to be agreed by the participating nations had already been reached, as well as a first outline of those in terms of timeframe, weight, powerplant and main role of the EFA (71:476). This decision led to a pre-feasibility

study to be completed in the early months of 1984.

- The Ministerial Resolution of July 1984 in Madrid, by which the five Defense Ministers agreed to go ahead with a formal feasibility study (26:1003). Compromises were also reached at that time in basic requirements (in service time of mid '90s, 9.5 tons of weight, two engines of 20,250 lb thrust each, wing area of 538 sqft, span of 34.44 ft, and leading edge unkinked and swept back 53 degrees). French and British requirements differed mainly in the weight and role of the future aircraft, powerplant and in-service time, and major discussions had already risen because of French claims of project leadership. Also, the FEFA name was changed to EFA.
- The signing by the Chiefs of Staff of the final European Staff Target (EST) in October 1984 in Rome. At that time, the potential market for the EFA was estimated to be about 1000 aircraft, with a share of 24.5% for Great Britain, Germany and France each, 16.5% Italy, and 10% Spain (5:148).
- The Turin agreement of August 1985, by which the Defense Ministers of U.K., Germany, and Italy decided to launch the program, and invited France and Spain to formally join them in the project. Spain confirmed its participation later that month, but France declined. The Turin agreement meant the formal birth of the EFA program as a four nation cooperative effort, and France

departed to continue with the Rafale as individual project. It also ended a long dispute on the basic characteristics of the EFA (main role and weight) that had caused Germany to announce its withdrawal of the program, just before the meeting, if an agreement was not reached (38:181). Attempts to reach an agreement had involved top level military and political negotiations in which, in the early 1985, broader strategic issues had been brought into the discussions by France, according to some sources (overall French-German military cooperation and the possibility of France providing a nuclear "umbrella" over German territory) (38:181). The requirements did not change from what had already been decided in Madrid, with the exception of the weight limit, that was fixed at 9.75 tons for fear of not meeting the EST. The final share on the program was fixed on 33% for Germany, 33% Great Britain, 21% Italy and 13% Spain, for a total of 760 EFAs (250 U.K. and Germany each, 160 Italy and 100 Spain) (5:149).

- The signing in December 1985 of the European Staff Requirement (ESR) by the Chiefs of Staff of the four nations, which detailed the agreed operational requirements for the validation phase of the program (5:150).
- The "way ahead" document of May 1986, in which the four nations agreed to proceed to the next phase

(definition) once the feasibility report was made available. An increase in the maximum weight to 9.892 tons was also agreed at that time to provide for follow-on growth capacity (71:477).

- The agreement of the European Staff Requirements for Development (ESR-D) in January 1987. The definition phase had already finished, but industry was at that time completing studies for what was called the refinement and risk reduction phase (what may be considered equivalent to a validation phase), which ended in December. The formal signature of the ESR-D was made by the air force chiefs of staff in Madrid in September that year (5:150). The share of the development costs was confirmed as 33% for Germany and the United Kingdom each, 21% Italy and 13% Spain.
- The signing of the development contract in November 1988 (51:95) once the risk reduction phase ended and each nation had completed the internal administrative and political process to commit the funds for the full development phase. The Memorandum of Understanding (MOU) to proceed to Full Scale Development (FSD) was signed initially by the Defense Ministers of Great Britain, Germany and Italy on 16th May 1988, with the understanding that Spain could sign later (5:151). Finally, Spain signed in November, after 5 months of delay because of uncertainty over its exact role in the production work share (67:1256).

The Requirements

The agreement on requirements has been one of the most lasting struggle through the EFA program development and shows the same characteristics as other past programs. Although the final EST signed in 1984 supposedly represented a final compromise among the nations, divergences seem to have been present until the issuing of the final ESR-D and during the evaluation of industry bids.

Differences existed because of the particular needs of each national air force and because national industries had been working on designs more or less tailored to those needs. It is worthy of note that some 1988 sources (5:155) report Great Britain still unclear about how the EFA is going to be employed and what current aircraft will the EFA replace, and that Germany was having difficulties in justifying the need for the EFA to overcome pressures due to budget constrains (13:693). From most sources, however, the initial need of the EFA was rather clear for the nations.

Great Britain. The British wanted an aircraft to replace the air defense Phantoms and the air-to-ground Jaguars (39:32), and accordingly they asked for an aircraft whose main role would be air defense, but they also wanted a very good capability for air to ground attack and able to operate from short airfields, since they had the air defense role covered with the Air Defense Variant of the Tornado (Tornado ADV). The British air force had fixed the basic empty weight around 11 tons, powerplant consisting of two

engines with at least 20,000 pounds of thrust, and wanted an in-service time around mid-1990.

France. The French wanted replacement for their Jaguar, (5:147) having already the Mirage 2000 for the air superiority role, and preferred a lighter aircraft of 8.5 tons with two engines of about 18,900 pounds of thrust, and an in-service time beyond the late '90s in order to avoid any interference with the Mirage 2000 exports.

Germany. Germany wanted replacement for its Phantom F-4F and RF-4E for the air-to-air role (5:147), and agreed with the British even though they did not emphasize the air-to-ground role as the British did. There were differences in weight requirements (the German air force wanted a slightly lighter plane than the British), but the agreement was reached with no significant problems. As it was shown later, the operational requirements imposed by the ESD lead to an upper weight limit of 9.892 tons, much closer to the British requirements than to the French ones.

Italy and Spain. Italy needed replacement for its F-104S and F-104G (5:155), while the Spanish Air Force had begun planning the replacement of its Mirage F-1 for a later timeframe. The Spanish air force did not have any specific requirements at that time, and the already purchased EF-18s allowed them not to press on schedules; in fact, the Spanish industry is working at this time in a separate project (the AX close support aircraft) which is intended "to meet the needs of the Spanish Air Force." (1:65). Both Italy and

Spain supported the British and German requirements rather than the French ones.

The Agreement. The compromise was agreed with no difficulty at the first meeting in Paris and in later discussions till the OEST approval in December 1983. A basic weight of 8.5 tons, air-to-air main role, and some other basic characteristics were agreed. Some other features relative to external load capability, short field operation, and a basic layout of the avionics and radar system were also solved, but, as it was to be seen soon, this agreement was not going to last.

A new compromise was reached in Madrid in 1984 in which, although the British position was not totally accepted, weight, powerplant and in-service timeframe were fixed almost in the middle of British and French requirements, despite the U.K.'s insistence in that the EST requirements would not be possible with the agreed mass of 9.5 tons (5:148). In the meantime, the German Foreign Affairs Minister Hans-Dietrich Gensher, at the opening of the International Aviation Exhibition (ILA) at Hanover, made a call for cooperation as the only way for Europe "to master its own destiny" (45:860).

Interim powerplant, weight and work share, mixed with French claims of leadership in the powerplant development and in the program became the major points of friction. In June 1985, Breguet-Dassault made it clear that if the EFA program went ahead, the French company wanted leadership in

the program and a 46% share of the project (85:1125), something that BAe regarded as "unthinkable" (5:149). In relation with the leadership issue, it is worthy of noting the words of the General Manager of Avions Marcel Dassault at two different interviews, one in 1983:

> In order to define suitable program rules, it will be essential to abstract all "prestige" matters from the negotiations and to concentrate on the "reality of facts." This can only be done through in-depth discussions at the top industrial level. (34:57)

And later in 1985:

> Quite simply I think that if it is to be a delta aircraft, we started making one with the Mirage III in 1953; we have made the Mirage V, Mirage IV, the 2000 and the 4000. It is certain that the future aircraft will be a delta with a canard which, moreover, exists on the Mirage 4000, where we have learned how to use it. It is therefore quite normal that the manufacturing control goes to the engineers of this sort of aircraft.....Delta aircraft, that is what we know. (85:1125)

According to some sources, before the meeting in Rome many participants were expecting the worst (23:181). In fact, when in June 1985 the program was officially launched in August 1984 in Turin, France withdrew. French reasons centered on "design leadership, work share and technical grounds, including engine thrust, weight and emphasis on an air-to air fighter rather than an aircraft better suited to ground attack". The same source indicates that at that time Spain withdrew "to express political sympathy" with the French position (68:12), but refused an alternative full partnership in a French program (the Rafale) considering that the EFA would provide greater industrial benefits.

Actually, Spain did not sign the agreement in Turin, and its participation was announced by President Felipe Gonzalez after a Council of Ministers meeting at the end of the month (68:12).

From that point it seems that the agreed compromise has suffered no alterations up to now. However, following the Turin agreement, weight and radar selection have been matters on which there has been much debate.

In March 1986, some program officials viewed the British attempts to increase EFA weight beyond 9.75 tons as something that "could cause the project to collapse", and that the British were trying "to impose their original plan" (78:494). The problem was solved in the "way ahead" agreement, and weight was finally increased to a limit of 9.892 tons.

The difficulties to agree on radar selection have reflected the differences in the national initial requirements, and "the sorts of difficulties inherent in any collaborative programme" (61:108).

The German backing of the U.S. APG-65 derivative, the MSD-2000 (Multimode Silent Digital radar for the year 2000), proposed by the U.S. Hughes, German Telefunken System Technik (TST, formerly AEG) and Britain's General Electric Co. (GEC), stems from the fact that they do not require the level of radar performance that the British ask for their EFAs, since the threat and the role of the aircraft in central Europe will be rather different than what the

British need (61:108). Germany has seen no need to undertake the risk and costs involved in the development of the ECR-90 (European Collaborative Radar, based on the Ferranti developed Blue Vixen for the Sea Harrier update) proposed by Ferranti (U.K.), Siemens (Germany), FIAR (Italy) and INISEL of Spain, which was supported by all other partners in the program, and besides, they preferred the enhanced APG-65 for commonality with their F-4Fs (12:316).

On the other hand, the radar issue has put again into light the differences between European and U.S. defense, technological, and commercial interests. As stated by the British Ferranti in 1987 in a flyer distributed to the Paris air show visitors:

> Adoption of a U.S. radar for an essentially European program with all the attendant security and commercial problems must be a retrograde step as -unless radar technology is retained and supported in Europe- the future of the military aircraft industry must, in the longer term, be in doubt. A European radar is essential to the health of the European military aircraft industry. (62:145)

The German threat to go alone with a non-common radar for its EFAs, confirmed at a NEFMA meeting in December 1988 (16:248), was a disturbing factor with a direct impact in the ongoing work related to other offensive and defensive sub-systems in the aircraft. According to some sources, it put the whole program schedule (already with seven months slippage at that time) in jeopardy (61:108), and could have killed the program (21:313). Besides that, a different radar for the German EFAs would have violated the terms of

the MOU signed in May 1988 (16:248) by which the radar choice should be unanimous. The concern over the EFA future was reported in one of the sources, in July 1989: "with West Germany facing elections in 1990, EFA officials are anxious to settle the radar dispute as quickly as possible to prevent a possible West German pull-out of the production phase if the Social Democrats gain the office." (80:1346).

By February 1989 NEFMA instructed EUROFIGHTER to extend the deadline to make a recommendation on the radar till 28 April. In December, more than one year after the development phase went ahead, the MSD-2000/ECR-90 competition was still unsolved. Meanwhile, negotiations had been held at political level, including talks between U.K. Secretary of State for Defense, George Younger, and the German counterpart, Rupert Scholz, who agreed in early 1988 that the EFA radar would adhere to budget and time schedules and that it would not result in an uncommon solution (15:340). It appears that, during 1989, the possibility of a hybrid design between the two radars was also explored, though it was not considered feasible (2:1318). Finally, the ECR-90 was selected in early 1990 (64:49). Apparently, in addition to the U.S. restrictions on technology transfers related to the APG-65 derivative, Ferranti's economic problems (31:541) helped resolve the issue. The ECR-90 was selected after Britain's GEC buying of Ferranti's radar business (64:49), and, if previous arrangements do not change, TST (AEG) will be allowed to join the ECR-90 team

(10:7). It is significant that the final solution has provided a place for the main firms involved in either proposal, namely GEC, TST, and Ferranti

Though the ESR and the ESR-D have not been accessible for this study, the overall requirements were summarized in the presentation by MBB at the AIAA/AHS/ASEE Aircraft Design, Systems and Operations Conference celebrated in mid 1989. Main role will be air-to-air, with air-to-ground missions as secondary role; it can be noted that the British requirement for short field take-off and landing capability was finally included in the agreed requirements (84:2). The difficulties to agree on common requirements are reflected by the available literature in reports related to development of subsystem specifications, to consortia that have appeared to bid for them, or to problems in selection of the proposals. It appears that, with the exception of the radar selection, all others have been solved without much noise within the program or industrial management structure up to the Steering Committee, since no major echo has appeared in the available literature. In that sense, it can be said that, with the exception of the French case, the remaining partners have succeeded in formulating common requirements for the EFA.

As a summary, the consulted sources report disagreements or frictions in the following areas:

- EFA main role, weight, and powerplant. These are the main issues which together with the French claims of

leadership in the weapon system and engine, caused France to withdraw from the program.

- The radar selection between the European ECR-90 and the derivative of the U.S. APG-65 (MSD-2000), that according to all sources could have caused Germany to adopt a non- common solution for the radar, which, due to the impact in other major subsystems, could have had a negative effect in the interoperability of the EFA among the four nations. The ESR and ESR-D had been agreed well before, so it is not clearly the case of disagreement in common requirements. Instead, it probably reflects the existence of a compromise in the agreed requirements, compromise that Germany did not want to maintain against the specific ECR-90 option because of the particular interests of its air force (commonality with the F-4F) and the higher cost involved.
- The Infrared Search and Track (IRST) system. The IRST was required mainly as a passive target tracking by all the nations but Great Britain, who required it to perform as a FLIR (Forward Looking Infra-Red) system to be used as an aid for navigation, low altitude flight and ground attack, using the radar for targeting information (61:112). The agreement was that the system will perform as an IRST with a secondary FLIR capability, which at the end have resulted in extra design complexity, added cost and constrains in weight,

location in the airframe, and more functions in the head-up display.

- The Defensive Aids Sub-System (DASS). According to some scurces there had been no major disagreement in DASS requirements, but it "was felt" that the German Air Force would go alone with an AEG (joined with Elettronica of Italy) developed equipment, taking a non common approach in the EFA DASS (61:110).

Program Management

The formal management structure of the program was not established until 1 February 1987. During the early stages of conversations before December 1983, meetings intended to agree the basic common requirements were held by delegates of the five nations air staffs (what is referred in some sources at "colonel level" meetings). The EFA (FEFA at that time) was not still a "program," and the nations were only attempting to agree on a common development while proceeding individually with their own projects, even though industries had already begun collaborating across the borders.

In the meeting at Cologne in December 1983 an "experts working group" was formed that included representatives of the air staffs and armament directorates of each country, coincident with the approval of the pre-feasibility studies (36:501). This group acted as the only permanent body until December 1985, when the feasibility studies were formally finished and the definition phase of the program was to

begin, once the program had officially been launched in Turin. No formal industrial consortia had been formed for the studies. In the meantime, the defense ministers met at Madrid in July 1984, and agreed that the key positions in the management structure of the program would be shared equitably among the partners (26:1003).

During the definition phase the first directing body (the Steering Committee) was formed and had its first meeting in Madrid on 5 December 1985 (36:502). The Steering Committee has responsibility for the direction and control of the program, and meets at least twice a year. Below the Steering Committee a Board of Directors (BoD) acts with delegated authority, and it is also the working body of the former. The BoD has had meetings once a month during the definition phase (36:504). Working groups were also formed by the air forces with the main task of defining and agreeing the common requirements and all the aspects to be included in the future ESR. By May 1987 there were more than 30 working groups covering all the necessary aspects during that phase (36:503).

In 1986 the two main industrial consortia, EUROFIGHTER/ Jagdflugzeug GmbH and EUROJET Turbo Union were formed in order to integrate the industrial efforts in the main areas of development: airframe and weapon system integration, and engine. With France out of the program, EUROFIGHTER joined BAe, AIT, MBB/Dornier and the Spanish Construcciones Aeronauticas (CASA), the main contractors for the airframe

and weapon system integration, and EUROJET included Rolls Royce, MTU, FIAT Aviazione and the spanish Sener-PROP to develop the EJ200 Advanced Fighter Engine.

If EUROJET can only be viewed as an industrial team with the specific task of developing the EFA engine, EUROFIGHTER, as it will be explained next, has in fact established a formal management structure in which the four nation's main aeronautical industries are joined to coordinate all the industrial activities throughout the program, as the actual program office of the consortium, and to provide direct technical support for the nations.

The necessity of one organization to act as contracting agency and to manage the program during the development phase led to the consideration of three alternatives (36:503):

- Selection of one national organization to act as contractor on behalf of the four nations, which might be viewed as nominating one nation as the program leader.
- Creation of an independent organization, like NAMMA in the Tornado program, which implied a long delay due to the time needed to provide legal power for that organization to act on behalf of the four nations, and
- Creation of an organization chartered by NATO, which would shorten the time for acquiring that legal power.

The third alternative was chosen, and on 4 February 1987 the NATO Council approved the NATO status of the NATO

European Fighter Aircraft Development, Production and Logistic Management Organization (NEFMO). The Steering Committee and the BoD were included within NEFMO, and a Finance Committee, a Legal and Contract Committee and the NATO European Fighter Aircraft Development, Production and Logistic Management Agency (NEFMA) are also part of NEFMO.

The creation of NEFMO completed the establishment of the management structure, once an actual program office acting on behalf of the four governments existed, while the organization set up by the main consortium, EUROFIGHTER, remained as the contractors counterpart.

The different phases in the overall organizational arrangements are shown in Figure 1. Figure 2 shows the working groups existing during the definitin phase, and Figure 3 shows NEFMA down to Division level as of April 1988, before the development contract was signed. That structure is completed in each country with a Program Office located at armaments directorate level.

NEFMA. The main component of NEFMO is by far NEFMA, with the responsibility of managing the program, placing the contracts for the development and production phases, and monitor and control their execution (36:504). It is under the BoD control and has been coordinating the activities of all the working groups set up by nations (mainly with airstaff and technical members) during the definition phase.

The agency was established on a similar basis to the Tornado agency, NAMMA, in February 1987 (36:503) after the

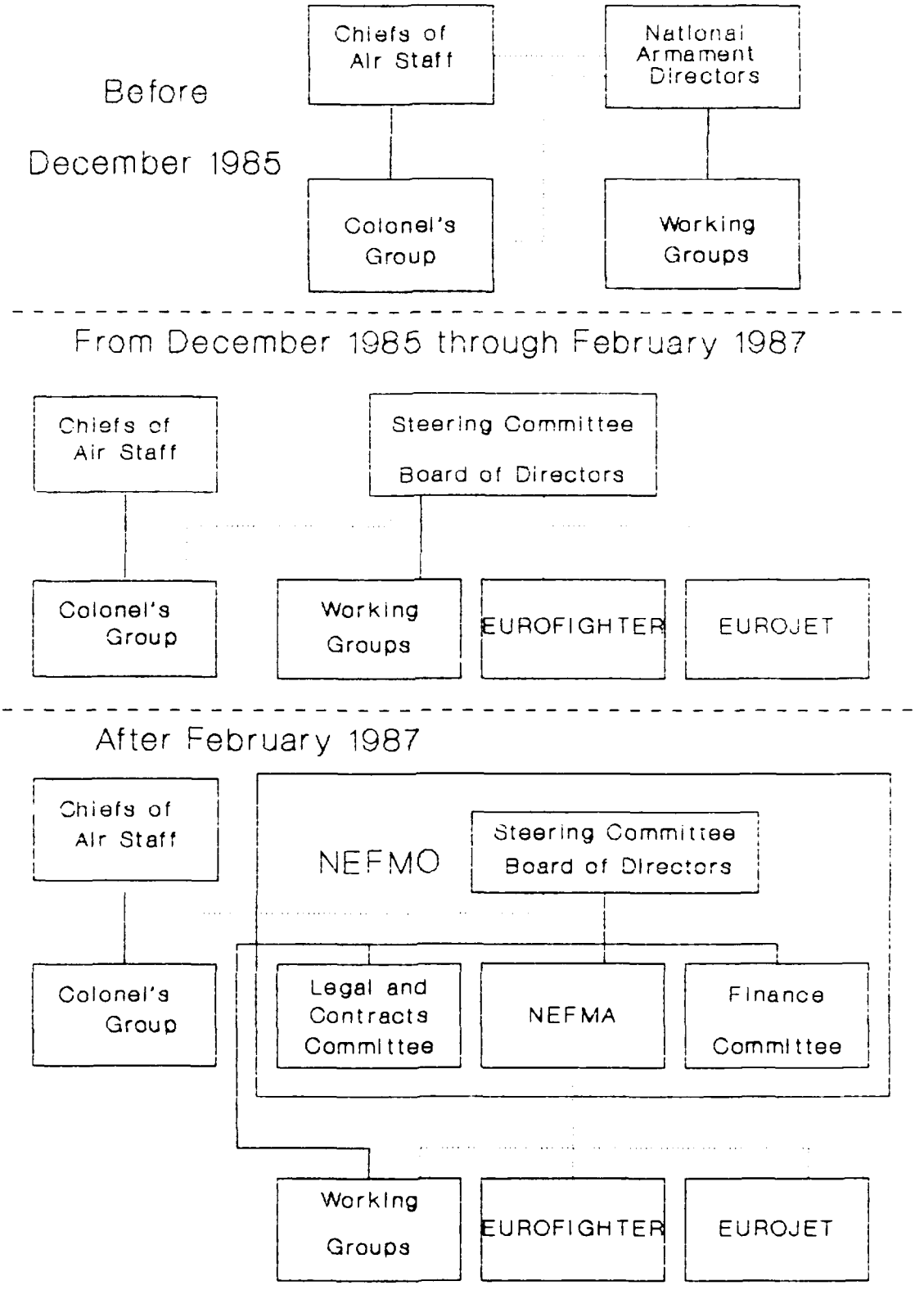

Fig. 1 EFA program organization phases (35: 502)

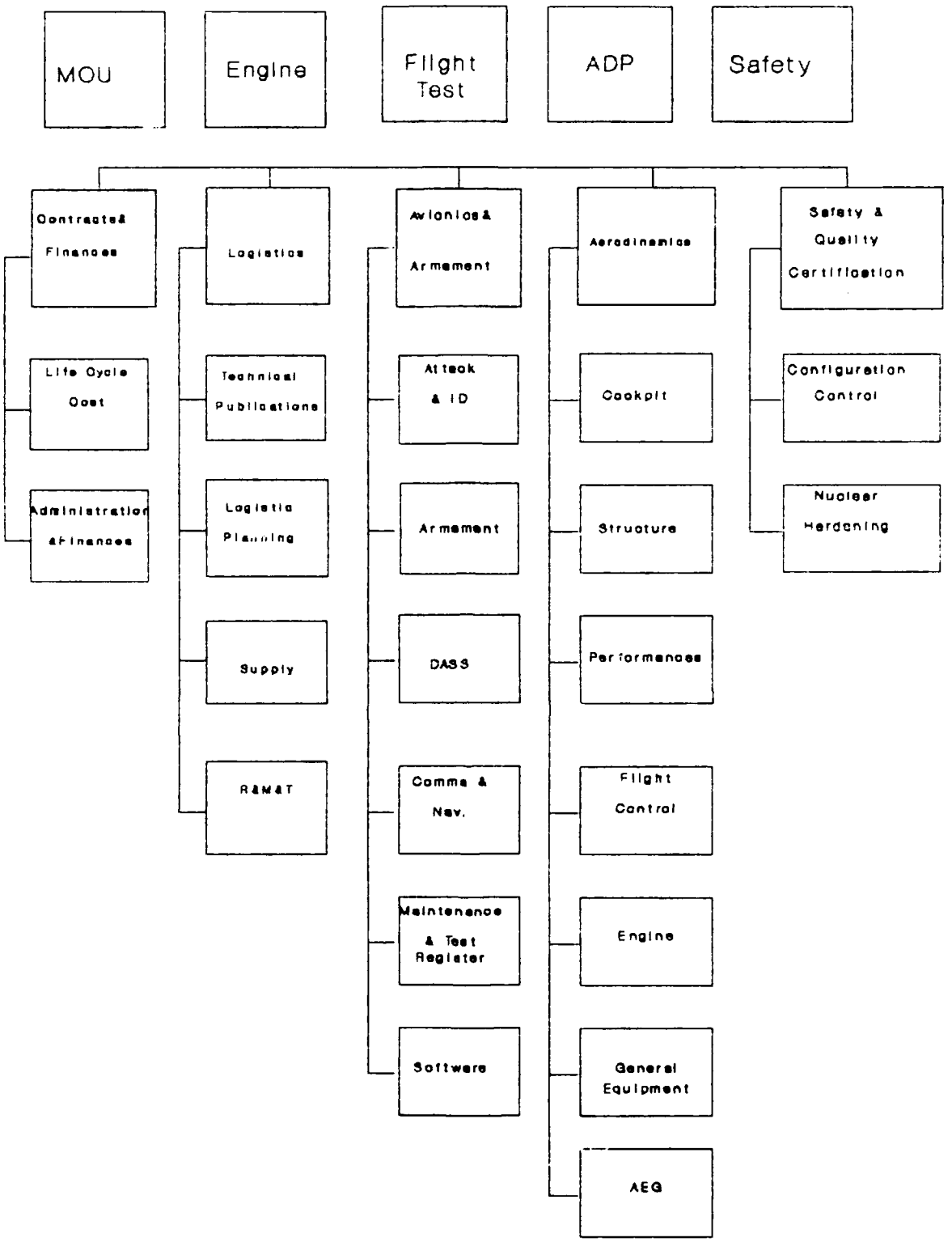

Fig. 2 Nations' working groups during the definition phase (35: 504)

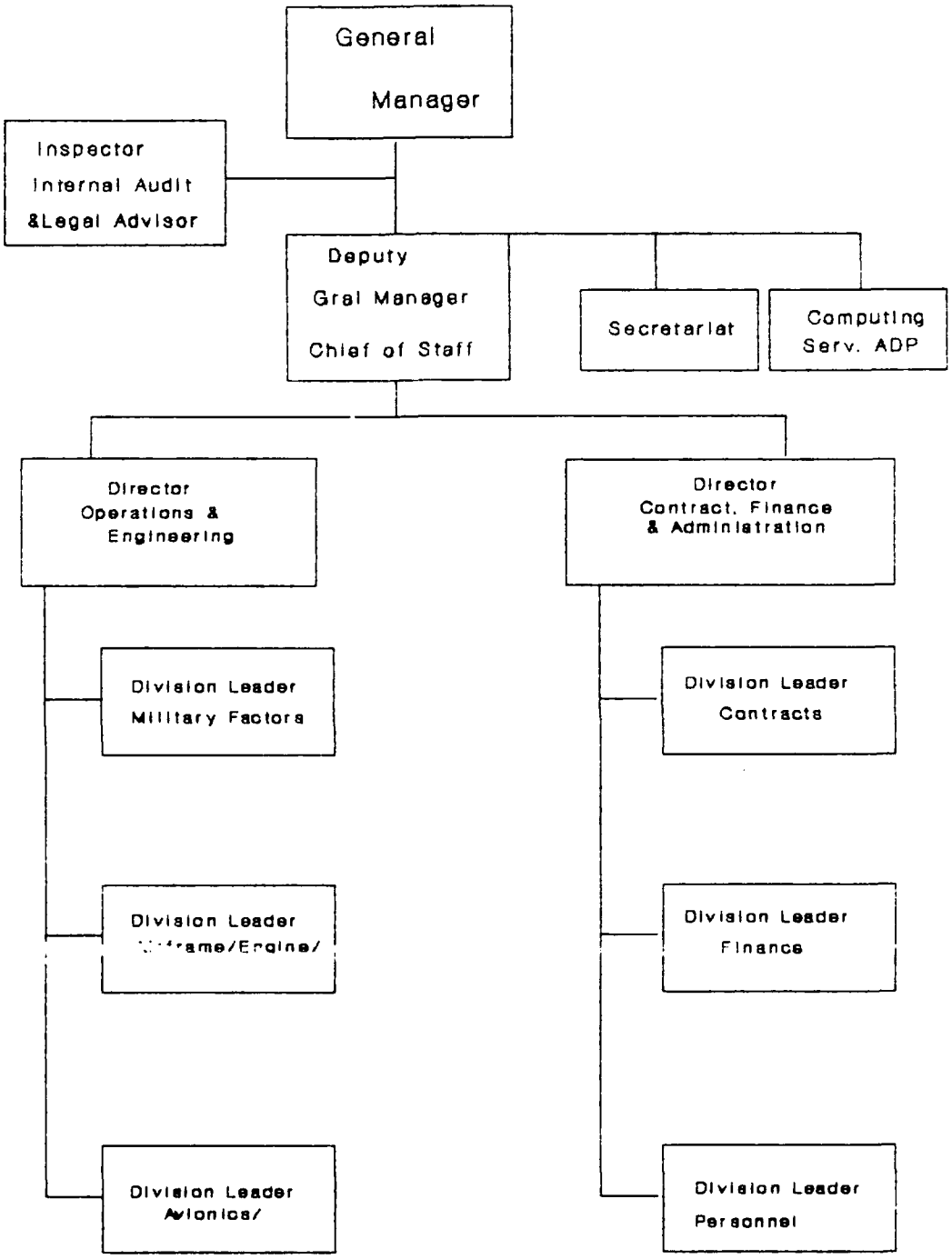

Fig. 3 NEFMA structure (35: 505)

ESR-D was issued, and it performs basically the same kind of activities as a program office. In 1986, the NAMMA General Manager pointed out that, despite the positive experience of NAMMA in the Tornado, the development contract took too long to prepare and offered little incentive to industry, that at the end there was insufficient spare parts supply, and that they did not give enough thought to testability during the development (42:65). In the EFA case, it is expected that these lessons learned from NAMMA will have a positive effect in the way that NEFMA performs those activities. With respect to the logistics aspects, not only the name but the NEFMA structure indicates that they are receiving the right attention, according to the air staffs requirement that R&M receive equal priority with the better known performance figures (64:49).

EUROFIGHTER. EUROFIGHTER was formed before the nations decided to create the management agency, NEFMA, and it is both an industrial team and a management organization. It acted as the program management agency from its creation in May 1986 (36:503), when the definition phase began, till the creation of NEFMO in 1987, time at which the development of specifications started.

It was responsible of the overall coordination of the industry activities during the definition phase and from the creation of NEFMO (and NEFMA) it has remained as the actual contractor's program office and a supporting agency for NEFMA. Its activities have included developing weapon

system specifications (37:500) in close collaboration with NEFMA and the working groups set up by nations, as well as rules and procedures necessary to proceed to the next phases, such as the equipment selection document or the bidding procedures, in accordance to NEFMA guidance.

The Industry

The main firms involved in the program began team-working from the beginning of the pre-feasibility studies, after December 1983 (37:498). Though no consortium had been yet arranged, BAe, CASA, MBB/Dornier and Avions Marcel Dassault shared the pre-feasibility and feasibility studies work, sometimes maintaining working meetings in different capitals for periods as long as one month, with participation of as many as 80 or 90 persons. These are the main existing European firms in aerospace and the same that had teamed before to some extent to carry out work in previous attempts to develop a combat aircraft, and the only ones that the nations could obviously contract the feasibility studies with.

Similar cooperation was carried by SNECMA of France, FIAT of Italy, MTU of Germany, the British Rolls Royce and Sener of Spain in regard to the engine, once the nations decided that a new engine had to be developed for the EFA.

The Industry Stakes. The fact that both EUROFIGHTER and EUROJET were established before the management agency, and the rules and procedures issued by the latter reflect

the extent to which the EFA program is as much a European political and industrial commitment as the actual result of a military need.

Teaming of European industries, as mentioned before, began earlier than the formal EFA program came to light, and responds to specific European defense industry interests and general worldwide conditions in the defense market. That can be traced through frequent references in the literature from the '80s, related to French industry economic problems (reported consistently in reference to the Mirage 2000 ard Rafale), the German backing of MBB (14:289) and the takeover of MBB by Daimler-Benz in an attempt to build a larger defense concern, DASA (Deutsche Aerospace), capable of competing worldwide (6:67). Teaming of U.S. and European firms for many of the current defense projects is also part of what one source calls European "race" for "initial positions and ultimate power and profit" in the 1990s European marketplace (40:1573).

Many of the European aerospace firms have staked their future in EFA (12:136), something that reflects not only their particular interests but also the confidence that governments are really backing the project, at least as it appeared up to now. Together with the constraints imposed by the agreed work share, EUROFIGHTER regulations reflect many of the already mentioned recommendations of the IEPG in 1985, as well as the nations' positions with respect to the collaboration. It helps explain the teaming process

undertaken by firms to submit bids for EFA subsystems, and part of the problems that U.S. firms have faced in participating.

Key factors for industry participation are the limitation to European firms, or otherwise teamed with a European consortium (and with arrangements to manufacture in Europe) for the submission of bids (48:7), or the provision in the Equipment Selection Procedures document that bids presented by teamed companies would be evaluated in more favorable manner than those submitted by individual firms (37:500), the need to guarantee the work share consistent with the proportional participation of each country, and the "principles" agreed for the collaboration (20:2):

- Utilization of all available facilities and capabilities.
- Validity for all technological areas, including those of the equipment suppliers (any technological innovation in the EFA has to be validated before the development or its risk sufficiently assessed in terms of its cost and availability at the moment it will be implemented).
- Production of major assemblies to be single sourced as far as possible.
- Each partner will conduct final assembly and flight test including workshared tasks (four assembly lines).
- Design responsibilities were segregated into four main areas of development: avionics, flight control system

(FLC), utilities control system (UCS), and structures. Each area was assigned to a selected company, which bears the System Design Responsibility (SDR). However, in order to preserve interdisciplinary system capability of each partner company, joint teams were established for each area and allocated to each leader company on a permanent basis: structures in CASA, avionics in BAe, FLC in MBB/Dornier, and UCS in AIT (37:499).

- The four partners would have unrestricted access to all data and results of the EFA program.
- Free exchange and utilization of all ADP tools for the development work and management within the EFA program.
- All partners are to have unlimited access to the technology on the EFA project.

From NEFMA and EUROFIGHTER actions, it appears that both governments and industry have seen the EFA program as it was described in a report by stockbrokers County Natwest in 1988: "the last major European military aerospace program of the 20th century," a kind of opportunity that industry from participating nations cannot afford to miss (82:36). Not only the technological benefits derived from the R&D investments in the project for the airframe (86:1072), the engine (5:154) or those in avionics equipment, such as the radar, but also estimated work for around 60,000 persons during the life of the program are at stake (51:95).

The report predicted an average of 14 bids for each of the 280 equipment items going into the aircraft, and also warned that it may be politically and economically optimized, rather than militarily, due to the need for equitable work sharing in all the development and production stages.

EUROFIGHTER Firms. For development and production of the airframe, the four firms will share the work according to the proportional share of each country. Bae will built the front fuselage, foreplanes and the right wing, MBB will make the center fuselage and vertical tail, AIT will be responsible for the left wing and half of the rear fuselage, and CASA will do the other half of the rear fuselage (5:154). Assembly lines will be set up in all the four companies for the production phase.

The four companies will build prototypes during the development phase and will carry out tests on different aspects of the development. On the trials program BAe will lead on avionics and will be responsible for the fuel system, aircrew systems and electrical generation. Flight testing will include work associated with the British EAP (Experimental Aircraft Program) demonstrator and the main avionics development and integration. MBB will lead on flight controls and will be responsible for secondary power supplies, stores carriage and release and the interface with the engine installation. AIT prototypes will be used for stores clearance and part of the avionics trials, and CASA will lead in structures and will be responsible for the

environmental control system (ECS). The Spanish prototype will be used to develop the ECS and the avionics for the trainer (5:154).

EUROJET. As in the airframe, the EJ200 production, based on the Rolls Royce XG-40 engine demonstrator program, will be split among the partner firms in accordance to the agreed workshare for the program.

Rolls Royce is responsible for the combustion chamber, HP turbine and intermediate casing, and is participating in the LP and HP compressors, the LP turbine, interstage support, the afterburner, and the condi-nozzle (convergent-divergent nozzle). MTU is responsible for the LP and HP compressors, the FADEC (Full Authority Digital Engine Control), and participates in the HP turbine. FIAT is responsible for LP turbine and shaft,the interstage support the afterburner, the gearbox and the oil system, and is also participating in the intermediate casing. Sener will make the condi-nozzle, the jet-pipe, the exhaust diffuser and the by-pass duct. A new Spanish firm, Industria de Turbopropulsores (ITP), was formed at the end of 1988 and will take design and development responsibilities on the EJ200. The new company is owned by Rolls Royce (45% share) and the Spanish CASA, Bazan, and Sener (59:56), and will receive management, technical, and engineering support from Rolls Royce. Each partner will build and test engines during the development and production phases (5:154).

Bidding Consortia. If we will need to wait a long time to see whether the EFA will be militarily or politically optimized, it is already possible to track the consortiums that have appeared to bid for subsystems of EFA, and see how they include firms of the four nations. Even though the EFA will incorporate many different technologies (like any other project of its nature), and to a large extent some new technologies in many areas, which is probably one reason for natural teaming of firms, it is clear that EUROFIGHTER regulations and the work share have forced some of the teaming arrangements. As it has been noted before, doubts in the final work share caused Spain to delay the signature of the development MOU, and it appears that at the end there will be some work within the EFA package for the Spanish industry not directly related to the program (67:1256). On the other hand, the teaming process has caused some Spanish firms, like INISEL, to benefit with an increased share in the radar work from its initial 13% to probably 18-20% (35:48).

Before the end of 1989, at least the following teams or individual firms that had already submitted, or were thought to submit, bids for EFA (besides the main contractors and those already mentioned for the radar) are cited in the reviewed literature:

- General Electric Engine Business Group (U.S.), with the F-404 engine as interim powerplant for the EFA prototypes (48:7).

- Garret Turbine Engine (U.S.) for an auxiliary power unit (48:7).
- Honeywell Aerospace and Defense Systems (U.S.), through its German subsidiary Sondertechnik, for an inertial navigation system using ring laser gyro technology (48:7).
- GEC Avionics (U.K.), Bodenseewerk (Germany), Aeritalia Avionic Systems and Equipment Group (Italy) and INISEL (Spain), competing with Nord Micro (Germany), Smiths Industries (U.K.), Microtecnica (Italy) and CESELSA (part of ENSA of Spain) for the flight control system (5:151).
- Fairy Hydraulics (U.K.) with Moog and Rexrath (Germany), Microtecnica and INISEL, competing with Liebherr (Germany), Dowty (U.K.), Zahnradfabrik Magnaghi (Italy) and CASA for direct flight control actuators (5:152).
- The Eurodass consortium, formed by Marconi Defense Systems (U.K.), TST (Germany), Elettronica (Italy), ENSA and INISEL (two Spanish firms). It was at the time the only bidder for the EW suit in the EFA, which includes radar warning, active ECMs, laser warning, IR missile approach warning and chaff/flares dispensing (5:151). No source has been found indicating any other bidder for the DASS, though it is thought that companies like Selenia, Racal, or Plessey should have submitted bids for DASS equipment (61:110).

- GEC, Bodenseewerk, Aeritalia, and INISEL for the flight control computer (11:1171).
- GEC for the engine Digital Electronic Control Unit (11:1171).
- GEC, Bavaria Avionik Technologie (Germany), and ELT (Spain) for the Maintenance Data Panel (11:1171).
- The Eurolog consortium, with Siemens/Rohde & Schwarz (Germany), Selenia, INISEL and GEC, for the development and in-service Support contract (11:1171).
- The ACMA consortium, with Aerea (Italy), CASA, MBB and ML Aviation (U.K.), competing for the stores carriage and release system with Eurolauncher, made up by Dornier, Frazer-Nash (U.K.), Gamesa (Spain) and Selenia (61:109).
- Smiths (U.K.), with already awarded contracts for the multifunction head-down displays, the cockpit glare shield and digital control units for the engine.
- Eurofirst consortium (83:36), with Thorn EMI (U.K.), FIAR (Italy), ELTRO (Germany) and Eurotronica of Spain, and Aeritalia and BAe Dynamics acting as subcontractors, competing for the TRST with three other teams: GEC Avionics, Karl Zeiss (Germany), ENOSA (Spain) and Selenia; Pilkington Optronics (U.K.), TI (Texas Instruments) Deutschland (Germany), Elettronica and Ceselsa; and Ferranti, Officine Galileo (Italy) and Siemens (83:36).

- GEC Avionics, Bavaria Avionik Technology and Eurotronica, for the air data transducer unit and the air intake data transducer (11:1171).
- GEC, Teldix (Germany), Aeritalia and Ceselsa, for the stores management system (11:1171).

The issuing of RFPs (Request for Proposal) by EUROFIGHTER began soon before the development MOU was signed. By February 1987 RFPs on the radar had been already sent to 15 manufacturers in Europe and in the U.S. (10:7). Over 300 RFPs were expected to be put out by EUROFIGHTER, of which 50% had already been sent by February 1989.

Cost and Schedule - The Economies of the program

In order to find whether the actual costs of the program have been consistent with those predicted at the beginning, the intention was to compare available data from August 1985, when the agreement to formally launch the program was reached in Turin. In relation to the schedule, references to required or predicted time "windows" for in-service time, production start, or to changes in scheduled prototype flights have been reviewed.

Cost Estimations. Actually, the references to the EFA cost in the literature are scarce and do not provide for a basis to make the intended comparisons, mainly because almost none of them refer to actual costs reported by EUROFIGHTER or the nations, with the exception of one source in which the development cost escalation is reported in

reference to the German MoD projections (56:1253), and also because they do not refer to the year in which the figures are expressed. So, there has been no reference point on which to allocate the different figures to inflation or to increases in costs.

Nevertheless, some of the sources relate partial figures with reference to the currency used, or at least the exchange rate between the German mark and the U.S. dollar or the British pound (mostly from 1988 and 1989).

The earliest reference found in the literature relative to the EFA costs cites a unit price of DM70 million estimated in 1983 (25:17). Later sources of 1988 relate a whole project price tag of about $54 billion, for an original estimate of $36.4 billion (82:36). None of these makes reference to the mark or dollar year in which those costs are expressed, and the second one does not refer to what the year is of what is of the original estimate.

In 1988 the R&D costs for the British were reported as £1.7 billion, with a total U.K. cost for 250 aircraft of £6 to £7 billion, and a total EFA R&D costs of £20 billion, citing the dollar exchange rate as £1 equal $1.88 (39:32). These figures almost coincide with most of the sources, and are the same as in reference (5:154-155), which cites currency of 1987. The total cost of the EFA program according to those figures was estimated at that date in about $34 billion to $40 billion, with a total expenditure in R&D of $9.588 billion or £5.100 billion of 1987, and

would allocate R&D costs of about $3.200 billion to Germany and Great Britain, $2.010 billion to Italy and $1.250 billion to Spain. These figures correspond to a final estimate before the development contract was signed in November 1988, and include total R&D relevant to the engine, radar, some unidentified avionics, weapons flight clearance and the associated government own costs of the four nations. This allocates a total figure to Germany, in marks, of 5.620 billion.

According to the source mentioned before (56:1253) the German share was finally fixed in the development contract in DM5.850 billion in December 1987 prices, after the German government, which had conducted a revision of the whole program bill, reduced its previously allocated share of DM6.700 billion (which is apparently not consistent with its proportional share of the EFA) to the above figure. With the outlays of DM814 million for the concept and definition, the Germans assumed a total of DM6.664 billion. From published evidence (5:155) the nations will acquire 765 aircraft for a total cost of £17 billion (≈ $32 billion), that makes a unit price of about $42 million in 1987 dollars. According to the German R&D figures, the total R&D for the four nations would be DM17.727 billion, or the 18 billion in 1988 prices that is reported in some other sources (43:1196). The contract has been one of fixed price type with payments to be made against accomplished milestones, though negotiations are taking place for an

incentive package to improve R&M levels already fixed (55:31).

In some other sources from 1988 and 1989 different figures appear as estimates for the total cost of the program (£20 billion, £22 billion, £21 billion, $35 billion, £32 billion), without reference to the year or to the concepts included to estimate the costs. Taking the smallest of those figures (39:32), and assuming that the currency is year 1987 (source is dated June 1988) that would imply a cost increase of about 12%, or a 7% if figures are taken as of 1988 (4.9% inflation in U.K. for 1988).

Total development costs increase till 1999 was estimated by the German MoD in mid 1989 as substantially higher than the rate that had been expected. In the German case, the cost projections during the development phase were allowed to incorporate a 3.5 escalation rate (56:1253), which, according to the 1989 German MoD estimations, has to be changed by a more realistic one of 5%. Although the source relates the differences to the fact that industry and MoD are using different costing models, nobody knows with certainty what the actual increase rates will be in the coming years, and the German MoD has found that the top ceiling fixed in 1988 has been exceeded by a 6.65 per cent (DM389 million) within a year. According to the same source, industry is using a 2.1% increase rate on the overall amount, whereas the German MoD is using a 5% rate based on the residual amounts, that will yield at the end of

1999 the same figure of DM7,449 m. The difference is that with the MoD model the annual payments will presumably be higher in the forecoming years.

The basis for that assessment is not clear, but even in that case, it appears that the present value of higher payments in the first years of the period will have a negative impact, and the German MoD, which is reportedly trying to use a "design-to-cost" approach (12:316) due to budget constraints, is rightly worried about the escalation of costs.

Schedule. The basic initial agreement of July 1984 called for an in-service time of mid '90s, and accordingly the first reference found cites mid 1995 as the scheduled in-service time for the EFA. Actually, the program has suffered delays in some of the major decisions points, like the signature of the go-ahead MOU in Turin (by Spain and France), the signature of the development contract (mainly by Spain, though it is also reported that it took too long for Germany to decide), and the selection of the radar. There may possibly be other minor reasons, but they are not reflected in the literature.

The schedule, as reported in most sources in 1988 before the development contract signature, established a first prototype flight in April/May 1991, with either the GE F404 or the Turbo Union RB199 engine (at that time it was not yet decided the interim powerplant for the EFA. The two first prototypes will be powered by the RB199, and for the

rest it is expected that the EJ200 will already be available), and the last flight of the last prototype in mid 1993. The fifth prototype would be the first with the complete avionics suit, including the radar, and would fly in 1992. The production investment phase would begin in 1991 and the series production would start in 1993, and the in-service time of the EFA would be mid-1996, time in which the aircraft performance specification were also expected to be met. The complete performance level for all the weapon system was expected to be met in 1999 (5:154-155). It appears that the British and the Italians would receive the EFAs in first place (44:137).

Later sources of 1989 and 1990 reflect the slippage that the program has been accumulating, mainly because of the radar issue. In-service time is reported as mid-1996 onwards (51:95) and first prototype flight at the end of 1991 (43:1195). The same source cites 1992 as the series production start, but that is not consistent with the previously mentioned prototype flight and in-service times, so it should be an error (unless the program were well ahead of schedule, which is not supported by the rest of the sources consulted), or it may be referred to the production investment instead of the series production.

Sources in 1989 indicate that the in-service time of 1996 will not probably be met, and that the radar will not be ready for the fifth prototype (61:108). In May 1989 the program was at least seven months behind the schedule

(81:7), and according to other sources, the first prototype fly is believed to have been slipped to 1992, with an in-service time now delayed till 1997 (70:29). That would confirm an slippage of as much as seven to ten months considering the initial target agreed in 1984, and if the rule is true, that slippage will remain or be larger at the end of the program.

On the other hand, the development of the EJ200 engine is reported to be running without problems and ahead of schedule (as much as two years) in some of the areas (22:55). The EJ200 was scheduled to reach the flight clearance at the end of 1991, a date that EUROJET expects to meet (22:56).

Industry and Budgets: The Economies Outside the EFA.

As early as in 1983, Mr. Benno Claude Vallières, chairman of the Board of Directors and General Manager of Avions Marcel Dassault-Breguet Aviation of France put the industry reasons for a new fighter in Europe in simple words:

> The main problem currently is to provide the design offices with new projects. In Great Britain, West Germany and Italy, we see that these offices have nearly finished their work on the Tornado, while production of the aircraft is running at full speed, and it is expected to remain so at least until 1988.....On the French side, the situation is about the same for the design offices, although we are still working on new versions of existing aircraft such as the Mirage 2000, and we already have some new projects such as the Mirage III NG and the Mystère-Falcon 900. We are thus a little less in a hurry than our British, German and Italian partners. (34:57)

That need to provide work for design offices and to the factory floors during the 1990s has already been mentioned in reference to the EFA first steps, as well as the industry efforts to come up with a project in cooperation and to get the necessary funding from governments. The fact that there was besides a military requirement for a new combat aircraft to meet the threat in similar timeframe, and that the industry had at that time assembled the technology to take a step forward in performance (46:207) does not minimizes the importance of the industrial and economic part of the problem for the Europeans.

The main aerospace firms in Europe not only needed new work for the '90s, but were also having trouble with their current projects, mainly loss of sales and lack of funding. Sources of 1985 report France as "deeply worried" about their ability to "maintain momentum" in their fighter programs, like the Rafale and Mirage 2000 (68:12), disappointed by the failure of expected sales to European nations and to Saudi Arabia, and awaiting a decision of the French government to get funds for its Rafale (66:20). In 1984 SNECMA "roughly broke even" (23:181). After withdrawing from EFA, France tried to re-enter with a 5% to 10% share, even though before they had requested a 46% share (85:1125), and asked the EFA nations to take a similar "symbolic" share in the Rafale (76:58).

In 1987 the British EAP was grounded because of lack of funding (9:43), when the other nations were still undecided

about including EAP within the EFA budgets. In FY 1986 MBB had losses of about $53.9 million (14:289) (and about $100 million in 1988 as reported in some sources), and financing policy for EFA was reportedly an argument between U.K. and Germany. The British position to pay contractors against specified milestones, with the provision of heavy penalties if milestones clauses were breached, was not shared by Germany. Under those terms, the German government would most probably have to bail out the company if it were forced to impose financial penalties on MBB.

Aerospace and defense industry support, and improvement of technological level of that industry, seems such a major goal of European nations that funding problems or major cutbacks in defense budgets do not seem to have caused any major impact on the EFA program anyway. The head of the Spanish General Directorate for Armaments and Equipment (DGAM), interviewed by Mönch Publishing Group at the end of 1988, pointed out that:

> The aim of the Common European Market is to make better use of the resources available in Europe for the purpose of common defense and this would extend geographically to the whole of NATO and not be restricted just to Europe. In this context, an efficient and viable industry on a European scale must be built up, i.e. one which is competitive and can be compared with its US or Japanese counterparts. (1:63)

And in reference to the Spanish participation, there is little doubt about the priorities:

> In terms of the avowed priorities for national defence, this project has received the required funds without seriously endangering the priorities defined by the other armed forces or even the Air Force itself.

> On the other hand, one should not forget that the strengthening of national industry which will be achieved through this programme, will not only be to the advantage of the Air Force, but to that of the whole Defence Ministry due to the ensuing industrial and technological advances. (1:65)

The expected benefits are high according to the European nations and to EUROFIGHTER consortium. Besides keeping up with technology, cost savings to the individual partners through collaboration is a major one, as pointed out by British Aerospace Chief executive Richard H. Evans:

> The U.K has the indigenous industrial capability to develop EFA on its own and at a substantially lower cost than the four nation program. However, by sharing in the development, the U.K. government's 33% contribution will be only 2 billion pounds. The French government is paying for Rafale twice what the U.K. government is contributing in its share of EFA. (63:86)

The second one is export sales of an aircraft that is claimed superior to its rivals in the marketplace. The EFA can become "a world-beater not just in aerial combat but in export sales" (8:30). According to Ivan Yates, British Aerospace chairman of EUROFIGHTER consortium, as a fighter and ground attack aircraft the EFA will have no rival. He admitted that the consortium is taking a risk in going for leading edge technology, but he said that without that risk the airplane would become technically outdated too rapidly. BAe identified an accessible export market for the EFA, excluding the U.S. and U.S.S.R., of about 2500 aircraft in the class of the EFA, and claims that it will gain "a very large part of that market." The French Rafale is viewed as

too expensive to compete, and the U.S. ATF as "big and expensive, and almost certainly not exportable" (8:30).

BAe performed a market analysis of the EFA comparing it to the projected threat and to current western fighters. EFA will be superior to the F-16C, F-15C, F/A-18A and Mirage 2000 in terms of sustained turn capability at sea level/Mach 0.65 and 30,000ft/Mach 1.6, maximum attainable turn rate, specific excess power available at Mach 0.9, air-to-air weapons carriage, and will be superior to all but the F-15C in radar detection range. The study compared the EFA with an enhanced Su-27 Flanker in single and multiple beyond-visual-range (BVR) combat and with an enhanced MiG-29 in close combat, and it came up on top of the list followed by the Mica (air-to-air missile) armed Rafale, while an upgraded F/A-18 Hornet was found well below parity (32:237).

With that perspective, European industry has been preparing through a consolidation process that has included the major firms (40:1573), and no references to any major trouble has been found in the literature related to EFA finances, with the exception of those related to cost increases from the initial estimates and to the mentioned differences between Germany and Great Britain on pricing and payments policy, nor to budget restrictions to fund the program. Only in 1989 and 1990 Germany and Italy are consistently reported as struggling for EFA funding in the reviewed sources. The revision of costs by Germany before signing the development contract and its parliament request

on March 1990 to study the cost of withdrawing, and the Italian need to fund its EFA development share in 1990 outside the budget (7:44) seem to be the first indication of budgeting problems.

The German review of the EFA was mandated "by the need to reduce government expending so as to finance German unification" (7:44). Defense expending would be cut by $58.8 million in 1990, with similar economies predicted for next year. According to a government official, it makes no financial sense to withdraw at the current stage, but he also warned that Germany would not be penalized if it withdraws from the program at the time to move on to the production phase (beginning of 1991 for the production investment, 1992 or 1993 to proceed to actual production), since that step is still to be negotiated (7:44).

For the Italians, the question is much more simpler than for the Germans, but quite similar with respect to funding resources. According to the air force's Chief of Staff Gen. Franco Pisano:

> After a through check of all the resources available for the Air Force, we have established that we don't have a single buck in the current budget in order to finance EFA research and development....We have nothing more to cut, because we have already scraped the barrel. Now it depends only from a political decision if we will get funds. (7:44)

It does not seem probable that budget reductions alone may have a major impact on the EFA, given the interests that industry, services, and governments have staked in the program, even though the current trend in NATO and in Europe

goes for defense expending cuts. But the reference to the German reunification raises the more deep political risks threatening the viability of EFA at present. The changes in eastern Europe with their impact on NATO, the subsequent push on negotiations for conventional force reductions in Europe, plus the costs of German reunification and its added implications in European defense may very well add up to the always expected cost increases or budget limitations, not to mention that budget limitations may actually grow harder within that political upheaval.

U.S Approach to EFA

Though some of the literature refers the U.S. attempts to participate in the EFA program as the "U.S. role," it appears that there is no such a role. The U.S. industry has managed to have a part on the program for obvious reasons, but the U.S. administration approached the EFA nations seeking participation of U.S. firms as subsystem or component suppliers, never to take a cooperative role in the program.

No indication of the existence of any formal invitation from the European countries to participate in the program has been found, and the letter that U.S. Secretary of Defense Caspar Weinberger sent to the defense ministers of the four EFA nations in October 1985 (72) shows that the European nations did not made any attempt to include the U.S. in the program when they had the first idea. The EFA

is first a European fighter, and will be NATO only in second place.

Mr. Caspar Weinberger approached the four nations to welcome their decision to go ahead with the EFA, and after a brief reference to the benefits that would be derived for NATO from the EFA, to commonality and interoperability and to mutual access and use of the best shared technology, called for a balanced mix of U.S. and European designed components and subsystems, and offered the participation of U.S. firms to supply them. He also made clear that the U.S. policy on technology transfer would not change in the EFA case, and that some sensitive technologies could only be shared under unique arrangements, while a very few highly sensitive technologies "might not be eligible for release" (72:166). More than any other, the struggle on the EFA radar selection has shown the truth of that warning.

The offer was welcomed by all the partners, but reactions were probably cautious; one expert close to the program at that time commented that it would have been hard for Europe to say no to Weinberger, but that Europeans would try to ensure that the U.S. received only a minimal share of the EFA (76:58).

Actually, European nations' desire to develop an advanced fighter by themselves and to retain exports freedom, in contrast with the U.S. inflexibility on U.S. technology transfer policy, have driven away all the

attempts of U.S. firms to participate in the program. From the very beginning, the four nations agreed to exclude the U.S. from any major portion of the program, letting only an edge to electronics firms (28:21).

After Weinberger offer, the U.S. DoD set up a committee to discuss with EFA officials the areas where the U.S. could contribute (79:224), and later on a draft MOU was submitted to the four EFA nations with the intention to formalize that contribution, while DoD was reportedly working on a new policy that would guarantee approval for unlimited EFA exports to specified countries. At that time U.S. DoD officials were sure that the EFA would never be deployed without export sales, but they claimed also that "no country in the world will give carte blanche for a country to sell to whomever it wishes. That's an unreasonable request" (48:7).

According to the same source, the draft MOU contained "general language intended to establish a formal relationship between the U.S. and European governments." Program officials reported that there was growing interest in formalizing the U.S. participation, but recognized that there would be no MOU (74:99). No later indication of the signing of that MOU has been found in the literature, though sources of 1985 and 1986 refer the U.S. as expected to "sign on" for the definition phase of the EFA, and also to be a part of a government-to-government technology data exchange program intended to improve the EFA and ATF (Advanced

Tactical Aircraft) interoperability and capabilities. No U.S. purchase of EFA was expected, and some EFA officials at that time felt that no commitment to disclose information about the EFA to the U.S. should be made unless the U.S. agreed to buy "a handful of the aircraft" (77:180).

Actually, there was no indication that the U.S. government would not impose restrictions on third country sales if some U.S. sensitive technologies were to be incorporated in the EFA, something that neither the European governments nor the industry would accept. On the other hand, the four nations had formally welcomed the Weinberger offer and had answered that there were areas of common development: avionics, radar and cockpit layouts, integrated electronic warfare and advanced navigational systems (79:224), all of them more than prone to involve sensitive technologies. Besides, it was clear that if some "highly sensitive" technology in those areas was not eligible for release (as in the case of the radar, which was the hot point for EFA), the U.S. participation would not be so valuable. That was the concern not only of the EFA nations, which wanted to incorporate U.S. made components as long as the technology was suitable to face the assessed threat in year 2000, but also that of the U.S. firms. Some of them were frustrated with U.S. policy, like Westinghouse, which in the radar bid was obliged to market enhanced versions of their already developed APG-66 digital radar, stripped of some of their electronic countermeasures,

against European systems that claimed to rival the U.S. most advanced APG-68 (62:146).

In 1987 the bidding procedures were issued by EUROFIGHTER, and the previous agreement that banned U.S. firms to participate was eliminated. Nonetheless, they have had to team with companies in a participating country, and licensed production is required with no restrictions on export sales (24:384). Even though the U.S. was working consistently on reviewing its technology transfer policy, and it is reportedly undertaking a major one as a consequence of the late changes in Eastern Europe in coordination with the COCOM (69:45), there was no significant change in that policy as far as the EFA is concerned, and accordingly the U.S. firms will not be able to contribute with any of their latest "state of the art" technologies if they are considered sensitive by the U.S. National Security Council.

A last approach was made in 1988 by offering a cooperative development and production program for the Hornet 2000. The presentation by Deputy Under Secretary of Defense Dennis Kloske got "a polite reception" according to an industry source, but it was viewed as if the U.S. were asking the EFA partners to dump the EFA and start again (73:426). The Hornet 2000, which did not meet the EFA specifications, was presented as an option for Europe should the EFA failed, and stressed the fact that EFA and Hornet 2000 would have to compete in a very tight market, so

cooperation would reduce costs and selling price, which would in turn open a wider market.

In summary, the U.S. "role" may be limited to the attempts to get its industry directly involved while keeping technology transfer policy unchanged, something difficult to achieve in the EFA case, for which future exports are paramount. Europe's priority is keeping up to date on technology, and if any, the issue has more highlighted the internal U.S. contradictions between its commercial and security policies and the role that the EFA plays for the European industry, as well as the fact that national interests and policies go before any standardization wish.

Summary

From the previous review the key elements relevant to the EFA program progress can be summarized in the following:

1. The first references to a "European" fighter found in the reviewed literature relate to the WEU, not to any NATO agency or organism. Till the first meeting of air staffs' representatives in 1983, industry had been making arrangements for cooperation in different projects and requesting appropriate funds from their respective governments. It appears that industry went ahead of the services and of the governments, and also that the political decision to build a "European" common aircraft was given more emphasis by nations than building the aircraft in a NATO context for

standardization purposes. Taking into account that the European Staff Target (EST) was issued at the end of 1984, it is worthy of noting that the first source found mentioning the nations' agreement to barr U.S. industry from the EFA is dated August 1984.

2. From the ministerial resolution it took until December 1985 to agree on the European Staff Requirement (ESR), though in August France had already declined his participation. Considering that nations had been working on the intended project from quite a time before the first referenced meeting in 1983, it cannot be considered a short period. It appears that France was the main problem in agreeing on common requirements, and also that the U.K. reportedly wanted a heavier and rather "quasi" multirole plane than the Germans.

3. Once France was out, the program progressed apparently without major disturbances through a number of meetings, most of them at Air Forces' Chief of Staff level, till the radar selection impasse. During all that process, however, major differences between Germany and U.K. appear to be a continuous problem to reach an stable agreement. In almost each of the key decision points the role and weight of the EFA has been slightly modified to the U.K. claims, with Germany often threatening to abandon the program because of the U.K. attempts to bring EFA to its initial requirements.

4. The major problem encountered during the program life, once France was out, has been the choice of the radar. It does not appear to be only a problem of disagreement in radar requirements for the EFA, but also a case of conflicting interests: British and Italian interest in using the opportunity that EFA provided to develop an advanced fighter radar in cooperation, and German resistance to take the unnecessary risk and costs involved in the ECR-90 development, since the APG-65 derivative had no such risks and would have provided some commonality with its F-4Fs. As a problem of technological-economic nature beyond the capabilities of the management organization, it was solved at top political and industrial level.

5. Nations agreed as early as in the first defense ministers meeting in 1984 to staff the key positions in the management structure according to their share in the effort, in order to avoid any problem with leadership issues. The management structure includes NEFMO, the program direction organization, and EUROFIGHTER, the industrial consortium set up by the major aerospace firms of the four countries, which is also the manager of the industrial side of the EFA. As a consortium, EUROFIGHTER is one of the prime contractors in EFA, being EUROJET the other prime contractor.

6. EUROFIGHTER has been a key instrument to implement the nations' policies regarding the kind of cooperation they wanted within and through the EFA with respect to both their national industrial and employment interests and their collective interests in front of the U.S.
7. No indication has been found of any conflict or issue related to program management itself, with the exception of schedule slippage, that can be estimated at least in seven months from the initial target, and a development cost increase in 1989, as estimated by the German MoD, of about a 6.5%. higher than expected. This figure is consistent with an estimated increase for the whole program of about a 7%, as derived from some other sources.
8. Availability of funds allocation in national budgets does not seem to have been a problem up to last year, and very few sources have been found that mention that issue. It is not the case for 1990, in which Italy and Germany have officially declared difficulties in providing funds for that year, and also their planned budget cuts in connection with the EFA program. Germany is the only one that has suggested the possibility of leaving the program in relation with cost or budget issues, while the Italians called for a "political" decision to get the appropriate funding.
9. Though only France appears to be mentioned in the sources as the one which raised political reasons or

national interests, all the nations involved in the program have introduced some argument of domestic economic or political nature at some point in the program conflicting with the collaboration, with the exception of the U.K.

France, with its attempts to include broader strategic topics in the EFA discussions was probably the first one.

Spain claimed that it was having difficulties in identifying its agreed workshare in the program when it delayed the signing of the development MOU.

Both Germany and Italy have officially declared their difficulties to fund the EFA due to budget constraints. Actually, Germany has warned about the fact that it will not be penalized if it does not sign on for the production investment, and has made reference to the costs of its political reunification. References to Germany may be identified in most of the sources by finding the words "quit," "withdraw," "abandon," or "political," and it is by far the one which has threatened to abandon the program more often than any of the partners.

10. The references to the technological and economic implications of the program for the Europeans are countless in the literature. The radar issue has provoked most of them, but they are consistently present from the beginning in 1983. The strongest

statements about the necessity of a technologically independent industry able to compete with the U.S. or Japan usually come from Germany and the U.K., but mostly from BAe representatives. The British BAe appears to be the one which most emphasizes the development of European industry, and opposes any technology transfer restrictions by the U.S.

V. Findings

Introduction

In this chapter the findings relevant to the investigative questions stated in Chapter I are presented, together with a brief summary of the analysis made.

From the review of the EFA program development, the investigative questions stated in Chapter I can be answered in part in the following terms:

Findings for Research

Question 1. Agreement on Requirements. Have the participating countries succeeded in formulating common requirements for the weapon system being acquired?

Findings. It appears that the nations that initiated the project actually failed to agree on common requirements for the aircraft, and only when one of the parties was out of the project the remaining air forces were able to issue the ESR.

On the other hand, it also appears that there was only two "sets" of initial requirements with major differences (main role, weight and powerplant) which needed to be reconciled, one defended by the nation that eventually quit, France, and one defended by the other four nations. Once the weakest party abandoned the negotiations, differences between Great Britain and Germany came up. These differences have often been reported during the program life, and apparently the U.K. has been able to convince the

other three nations to agree to its positions. Despite the frequent German threats to abandon the EFA because of the U.K. claims, it can be said that the four nations have succeeded in formulating common requirements.

Role, basic weight and powerplant were the most debated issues, and the ones that actually caused a major impact, materialized in the French withdrawal. Similar differences between Germany and U.K. on the role and weight could have caused a major impact according to most sources, namely the German withdrawal.

The radar selection process is not solely a requirement issue, but it undoubtedly reflects initial differences that were compromised at some point in the agreed requirements. The radar selection issue could have had a major impact on the program, since it could have caused Germany to abandon the EFA or to choose a non-common fit, which would have resulted in reduced interoperability of EFA among the forces of the participating nations.

Question 2. Program Management. Have the process and the organizational arrangements that nations have followed to set up the program been effective up to now in order to ensure that performance, schedule and cost requirements will be met?

Findings. No true indication has been found valid enough to answer this question. It appears that nations have taken advantage of the lessons learned in NAMMA to avoid the undesired results they had in the logistics area

with the Tornado, and that the management structure has worked well up to now in the sense that schedule slippage or cost increases in the development phase cannot be considered significant in comparison with past experiences, and it has avoided any leadership issue from the very beginning.

Issues related to program progress that have found echo in the literature are the ones which were clearly beyond the regular management capability of NEFMA , such as the radar selection or the reported differences between Germany and the U.K. in the penalties to be imposed to contractors in case of milestones breaches.

It may be assumed that the separation of program and industrial management functions has allowed the services and NEFMA to concentrate in preparation of military requirements and program planning and control, while EUROFIGHTER, an agency staffed directly by industry, seems better suited to assess technical risks and feasibility of requirements, write final specifications, assess proposals and bidders capabilities, ensure the right consideration of R&M or integration aspects in the development, and to support NEFMA as a big engineering office, but no true indication of that effectiveness has been found in the literature. At most, it can be said that no indication has been found of the management structure being ineffective.

Question 3. National Interests. Has any of the partners presented, at any stage of the program, any argument or claim that can be reasonably identified as based

on individual economic or political interests that has caused, or could have caused, a major impact on the program?

Findings. All the participating nations have used at some point in time some argument based on national political or economic interests within the EFA context.

In the French case, national pride is cited as one of the reasons for its withdrawal, together with disagreements on common requirements, workshare and program leadership. National pride may have played a role. However, the differences in requirements followed closely the differences between the British EAP (in which BAe had worked in cooperation with the German MBB and Aeritalia of Italy) and the French ACT/Rafale. That is not a surprise, since each national industries had worked on designs guided by the requirements of their respective air forces, but the fact is that, once France was out of the program, the U.K. actually managed to increase weight and expand the EFA capabilities closer to its initial claims and to the EAP design.

According to that, it seems more the need to support its own industry (when it was reportedly in serious trouble), and possibly the awareness that there was no option for them to take advantage of the work done in the Rafale within the EFA, since no other nation seemed to approach the French requirements, what made France to withdraw. Entering EFA would have meant not only accepting requirements on which the French air force did not agree, but also to interrupt industry work during an uncertain

period and lose much of the effort already done. Program leadership could have been irrelevant, but the claimed 46% workshare could have compensated for the Rafale loss. In the belief that the Rafale would be ready at an earlier date than EFA and accordingly in an advantageous position in the marketplace, it appears that there was no reason for France to sacrifice its Rafale to the British EAP.

The impact in the collaboration was a major one, since the EFA lost one major partner. French claims did not make the other countries modify their positions in the basic requirements for the EFA, nor endorse its pretended 46% share and leadership in the program. Eventually, its national interests had more weight than collaboration or standardization wishes.

In the Spanish delay to sign the development MOU, it is understood that the "difficulties" in identifying the workshare could have caused Spain to withdraw from EFA, at a time in which France was still pressing so that Spanish industry would take a significant share in the Rafale, thus causing a major impact in the program.

Germany is the one which more consistently has reportedly threatened to quit the program, either in relation to specific program issues (differences in requirements, cost matters, or the radar selection, usually in front of the U.K. position), or in relation to planned budget cuts or to internal political or economic issues.

The German frequent threat to abandon the program may be seen as a tactic to keep the U.K from bringing the EFA too close to their initial requirements, but it is also identified in this study as permanent political pressure on the rest of the partners to better defend its position each time an issue came up in which Germany differed from the U.K. or the other two nations, knowing that it was a "heavy weight" in the program, and that its withdrawal would have a significant, if not definitive, effect on the program and in the other three nations.

In relation to specific political or economic arguments presented by Germany, last reports relating budget cuts to the reunification and the parliamentary request to study the costs of withdrawing have credibility enough to be considered as a major internal issue that may have a major impact on the program. In that sense, it would be the political changes in Germany and Eastern Europe what could cause a major impact in the EFA. That impact may not probably be the German withdrawal, but perhaps stretchouts in the scheduled orders that could significantly increase the final cost of the EFA.

The Italian lack of funding levels for its 1990 development share is not viewed as a threat of major impact by itself. The expected benefits for the industry seem enough to assure that Italy will stay in the program, even though order stretchouts may be possible. Italy's withdrawal is not seen as probable, unless Germany actually

abandons the program, since that event would cause all the other nations to re-think the EFA program, in which case defense budget cuts in Italy and probably Spain could be a major factor.

Finally, the two most significant findings are directly related to the economic and political interests of EFA nations: First, the value that the participating nations and national industries give to the program in relation to the technological benefits directly derived from it, and the determination to ensure that national industries will actually benefit from the collaboration according to the program share and that the economic benefits actually go to the Europeans to the largest extent possible (and not to the U.S). Second, the emphasis that nations have put on the EFA as an instrument by which the technological dependence from the U.S. may be reduced.

The five nations' agreement to bar U.S. industry from EFA, though it was later replaced in the EUROFIGHTER's bidding procedures by the requirement from U.S. firms to team with some European company and be ready for production in Europe, is the main political issue introduced by nations in the EFA program. It is clearly not directly related with the specifics of the acquisition, but with economic and political interests of the five nations (France was also a part in that agreement) and has had a major effect on the program. The EFA as weapon system has for sure lost a valuable input from the U.S., but above all, it becomes a

sort of symbol of the European determination to end technological and defense dependency from the U.S.

The criticism that the EFA may be politically, instead of militarily, optimized reflects the determination to spread the EFA benefits to the industry and to the labor force in each country strictly according to its share in the program. That determination has had a major effect on the program and in the nations, exemplified in EUROFIGHTER bidding procedures and source selection criteria, for every major system in the EFA has required the creation of industrial teams with firms of each country. Not only the EFA will receive the benefits of a more intense collaboration among European industry, but also the partners with a weaker defense industrial setting have seen how the politicians and the EFA have facilitated their firms teaming with the stronger companies in Europe and the reinforcement of their defense industry.

VI. Conclusions and Recommendations

Conclusions

This work has shown that up to now the EFA has been subject to the same problems that other past collaborative projects.

From the initial five nations involved in the effort, four actually undertook the program, since the inability to agree on common requirements, mixed with the conflicting interests in national political and economic matters, actually caused that reduction in the number of participants. As a four nation program, the EFA has still shown the conflicting requirements between the two major partners.

It cannot be said that the process followed by nations to set up the program and the management structure will actually succeed in getting the weapon system within the cost and schedule initially planned, nor that the final performance of the EFA will actually be the required in the ESR-D. But it can be concluded that, up to now, there is no significant cost increase or schedule slippage. The management structure has been effective in implementing the political decisions regarding the achievement of the maximum cooperation during the definition phase in the issuing of the ESR and ESR-D and in developing the specifications for development, as well as the maximum industrial collaboration across the borders according to the agreed program share.

The existence of political and economic interests of the individual nations not related to the specific aspects of the acquisition program nor to their specific defense posture is also confirmed through the study. However, what is actually overwhelming is the political will to carry on the EFA program because of the industrial and economic goals of the four nations involved, and that those goals respond to both individual and collective economic and political interests.

Whether the conflicts that nations have had within the EFA program because of the differences in the requirements or because of their individual interests are of the same scale as those experienced in past projects is difficult to measure and is not addressed in this study. As it has been noted, the differences in requirements at the initial stages of the program were actually French requirements versus those of the other four nations. It is clear that yielding in the requirements and sacrificing Rafale was too much for France, no matter how strong its political will to cooperate might have been. Accordingly, differences in the U.K. and German requirements do not seem strong enough to overcome the same political will.

The collective political and economic interests, on the other hand, have clearly been strong enough to keep EFA alive, to restrict U.S. industry from participating on a free basis, and to push industrial collaboration across the borders of the countries involved. In that sense, the EFA

shows in first place the political will of the European nations involved to cooperate through the program. It confirms in part the thesis of Richard Fast about political will as the only means of making cooperation successful, since the program comes out more as a means for cooperation than a goal.

On the other hand, interoperability with U.S. NATO forces will eventually be achieved by other means than standardization. The EFA program shows the fallacy of standardization needs in NATO, and reminds us that standardization is not the only way to achieve interoperability. While the U.S. and the European NATO countries do recognize the need of interoperability among their forces, the EFA case shows that they are equally concerned about their domestic economies, their technological and industrial resources, and their share in the world defense market, matters that go before any standardization goal at both sides of the Atlantic.

Recommendations

The conclusions drawn in the study need to be validated or refuted during the next program phases. Whether the German warning about the possibility of its leaving the EFA when the time comes to move on to the production investment phase, and whether the reference to the costs of its political reunification is in fact a real threat to the

political will to carry on the program will be seen on the future.

Similarly, specific cost and schedule results, the final outcome of the EFA in terms of performance, or whether the European electronics firms involved in the ECR-90 radar will be able to develop it and whether it will meet the expected requirements and able to compete with the most advanced U.S. developed systems, as it is claimed by Ferranti and its partners in the team, should also be examined in the future.

Accordingly, further tracking and study is suggested as the program progresses, in order to find if the expectations that the four European nations have put on the EFA, on the weapon system itself and on the claimed benefits for the industry, actually come through, as well as to validate the conclusions drawn in this study.

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Difficulties faced by cooperative acquisition programs are identified as the inability to agree on common requirements and the existence of economic or political interests of the partner nations which conflict with or impinge on the program. These are the causes of failure of many of the past cooperative projects undertaken by NATO countries for the purpose of standardization.

The study investigates the European Fighter Aircraft (EFA) program in order to find if the same holds true for the EFA and the impact that those difficulties had in the program.

The EFA has been subject to the same problems. All the nations involved have defended their internal economic interests within the program. On the other hand, their collective economic interests have had the effect of keeping the program alive despite the difficulties. Irrespective of standardization purposes, the EFA appears as both a military and industrial necessity to push the aerospace industries of the partner nations to a competitive level in the world marketplace.

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