THE POLITICS OF DEFENCE CO-PRODUCTION

THE MRCA - TORNADO

By

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Abstract.

The thesis begins with a review of the literature dealing with the incentives and disincentives for pursuing defence co-production policies in Western Europe. Political, economic and military aspects are each dealt with in turn, and their relative importance assessed. Following this section is a case study of the Panavia Multi-Role Combat Aircraft - the 'Tornado' - now in service with the air forces of West Germany, Britain and Italy. The study traces the progress of the MRCA programme from its initial conception through to production.

The main theme of the case study is how the concerns of military-operational performance, cost-saving benefits, and programme efficiency were all secondary to government pursuit of wider political objectives. While the general literature was found to focuss upon cost-savings in collaborative procurement, such savings are seen to be constrained or even determined by the outcome of frequently unrelated political decisions. Although set within the broad framework of national economic performance and the demands of social needs upon limited public expenditure budgets, these decisions are based upon government preferences rather than industrial or other lobby-group pressures. A cursory evaluation of the MRCA programme and the aircraft itself is included in the conclusion. The project is seen to have achieved mixed success, but with significant problems.

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The Politics of Defence Co-production : the MRCA Tornado

Section 1 : Introduction

European collaboration in the procurement of major new weapon systems has become a central feature of defence planning in NATO. Such collaboration may take the form of co-production with or without co-operation in research and development; licensed production; or planned interoperability of systems. The latter policy involves the least amount of effort in international agreements, but assumes either national production or the purchase of a system from another source. Within western Europe, full defence co-production has emerged as the most common method of collaboration in procurement, particularly since the later 1960s. The possible reasons for this preference are the subject of the literature survey presented in Section 2 below.

The most pressing problem facing the European defence planners is one of limited budgets. Economic constraints take two general forms, the first of which is the demands placed upon tightly-controlled public expenditure budgets by other sectors such as social welfare and education. Whilst defence budgets have risen slowly, the proportion of GDP spent on defence in Europe has declined steadily since the decade after the Korean War. The emphasis has shifted away from defence as the immediate threat of conflict has receded. Secondly, the rising real cost of military weapons systems - estimated at 6 to 10 per cent. per annum on the capital production costs of major equipments after allowing for

inflation - has reduced the purchasing power of those funds which are allotted to the defence budget. (Baylis, ed. 1980, p.41). There is proportionately less money for defence, and less defence available for the money.

A further development has added urgency to the debate within NATO over possible solutions to the defence budget "squeeze" . The traditional technological and qualitative advantage possessed by NATO forces over the Warsaw Pact forces has been been steadily eroded by improvements in the latter's equipment. The previous reliance on smaller numbers of superior weapons systems is perceived as becoming both dangerous and difficult to maintain. The result of the debate has been the adoption of the NATO policy-goal of increased standardisation of equipment within and between the Allied forces as a means of improving their flexibility and effectiveness. Within the West European nations, co-production programmes are claimed by their participants to provide one method of achieving this ideal of complete standardisation. The reality of these claims will be discussed later in this paper.

European governments considering collaboration in defence procurement must do so in the light of a number of policy-choice questions. There are strong pressures both within and outside of governments to maintain or to increase domestic levels of employment. While debate continues as to the value of civilian spin-offs from military research programmes, many large defence-producing industries or companies have considerable civilian

sectors. Within Britain, Rolls-Royce and the British Aircraft Corporation are two of the most obvious examples of such companies.

> Specific national motives for collaboration have varied from project to project. In all cases, however, they appear to have been as much the product of economic and industrial considerations as of strategic and military objectives. (Leebaert, ed. 1981. p.81).

The politics of the national defense aquisitions process are in this sense important to any understanding of European collaborative ventures.

The aim of the present paper is to add to the sparse literature which exists on co-production policies in NATO. Although much has been written in the debate on rationalisation, standardisation and interoperability, there are comparatively few studies of the particular type of collaboration most favoured within Europe. Those which have appeared are often marked by an obvious bias either for or against such collaboration, as the authors are writing within the confines of the continuing debate over costs and benefits. Case studies of the Multi-Role Combat Aircraft (the MRCA) especially are hindered by this difficulty, due to the intense publicity surrounding the project as one of the ambitious undertakings of its kind.

The literature review is intended to provide both a summary and an evaluation of the various arguments presented by authors concerning the incentives and disincentives for co-production in Western Europe. National and international political objectives, national economic policies, programme cost-savings, and military

requirements are all considered in turn, and some indication given of their relative importance as motives in seeking collaborative ventures.

The central theme of the case study is the proposition that the political objectives of national governments may be seen to have overridden other considerations more directly relevant to achieving the most efficient or optimum results in terms of either cost-savings or military operational capabilities. In such a situation, the question for NATO is whether collaboration helps or hinders in the goal of achieving equipment commonality and in maintaining the political cohesion of the Alliance.

A second question implied in the case study is whether the concept of a multi-role weapon serves as a convenient "hedge against uncertainty" for European defence planners, or whether it creates additional uncertainties. In the face of concern over possible American disengagement from Western Europe, production of a multi-role weapon may be a means to ensure maintenance of European technological capabilities. However, by forcing design teams against technical barriers and the need to incorporate compromises based more on political agreements than operational neds, co-production may also create problems of cost escalation, uncertain operational performance, and delays in development and delivery.

Before presenting the main body of the thesis, a brief historical description of the MRCA programme should serve to give the reader an indication of the differing operational demands of

the three nations involved, and perhaps suggest some of the problems which they faced. It may also provide a more solid base against which may be placed the arguments to be considered in the literature review. A cursory evaluation of the MRCA's performance characteristics, and the main programme-goals of the Panavia consortium, is presented in the conclusion. Although this is not the main concern of the thesis, the strongly coloured views of earlier articles on the MRCA has been such that it was felt a more objective assessment might be useful now that the aircraft has reached operational service.

The Tornado was intended to provide a single aircraft to replace several existing types in service with the three nations involved in co-production: the U.S. F-4s, F-86s and F-104s of West Germany and Italy; and the British Lightning, Vulcan, Buccaneer and Canberra aircraft. The table below sets out the various missions required of the new system.

Table i). Roles of the MRCA-Tornado

Long-range strike/interdiction[a]	- GB, FRG.
Land-based strike at maritime targets	- GB, FRG.
Close support/battlefield interdiction	- Italy, GB.[b]
Air superiority/air combat	- Italy, FRG.[b]
Air Defense Interception[c]	- GB.
Recconaissance	- GB.
Training	- GB, FRG, Italy.

a - attacking enemy airfields, railways and yards, communication centres, to hinder movement and activity.
b - secondary roles only.
c - role to be met by Air Defense Version. (Smith,1980,p.133).

Each of these roles desired by the participating nations required distinct operational performance characteristics which were not always readily compatible. The result, discussed in more detail in the conclusion, was a mixed success in terms of performance and the achievement of programme goals, but also an aircraft which took twelve years to produce. This last difficulty has almost certainly cut sharply into the operational life-span of the Tornado aircraft type, and may be one of the main problems facing any attempts to co-produce advanced aircraft in Europe.

Section 2. Literature Review.

In his analysis of NATO co-operation in defence procurement policies, Keith Hartley states:

> Aerospace markets are more appropriately analysed as political markets in which the relevant economic agents are governments, bureaucracies and contractors. (Hartley, 1983, p.105).

Non-military goals may have a profound impact upon defence policy decisions. Trevor Taylor equally believes that simple analysis is perhaps unhelpful "...because whether a particular consequence is viewed as positive or negative depends upon an individual's political values." (Taylor, 1978, p.121). The diversity of possible implications, and differences in the values placed upon these implications between nations, makes analysis a complex task.

There are very few studies extant on the topic of defence co-production as a specific type of collaboration other than case-studies of present or previous projects. In order to present an assessment of the possible advantages offered by such a policy, it has therefore proven necessary to take the concepts applied in the RSI debate and to interpret their relevence to co-production. The various arguments are divided into three broad categories for the sake of clarity: political, economic, and military implications are each considered in turn. The existence of close connections between many of these influences is, however, recognised and these linkages are indicated where necessary. Whilst emphasis has been placed upon examples relevent to the aerospace industry, the arguments may be equally valid to procurement of other major new equipment.

To assess the political incentives or implications of co-production, a brief presentation of the perceived disadvantages of alternative procurement policies will serve to indicate or to highlight advantages which advocates of co-production claim to exist. The three main alternative acquisition policies other than collaboration are "off-the-shelf" purchases of existing weapons systems; licensed production; and independent national development and production.

For the major West European nations, purchasing of a complete weapon system often presents the cheapest but also the least politically acceptable alternative policy. Long-term reliance on such a policy is regarded as likely to create dependence on U.S.

industry and sources of supply.

> Complete dependence on another country has, in some cases, proven to carry with it a high risk... it is becoming clear that a nation without an independent industrial base actually has no assured military force.[1]

Such a result is politically unacceptable to the national governments in Europe, especially in the face of U.S. debates on possible disengagement from the defence of Western Europe unless its European partners shoulder a 'fair share' of the financial burden involved.

Domestic political and social pressures serve further to reduce the acceptability of direct purchasing of major military equipment in the larger European nations. Thomas Callaghan, a central figure in the advocacy of increased NATO co-operation and standardisation, indicates these pressures clearly:

> Europe's defense industries are now expected; first, to provide employment; second, to redress the balance of payments; third, to amortize research and development costs through exports; and fourth, if not inconsistent with the first three, to provide for...defence. (Callaghan,1978,p.26).

Purchasing equipment from abroad - mainly the U.S. - would fail to offer the prospect of increasing or even maintaining domestic levels of employment in defence-related industries, or of significant improvements in national industrial capabilities.

The second alternative to co-production, licensed production of a foreign system, does offer some of the potential benefits which the previous policy lacked. Off-set agreements allow the nation obtaining the equipment to seek expansion of domestic

production capacity and employment, whilst technology-transfer agreements may offer further industrial side-benefits. The Italian and West German aerospace industries emerging in the 1950s were sustained by licensed production of the U.S. F-104 Starfighter, and the "arms deal of the century" in the 1970s saw Belgium, the Netherlands, Norway and Denmark obtaining off-set agreements for licensed production of the American F-16.

The opinion of the major European aerospace producing nations, however, is less sympathetic towards licensed production. Taylor mentions that this policy does not offer the licencee an opportunity to obain experience in system-management and design, and also eliminates most direct involvement in research and development. " Production of American equipment ", Taylor argues, "represents a rapid road to dependence on the U.S." (Taylor,1982,p.155). Burrows and Edwards report a comment by an unidentified U.K. industrialist to the effect that

> We in the U.K. do not regard the production of F-16s in Europe as an outstanding example of project-sharing... This particular programme appears to be too much a benefit match for the U.S. industry and economy without equal technological reward for Europe or NATO. (Burrows and Edwards, 1982,p.67).

Amongst the larger and more advanced of the West European defense producers, the fear appears to be that either direct purchasing of existing systems or licensed production would be solutions to the problem of alternative defence procurement policies which would "...transform European advanced weapons industries into the step child of U.S. technology." (Dean,1979,p.97).

The third main alternative to joint collaborative development of a major new weapon system is the pursuit of an independent national programme. This option is certainly attractive in that it offers to the national government and the domestic industry the opportunity to maintain or to expand industrial employment levels, to obtain greater experience in design, development and production of an advanced-technology system, and at least some potential benefit to the national balance of payments through export sales. Despite this apparent advantage, national production of high-technology weapon systems is not favoured. The decisions by the British government and the West German government to cancel their TSR-2 and NKF aircraft programmes are two of the better-known cases where independent national development schemes were scrapped due to the prohibitively high costs involved in such work. In the case of purely national development schemes, criteria of cost therefore outweighed all other considerations.

The discussion presented above has introduced some of the considerations which are presented in the literature review below. It is now possible to examine in detail the incentives and disincentives for co-production as they are given by the various authors in this field.

Political Implications of Co-production.

There are both national and international political implications of co-production which are claimed to provide

incentives to pursue this alternative. Representatives of the European members of NATO have all accepted the necessity for greater standardisation of their forces, and this policy has become institutionalised in the NATO administration through groups such as the NATO Long-Term Defence Programme, the Military Agency for Standardisation, and the Conference of National Armaments Directors[2]. However, the question that this apparent acceptence invites is whether the governments themselves believe such a policy to be worth the political concessions and the industrial reorganisation which it would be likely to entail. Trevor Taylor expresses the opinion that this is not the case;

> ...while the European NATO states may come to have accepted that autonomy in defence production is not feasible, and that any major project will require at least one partner, there is but limited evidence that they desire the kind of integration which standardisation would require. (Taylor,1978,p.121).

The author makes the point that standardisation would necessitate the emergence of NATO as the pertinent decision-making body in all defence questions, as national operational and strategic doctrines would become irrelevant. Though regarded as being militarily desirable, standardisation could also imply loss of sovereignty over defence policy.

Advocates of co-production contrast this scenario with the more limited constraints of collaborative agreements. It has been asserted that "...collaboration could be defined as the pursuit of national goals through international means." (Dean,1979,p.80). Co-production may even provide governments with

a useful instrument for pursuing wider foreign policy objectives.

> The national technology policies of Britain, France and West Germany in the defense sector transcend economic motives of national profit and employment... Their competition for power and influence within Europe, as well as national political and economic ambitions which extend beyon Europe, are also important determinants. (Dean, 1979,p.82).

Deans' argument is supported by other analysts, including Walter Schutze who believes that the political dividends of European defence co-operation are essential to European relations. Such agreements could be used either to cement political ties between nations or to coax another government into giving support to a particular foreign policy goal.(Schutze,1969,p.154).

A more cynical view of potential political advantages of co-poduction is concerned with the result of governmental interest in continuing a programme in which it has wider concerns at stake. Difficulty of cancellation of a programme in which there are present the interests of one or more national governments is cited by authors as diverse as Kaldor and Smith, Hartley, Hagen and Trevor Taylor. According to this more cynical interpretation, the other 'incentives' argued for co-production provide an ex post rationalisation and justification for the real political reason that once begun, such programmes are less likely to be abandoned by governments facing financial shortages.

This argument may indeed have some validity, in that collaborative programmes are likely to prove difficult and costly to cancel. However, in this case one would expect that industries would also be interested in pressing for collaboration

as a means of ensuring continued defence contract work, yet this does not appear to be the attitude of industrial leaders when left to decide their own affairs. The attitude of aerospace leaders in the MRCA partner nations will be discussed later in this paper; even as early as 1969, a difference of opinion over collaboration was clearly apparent.

> At this time, a pattern is emerging in which the nationalised companies, or those which depend largely on government backing, are pushing consortiums, while firmly-established companies in the private sector are avoiding this type of arrangement.[3]

If non-cancellation is valued as a benefit of co-production or collaboration generally, it is held as such by governments and closely connected industrial leaders, but not by the private sector. In some cases, then, economic benefits or company profits may be valued higher than a less-than-efficient but hard to cancel project; subjective valuation of this aspect of co-production renders any conclusive assessment difficult.

One political implication which may result from co-production is frequently cited as a potential problem for the NATO organisation, and is the other side of the coin to a benefit discussed previously. The NATO administration has no international political authority of its own, and therefore depends upon the will of the nations involved. At worst, it is a "...mere tool of these governments and all its activities are subject to national control." (Ruhl,1975,p.217).

> The European impulse towards collaboration and co-operation...(is) not necessarily

> congruent with Alliance impulsestowards rationalisation and standardisation if these proceed on the basis of United States equipment and planning.Indeed the two... are competetive and opposed. (Dillon,1977,p.224).

Co-production offers governments the chance to claim to be pursuing standardisation whilst actually seeking other objectives. The result of this could be detrimental to NATO effectiveness.

Collaboration or co-production are claimed to assist NATO by requiring harmonization of replacement schedules and other forms of longer-term co-operative planning. These claims will be analysed later in this section. Once again, however, the obverse of this benefit may hamper the progress of NATO towards its own goals, as national objectives become confused or contradictory.

Gardiner Tucker discusses three policy options which may be involved in European collaboration in major weapons-systems development projects. The first option is that of creating an independent and competitive European defence sector as an insurance against decreasing U.S. commitment to Europe, and to allow greater competition in equipment sales. The second alternative objective of co-production might be to develop a more equal partnership in defense production between the two sides of the Atlantic through greater scale of production and market size and through rationalisation of European industrial resources. Finally, as Tucker notes, it is important to realise that neither the adversarial nor the co-operative interpretations offered above are the same as the NATO objective of standardisation, as

their results could be markedly different (Tucker,1976,p.48). There is a possibility that confusion over the real goals being sought in co-production programmes may exacerbate problems of political disunity and destandardisation in NATO, the opposite of what might be expected.

The necessity to make long-term planning which is a feature of collaboration in procurement creates its own potential difficulties for the governments involved in such a programme.

> It must be stressed that co-operation regarding defence equipment has...wide implications reaching well beyond the field of security...co-operation on defence equipment requires governments to make long-term binding commitments to others on expenditure. (Taylor,1982,p.7).

This is why collaboration is often very difficult or impossible to arrange. European governments are well aware of the restrictions which a long-term commitment to expenditure on all such projects may place upon their freedom of choice in determining national defence priorities;

> Co-operation in fact concentrates on specific projects which governments treat as individual and separate cases. Thus commitment to principles is avoided. (Taylor,ibid).

Under such circumstances, there may be a tendency for collaboration to remain ad hoc in nature, detracting from the possible benefits of replacement schedule harmonisation. Collaboration may paradoxically result in the reinforcement of governmental awareness of possible encroachments upon national sovereignty.

The next potential disadvantage of co-production which is

discussed in the literature is the vulnerability of these projects to the vagaries of national political opinion or stability within the members. Political instability can cause uncertainty at home and abroad, thus delaying the progress of achieving agreements on project definition, funding, or work-sharing.

Domestic influences such as opposition party pressures and turnover of governments, even if they do not result in cancellation of a programme, may oblige a government to seek to reduce the immediate financial burden of that programme by stretching out the delivery schedule. Such a decision is a purely short-term expedient;

> Industrialists stress that costs are minimised when production rates are planned and not changed; either speeding up or slowing down production costs money. (Taylor,1982.p.52).

In his examination of the production of the F-14, Taylor cites the claim by Grumman that cutting the production rate from 3 to 2 per month would increase the unit cost from $23.9 million to $28.9 million. It is worth mentioning here that modern aircraft have an expected useful life-cycle of ten to fifteen years. Hence if production schedules are drawn out, the system may be approaching the end of its life-span by the time it is in full operational availability.

Political advantages and disadvantages present an awkward area of analysis in considering European co-production. Just as the goals sought may alter from project to project and

between nations, so may the value placed upon particular objectives. What does emerge from the discussion of the political implications of co-production in Europe is the continued primacy of national political and economic interests (as perceived by the governments) over purely military or NATO-policy concerns and policies. The potential political advantages of co-production are mainly those which seem to maximize the opportunity of the national governments to use collaboration as an instrument of their own in achieving goals frequently unrelated to the immediate context of the project. The potential political costs, or else the actions which are taken by governments to avoid these costs, are often at the expense of obtaining either the most effective programme or proclaimed NATO objectives.

Economic Implications of Co-production.

Although the influence of political considerations in undertaking co-production appears to be a central, or even the central feature of contemporary co-production programmes, the difficulty of providing empirical analysis of this influence has meant that the literature concentrates far more on the potential economic advantages or costs. As will become apparent, however, this has not resulted in general agreement as to the nature or the extent of these economic implications. Most authors tend to argue that co-production does offer potential cost-savings for the participating states, but a vocal minority

believes that collaboration is no more than an inefficient and expensive mistake.

Two general categories of economic incentives can be identified as existing: the first category deals with cost-savings associated with a co-production programme, such as economies of scale; the second involves government policy, and the use of co-production to pursue wider national economic policies. An analysis of each of these areas is presented below.

Estimates of the amount of money wasted each year by inefficiencies in the NATO equipment procurement 'system' range as high as the Senate Armed Services Committees'figure of $15 billion, or Thomas Callaghan's total of $11.2 billion (Hagen,1980,p.45). These authors' figures are very rough and are increasingly questioned. Even the strongest advocates of co-production, however, would not claim potential savings of such a magnitude for this type of collaboration. Nevertheless, in the procurement of high-technology, high-cost weapons systems such as advanced combat aircraft, supporters of co-production claim that the result of their policy is (or would be) considerable cost-savings for the governments concerned.

Analysis of potential cost-savings attributed to this policy centre on three specific stages in the procurement of a new weapon-system. These stages consist of the workinvolved in research and development (R&D), production, and in logistic support once the system has been deployed.

Planned R&D in a co-production programme would, ideally,

reduce or eliminate duplicative efforts amongst the partner nations' defence industries. This represents the optimum condition according to the advocates of this policy. However, this ideal is unlikely to be achieved for at least two reasons. Firstly,

> Nations will demand their 'fair' share of each sector of advanced technology and production work. Consequently, development...will tend to be allocated on equity, rather than efficiency, criteria. (Hartley,1983,p.148).

Governments seeking to maintain or to expand industrial capacity will not accept specialisation of tasks amongst the partners if that means failing to obtain an equitable work-sharing agreement. Opponents of collaborative policies argue that instead of reducing the R&D burden, partners in co-production programmes continue to employ full-sized research teams and that these teams are then employed for a longer period than on a national scheme (Hartley,1983,p.155).

The second complication to the most efficient use of R&D facilities is that on jointly-produced weapons systems, each nation would require some modifications to make the weapon suitable for its own specific operational requirements. This would then serve to increase R&D costs and possibly reduce the ability to obtain economies of scale in production. Other possible sources of increased R&D costs resulting from collaboration might include the creation of duplicate organisations for administration of the development phase in each of the partner nations, and delays due to the need to harmonize

differing national industrial standards of measurement. Finally, in the case of aircraft design, the necessity to meet different operational requirements may cause designs to be pushed against technological barriers. If this results in schedule delays during the design phase, then additional costs clearly will be incurred.

Taylor quotes from a Vertex Corporation Report[4] which esentially rejected any possibility of obtaining meaningful R&D savings on the grounds that nations would never agree to give up their existing research capabilities:

> Those who imagine that national R&D efforts are 'negotiable' within broader transnational procurement strategies delude themselves... (Taylor,1982,p.49).

This conclusion does appear to have some degree of validity given the earlier discussion of government concern with maintaining independence in policy decisions.

There are some arguments which may reduce the absoluteness of the Vertex Corporation Reports' rejection of potential R&D savings, and these are also pointed out by Taylor. Firstly, nations can maintain their military-industrial research capabilities through methods other than the actual production of specific weapon systems. The Anglo-French Variable Geometry project and the UKVG work which followed the cancellation of research on the AFVG were attempts to provide for the continuation of British industrial capabilities without incurring other programme costs until a better collaborative programme

could be established. Secondly, the provision of technology transfer arrangements would allow national maintenance of development knowledge even if some specialisation were to take place on the grounds of increased efficiency. Finally, Taylor points out that European governments have given up national R&D efforts in areas where costs have become prohibitive - for example, British abandonment of work on strategic missiles and considerable limitation of work on tactical ground-to-ground missiles. (Taylor,1982,pp.49-52).

The second stage in the procurement of a new weapon system which is seen to offer potential cost-saving benefits is that of assembly and production. Here, the advocates claim that savings can be made through obtaining economies of scale and through the effects of the 'learning curve'.

Thomas Callaghan, in advocating the integration of European aerospace industries, argues that

> The individual nation states of Europe provide markets too small for an adequate division of labour - too small to sustain healthy defence industries... (and) too small for military trade and co-operation with the United States; the defence industries of Europe are too small to produce weapons to a transatlantic scale. (Callaghan,1976,p.26).

Co-production, by merging the markets of the participating nations, could create a solution to this problem, identified as early as the 1965 Plowden Report commissioned by the British government to assess the condition and future of the aerospace industry in that nation and throughout Europe.[5] It would also offer potentially greater export opportunities by adding together

the traditional markets overseas of the nations involved.

All of the considerations discussed above would have the effect of increasing the total number of orders placed for the weapon system and hence allowing for a potentially longer production run. Taylor gives some estimation of the scale of savings this could produce on major weapon systems:

> In the case of aircraft, normally produced in the hundreds, it is widely believed that a doubling of production should have the effect of reducing production costs by up to 20%. In other words, if the 100th aircraft cost (UK) 10 million pounds to produce, the 200th should cost 8 million pounds, the 400th 6.4 million pounds, and so on. (Taylor,1982,p.52).

At the same time, longer production runs would allow both management and workers to progress further down the 'learning curve'and increasing their efficiency, as well as permitting the installation of the most advanced automated (and other) plant in the factories where production is to take place. All of these influences would result in greater production efficiency, and possibly increased production economies.

Both Taylor and Hagen discuss the concept of 'minimum efficient scale' of production (MES), or the level of output at which average costs reach their perceptible minimum. The individually small European industries operate well below the MES, whereas the U.S. industries - with much larger domestic markets - are able to operate at this optimum level. Production of the Tornado totalled 809 units; of the Jaguar, 583 units; the Mirage F1, 649 units; and the Alpha Jet, 486 units. In contrast

to these figures, the U.S. F86 programme produced 9502 units; the F4, 5195 units; the F104, 1958 units; the F16 1949 units; and the F18, 1500 units. (Hartley,1983,p.113). Taylor provides an estimate that raising European production to the MES through co-production programmes could yield savings of between 10% and 25%[5].Hagen cites a figure of between 5% and 15%, "...with 10% being the most likely figure." (Hagen,1980,p.115). Hartley supports the view that two nations combining their orders could obtain production cost-savings of up to 10%.[6]

Although these authors generally agree that co-production or collaboration offer potential savings to the participants, Hagen also points out that these estimates rest upon a series of assumptions which affect the accuracy of the claims. It is assumed that price responds 'ideally' to output and learning conditions, but this ignores the possible influence of government regulations, restricted competition, or organizational inefficiency. The possible trade-off between scale and competition among suppliers, both domestic and international, is similarly overlooked. Thirdly, possible diseconomies of scale are ignored: costs of transportation, support and distribution are not accounted for, although they would certainly be increased in a joint international programme (Hagen,1980,pp.116-118).

In giving his estimates of potential savings from longer production runs, Taylor assumed a single production line. However, this may not be the case in reality, as co-production agreements often stipulate that each nation in the programme

should obtain a share of production work, often for reasons other than achieving optimum efficiency. W.B. Walker argues that such proliferation of assembly lines is inevitable in any collaborative programme, and serves to increase costs and reduce possible savings.

The validity and accuracy of this counter-argument against collaboration is, however, not as conclusive as its proponents would suggest. Taylor points out that final assembly actually accounts for only some 10% of total production costs and that the detrimental impact of several assembly lines may therefore be reduced:

> While multiple production lines and other inefficient modes of production can easily mean the loss of savings, the use of 'assembly' lines and a maximum of one production line (per nation)... could produce an intermediate but nevertheless improved position. (Taylor,1982,p.54).

Hartley concludes his evaluation of potential cost savings in joint projects by estimating that, compared to a similar national venture, a co-production programme could involve R&D cost increases of up to 30%, and production inefficiencies of between 1-10 % for a given output. Despite these increases, however, savings may still be obtained, since by combining their orders two equal partners "...will save at least 35 per cent. (each) on R&D and up to 10 per cent. on production costs." (Hartley, 1983,p.161).

In all the debate over potential savings to be achieved in R&D and production, many of the authors have touched only briefly

or not at all on the area of logistic support. This may be due to skepticism over the possibility of common logistics systems ever being established, as this area is traditionally regarded as a national concern. Nevertheless, the importance of logistics expenditure and possible waste has long been recognised:

> Year in, year out, support costs are incurred in maintaining and operating non-standard weapons and equipment, and munitions of every calibre. This means a proliferation of sub-assembly and component repair parts; of repair facilities; (and) operatonal and maintenance facilities. (Taylor,1982,p.115).

The general 'rule of thumb' for estimating system costs for an advanced combat aircraft is that it will require between its original acquisition cost and twice this amount for logistic support and maintenance. The system cost for an aircraft of unit price $10 million would therefore total between $20 and $30 million.

Thomas Callaghan estimated that $5.65 billion dollars is wasted annually in the area of weapons-support, and that the creation of an alliance-wide logistics system would reduce most of this waste[7]. Taylor responds to this idea by arguingthatthe supposedly integrated U.S. forces "...have never been able to make the resupply of spare parts work effectively despite many herculean efforts." (Taylor,1982,p.118). Within Europe, the concept of a European Army or Defence Force was discussed but never advanced beyond that stage. Hagen again indicates his belief that Callaghans' assumption that complete logistics integration is politically feasible, or even organizationally

possible, is at best doubtful. (Hagen,1980,p.110).

Where complete logistics integration is unlikely, co-production may offer the European governments a politically acceptable solution to the need to create some improved support organization, though only of a limited or project-bound nature. Despite his skepticism of Callaghans' views, Taylor argues that there is scope for logistics cost-savings:

> The most meaningful specific figures are those pertaining to particular weapons. The salient general statement is that the greater the commonality of equipment and subsystems in the Alliance, the greater the scope for co-operative, large-scale purchasing of parts. (Taylor,1982,p.56).

In its place, co-production may thus offer a more modest but also a more realistic possibility of achieving cheaper logistics support arrangements.

These more modest possibilities are still questioned by some commentators. David Greenwood argues that such claims are dubious because co-production does not solve the problem of logistic support for existing non-standardised weapon systems. Until this difficulty is overcome, "...nations may have to bear part of the costs of joint facilities without a commensurate reduction in the expense of their existing support apparatus." (Greenwood,1980,p.328). Greenwood fails to take into account two points: first, that one assumes that the co-produced system is replacing an existing system whose support costs will then cease; and secondly, international logistics arrangements for the new system should be judged in comparison with the alternatives which

would otherwise have been pursued. In these circumstances, co-production may well offer a cheaper support option.

The second main type of economic arguments concerning co-production are those which deal with the use of this policy to achieve wider national economic objectives. The perception by governments of the need to obtain such goals is recognised by most authors in the defence literature.

> The economic well-being of the individual member-nations - based on technological competence and competetiveness - is directly relevant to their sense of security. So too are political and social stability, which economic weakness can put at risk. (Greenwood, 1980,p.330).

For this reason, Greenwood argues, it is reasonable for governments to judge any co-operative procurement policies in terms of the possible repercussions on national defence industry capabilities, employment levels, or other domestic economic problems.

Table 1) in the Statistical Appendix illustrates the re-orientation in public expenditure budgets in Britain away from defence and towards sectors of social welfare requirements. Under these circumstances, as indicated by Thomas Callaghan's quotation earlier (page 6), there are broader expectations from co-production or from any defence procurement programme as "...taxpayers expect defence expenditures to produce not only defense material but also jobs." (Walsh,1975,p.11).

In the Economist Intelligence Unit report of 1963,it was

estimated that defence work constituted 70% of British aerospace production, financed 80% of aircraft industry R&D work, and directly involved some 45% of aerospace workers. Of the latter total, more than half were employed in regions badly hit by unemployment, especially in the north-west and south-west.[8] By 1970, total aerospace employment in Britain was estimated at some 230,000, with a substantial proportion of these workers depending upon defence contracts. Under such circumstances, employment opportunities provided by co-production are cited by its advocates as a major incentive for pursuing this alternative.

Strong government awareness of the pressure to preserve employment levels in industry is illustrated in this extract from an article by the British Secretary of State for Defence in the early 1970s, Mr. Roy Mason:

> ...we have to recognize, if we are to be realistic, that it is jobs that move the man in the street, the unions, conveners, shop stewards, and even Parliament, when the subject of defence is debated. (Mason,1975, p.225).

Whereas 'off-the-shelf' purchases give no opportunity of increasing or even maintaining employment, and other alternatives are politically unwelcome or financially prohibitive, co-production offers governments a viable means of achieving their goals.

Apart from the political advantages of an independent defence industrial capacity discussed previously, co-production is also argued as a useful instrument by which governments can pursue an

industrial policy designed to assist domestic competetiveness or to address problems of surplus production capacity.

The close link between defence and civilian industry, especially imareas of high technology, is mentioned by a number of authors. Bellini and Pattie discuss the connection in the electronics industry in Europe; in France,for instance, 45% of the French national output in that sector was underwritten by defence contracts[9]. Burrows and Edwards argue that not only is there a close connection in this sense, but manufacturers also have frequently financed civilian projects through their earnings from military contracts.[10] While the nature and extent of civilian benefits from industrial or research spin-offs is uncertain, by allowing governments to pursue advanced-technology programmes whichotherwise might be beyond nationalcapabilities for financial or other reasons, co-production opens up the possibility of obtaining progress in sectors which would otherwise lose an important stimulus.

Connected to the concern for progress in high-technology industries is the possibility of direct advantages being obtained from the considerable technology-transfer between nations which is a necessary aspect of co-production programmes.

> Both receiving and transferring countries recognise that know-how currently used in the manufacture of military equipment... is usable in (the) production of internationally-traded, technologically-intensive civilian products. (Greenwood,1980,p.330).

Selective use of co-production programmes can thus provide

national industries with valuable technological progress and (Greenwood implies) provide balance-of-payments advantages through creating new export potential.

As with the discussion of potential political advantages from co-production, the literature which deals with possible economic benefits tends to avoid these more subjective aspects of debate and to concentrate instead on the quantitative study of cost-savings. However, two authors in particular have sought to address the question of government involvement in or direction of defence procurement policies, and their views are at least worth examination as illustrating the disadvantages accruing from such manipulation.

Both Mary Kaldor and Dan Smith, outspoken Labour Party critics of government defence policies in Britain, discuss the merits and problems of European collaboration in the context of a 'crisis of surplus capacity' in the British defence industry;

> Management of British defence policy is a constant compromise between the availability of resources forever inadequate to provide desired capabilities, and the super-availability of military industrial resources able to produce what the budget cannot afford. (Smith,1980,p.120).

The authors represent the left-wing of the Labour Party, and while less critical of that party's defence policies, they continue to criticise the diversion of industrial capacity to defence production and away from other types of commercial and civilian uses. They are also a useful illustration of some of the domestic opposition faced by the British governments.

Smith views collaboration as part of this wider government concern with over-capacity in industry, and considers that the military product of such policies is frequently irrelevent. The author argues that it is not in "...the unit cost of finished products that the advantage is felt (to exist), but in the overall cost of sustaining capacity." (Smith,1980,p.165). Mary Kaldor clearly agrees with this analysis, and also with the view that collaboration is no more than a temporary solution which does not address the real problem of surplus capacity.

> International collaboration does not provide a solution to industrial problems, nor can it be said to have contributed to standardisation in NATO. (Kaldor,1982,p.203).

Whilst co-production policies are unable to provide goverments with an adequate solution to their domestic defence-industrial difficulties, Kaldor also believes that it offers little hopeof progress towards the official NATO objective of standardisation.

According to these authors, therefore, co-production and collaborative procurement policies generally fail to offer any genuine political advantages to governments seeking to address 'fundamental'domestic industrial problems. At the same time, such political direction not only hampers military and industrial efficiency, but renders such criteria largely irrelevant.

Some comments need to be made concerning this interpretation of collaboration. Firstly,the authors' studies concentrate on the policies of British governments, and their conclusions are

not always relevent to other nations. West Germany and Italy, for example, could not have been said to have faced a crisis of surplus capacity in their defence industries. In these cases, collaborative programmes may have offered potential benefits through allowing planned expansion of underdeveloped or underexploited industrial potential. Secondly, while Smiths' case study of the Tornado provides useful criticisms, both his and Kaldor's assessments of the usefulness of collaboration as a political tool are marked by predetermined biases. Neither author makes any pretension towards presenting an objective analysis, and instead are concerned with arguing the case either for reallocation of limited resources to civilian uses or else for British disarmament and the turnover of all defence industrial capacity to other modes of production. However, the work of both Kaldor and Smith does help to indicate some of the possible disadvantages which may result from political manipulation of procurement policies and contract allocation. At the same time, they are useful as illustrating the nature and views of at least a part of the domestic lobby-groups which governments must deal with in formulating or defending their policies.

Military Implications of Co-production

The final area of potential benefits from co-production which requires consideration is that of the military capabilities and

effectiveness of European NATO military forces. Once again, opinion in the literature is generally supportive of the view that commonality of equipment would be a valuable asset to NATO, but neither the precise type of policy required (standardisation, or interoperability of fuels, munitions etc.), or the extent of the potential gains to be made, are unanimously agreed upon.

The most obvious potential benefit of co-production which is touted by its supporters is that by creating greater commonality of equipment among NATO forces,it will increase their levelof flexibility and efficiency. This claim rests on two presumed effects, the first of which is that use of common equipment will simplify the task of co-ordinating operations by adjacent forces. Secondly, by reducing difficulties of support and maintenance, commonality permits swifter redeployment of forces and major weapon systems such as aircraft. Taylor supports the need for commonality on the grounds that

> NATO forces could fight much more effectively. Their deployment would be more flexible, they would easily be able to reinforce and resupply each other and joint operations would be immeasurably easier. They would be well-suited to fight a coalition war. (Talor,1982,p.117).

Co-production is thus seen as a possible method to overcome the destandardisation which - in the words of General Johannes Steinhoff - has given NATO the appearance of "...an army museum." (Tucker,1976,p.6).

Aside from these ideas, promoters of co-production argue that increased commonality will enable NATO to improve its poor

'tooth-to-tail' ratio (that is,the ratio of combat-to-support troops and equipment);

> With regard to the admittedly special case of the ACE Mobile Force (Allied Command Europe), it has been suggested that its fighting capabilities could be increased by 50 per cent. if it used common equipment. (Taylor, 1978,p.117).

Callaghan has estimated that NATO requires twice as many support troops as the Warsaw Pact. Thus despite similar total manpower figures, the WPO is able to field a larger number of combat forces.[11]

The third potential military benefit of co-production stems from the cost-savings which are claimed to result from this policy. The suggestion has been made that this may in fact be the military argument of most appeal to military planners whose budgets are under pressure from rising costs, as the resources 'saved' in this manner can be redeployed elsewhere in the defence sector. Development projects previously neglected could be undertaken, or greater numbers of a particular existing system procured.[12]

Before moving on to consider the counter-arguments presented in the literature against some of the claims discussed above, two further possible military advantages require mention. First, co-production may also be the only economically feasible means by which European NATO forces can obtain advanced, high-cost weapons systems without turning to the U.S. As was mentioned earlier, dependence on foreign sources of supply might be considered potentially dangerous or restrictive as national forces are tied

to another nations' foreign policy decisions. While independent sovereign states continue to exist, national military forces will be considered an essential part of national security.

The final military benefit from co-production which appears in the literature concerns the avowed NATO objective of standardisation of forces. The political acceptability of standardisation is questioned by many if not all authors, for reasons given earlier. Co-production, an acceptable alternative policy, not only can result in commonality of equipment, but also planned commonality of training programmes and the establishment of international logistics arrangements;

> ...commonality as an ideal does not involve only a single weapon type in all circumstances. Several sorts may be deployed if there are military advantages in terms of making the enemy's job harder or having a more appropriate system for the environment. The crucial factor is to plan duplication of type rather than leave it to chance. (Taylor, 1982, p.37).

Planned duplication is similarly advocated by Gardiner Tucker as a means of countering the problems of destandardisation and dissipation of resources.[13] By requiring several nations to harmonize their replacement schedules and to agree upon common operational requirements, co-production may be a partial step towards such planned duplication of types.

There are two forms of military arguments presented in the defence procurement literature which attempt to indicate the potential disadvantages of co-production. The first argument deals specifically with the military costs or inefficiencies

which might result from joint development programmes. The second area of opposition concerns an alternative view of the actual necessity of the results that the advocates proclaim.

One of the specific arguments against equipment commonality is that it would make an opponent's task of creating effective counter-measures far easier. Diversification of weapon systems is thus seen as militarily advantageous, and co-production as endangering this advantage. The superficiality of this view is neatly indicated by Hagen's remark that

> This has a rather odd ring about it; it is hard to find a NATO commander rejoicing over equipment standardisation within the Warsaw Pact. (Hagen,1980,p.38).

Although proliferation in areas such as radars, electronic warfare, or armour may be desirable, the planned proliferation discussed previously is an entirely different condition to the unco-ordinated duplication which has existed up to the 1970s and even into the 1980s.

The claim that cost savings obtained through co-production could be used by national defence planners to procure extra or alternative weapon systems makes an assumption which may be incorrect. With the pressures in West European states to improve social welfare and living conditions, "... there is no guarantee that governments who save on defence will be willing to put funds back into the defense sector." (Taylor,1978,p.116). Priority might instead go to education, health care, or other types of public expenditure which are more popular with voters.

Co-production does entail the need for nations to harmonize their equipment replacement schedules and to make compromises regarding operational or mission requirements. This is especially true if they are to seek economies in R&D and production, or in support services. However, co-production may not always result in a greater degree of equipment commonality. Kaldor argues that commonality is severely hampered due to differences amongst national production standards, including machine tools, measurement systems, and quality standards. The author cites the case of the U.S. and European Hawk aircraft, which are not in fact interchangeable although this was supposed to be one of their main features.[14]

While the criticism presented above certainly does create problems in any co-production programme, these difficulties can be overcome by agreeing to use specific measurement standards throughout the project, and by translating or converting differing national standards to these new specifications. However, this involves time-delays in the project definition phase, adding to delays which might result from problems in reaching acceptable compromises on operational requirements or work-sharing agreements. These delays all serve to increase the final unit cost of the equipment being produced.

Apart from the arguments presented by authors against the advantages claimed to result from co-production, there are also a number of authors and other analysts who , rather more broadly, question the actual need for the complete standardisation sought

by NATO or even the equipment commonality proposed by those pushing collaboratlve procurement. Kaldor cites the view of General James Polk, commander-in-chief of the U.S. Army in Europe in the later 1960s, who remarked that

> ...the whole effort of standardisation or interoperability... should be concentrated exclusively in the area of petroleum products and ammunition... The rest is just window dressing. It is not worth the time, trouble and money required. (Kaldor,1982,p.204).

This expression is representative of those authors who argue that what is really necessary is concentration not on equipment standardisation but upon the 'essential expendables' indicated by Polk.

Although there is some validity in this concern, these authors overlook a point of considerable importance: that much depends upon the nature of the war or conflict being envisaged. If the expectation is of a swift conflict, then this limited interoperability would be adequate. However, as Hagen points out, this may not be the case if the conflict were to be a protracted one. In this situation, there would remain for instance "...little aircraft interoperability at the level of repair capability, armament, and electrical power supply systems." (Hagen,1980,p.36).

> Thus, the availability of fuel and ammunition at a friendly base means that... after several missions flown, an aircraft will probably be able to return to combat, if at all, only with a reduced capability. (Taylor,1982,p.43).

For advanced combat aircraft, fuel, ammunition, and other predictable 'essentials' such as oxygen or lubricants are

insufficient to fully service the system.Instead, periodic large-scale maintenance is required,the nature of which cannot always be foreseen. Under these circmstances, the common training of ground support staff and crewmen, and international logistics organisations, which are offered by co-production programmes would provide much greater opportunities for adequate maintenance.

The arguments concerning the military value and implications of co-production clearly are not entirely conclusive either in favour of, or against, such a policy. However, the weight of opinion in the literature on alternative defence acquisition policies does lie with those who argue the case for either standardisation or commonality. Those who argue against collaboration have few if any viable suggestions of other courses of action to improve NATO forces in the face of strict economic restraints and theinevitable political interests of national governments in any major defence budget item.

Analysis of the political implications of defence co-production in the relevant literature showed that most authors preferred to avoid attempting any detailed theoretical consideration of potential advantages or problems. While certain points may be generalised - such as use of work-sharing agreements to provide another government with incentives to support a particular policy - the differences in objectives and values placed upon similar goals or results is such that

conclusive answers to 'cost-benefit' questions are impossible. One can only say that in the absence of wider political incentives either to initiate programmes, agree on compromises, or to continue projects underway, the likelihood of cancellation would increase dramatically. In this sense, those who state that one result of government involvement in co-production is to make such programmes far harder to dissolve are correct. Whether one sees this as good or bad depends on what combination of political, military and economic results one is examining, and upon the analysts' own political perspective.

Whereas political interpretations of co-production policies are few and often value-laden, consideration of cost-savings potential dominates the literature on defence procurement. Despite this concentration, there is no real agreement in the literature on either the nature or extent of potential benefits to be obtained. However, when compared to individual national programmes to produce similar weapon systems, opinion is strongest on the side of national economic benefits through relative cost-savings. In considering domestic economic benefits other than immediate cost-savings, conclusions as to the 'value' of co-production again depend upon the author's political perspective. One can state that co-production offers governments a potentially useful additional instrument for influencing economic policies; one cannot assess the worth of the specific policies other than by individual case-study.

A problem which pertains to much of the literature reviewed

in this paper is that which Greenwood describes as the tendency to step into the 'efficiency trap':

> ...that is, the tendency to ask "what is required of a system without including the political parameter that may demand a second-best or third-best solution." (Greenwood,1980, p.320).

Co-production programmes may be marked by a necessity for compromises on national military-operational requirements. The most efficient R&D or production arrangements may not be obtained. These results, if they occur, should not be accepted as inevitable. Nevertheless, it may not be helpful to have "...what is really testimony to the relevence of values and interests other than efficiency castigated as obstacles." (Greenwood,1980,p.323). Despite the tendency in the literature to suggest, almost implicitly, that cost-savings are the most important incentive for governments considering co-production, it is the view of the present author that Greenwood's warning should be remembered. Political objectives, discussed only superficially in the general literature on defence procurement, are often central influences on the agreements reached in such programmes and simultaneously set out the general background against which the agreements are eventually made.

Section 3. Case Study of the MRCA-Tornado.

In determining the industrial and military sector which might best provide opportunities for case study material concerned with European collaborative procurement, aerospace policies appeared to offer several advantages. First, and most obvious, was the fact that high-cost, high-technology aircraft have a pronounced impact on limited national defence budgets. It therefore seemed likely that government interest in controlling or influencing projects in this sector would be considerable. Secondly, the high unit price of advanced combat aircraft would give the greatest opportunity to assess potential cost savings in R&D, production, and logistics. Third, it was hoped that the high cost and prestige value of aerospace programmes, and the necessity to establish work-sharing arrangements between nations and industries, would would provide a good example of the conflict in collaborative programmes between political and economic 'nationalism' and the desire for cheapest-source purchases. Finally, the Multi-Role Combat Aircraft or 'Tornado' has certainly been the largest, most costly, and ambitious attempt at European collaboration in the development of a major new weapon system for use in NATO. All of these considerations will therefore lend to the present work a higher degree of policy relevence in assessing the current condition of NATO and European defence procurement and the problems which must be faced in the

future. Case studies of co-production programmes in NATO are relatively few, and attempts at objective assessment fewer still. It is hoped that this paper will provide a step in the direction of remedying this deficiency in the literature.

i). International Bargaining in the MRCA Programme

The first major hurdle facing a co-production programme is project definition phase. Differing national operational requirements and military doctrines must be reconciled and equipment replacement schedules harmonised, without resulting in a product which is prohibitively expensive. The early history of the MRCA, or the MRA-75 (Multi-Role Aircraft for 1975) as it was then known[1], gives a clear illustration of the problems which multi-national programmes must face, and the effects that these difficulties can have on the size and shape of the project.

The MRCA programme began in mid-1968 with the signing of a Memorandum of Understanding (MOU) between the governments of West Germany, Britain, Italy, the Netherlands, Belgium and Canada. All signatories had indicated their interest in a collaborative venture to design and produce a combat aircraft to replace their current inventories in the mid-1970s. During the twelve months that followed the signing of the MOU, however, the governments of Canada, Belgium and the Netherlands withdrew from the proposed programme before any commitments to long-term participation were made. The reasons for these governments' withdrawals were based

on political, economic and military considerations.

The decision of the Canadian goverment not to continue further with the MRCA project coincided with the re-orientation of Canadian defence policy away from NATO Europe and towards national borders. While shortage of funds was the original reason cited for the withdrawal, the major government review of defence policy was recognised as one of the main influences in making the decision[2]. In a speech in Ottawa less than a year after the withdrawal, the Canadian Defense Minister explained that the air element of the Canadian forces in Europe was to be reduced to three squadrons of the ageing F-104s to be used for conventionally-armed ground support roles[3]. It is notable that whereas British or West German political attention was focussed on Europe, Canadian interests were centered on the defence of national boundaries in co-operation with the U.S. The result for Canada was that there was no overriding or important political incentive to become part of the co-production programme, but rather the opposite.

Without political support for the project in Canada, either military or economic and industrial advantages might not have been sufficient incentives to continue. However, further analysis indicates that the MRCA did not even appear to offer any potential benefits in these areas.

> ...we withdrew because it looked as if we would not get sufficient attention paid to the Canadian (as opposed to European) requirements, because there appeared to be very little opportunity for Canadian manufacturing content, and because it showed

signs of being very expensive.[4]

While the primary Canadian operational requirement was for an air superiority fighter, it was apparent that the MRCA would not be ideally suited tothis role. A comparison of the thrust-to-weight (T/W) ratio of the F-104 and Tornado aircraft reveals that this concern was correct, as there is little difference between the two - 0.72 for the former, and 0.82 for the latter[5]. European determination to obtain work on the aircraft - which will be examined below - also severely limited the chance for Canadian industry to obtain valuable work-sharing agreements.

After the Canadian announcement of its withdrawal, the second nation to leave the proposed MRCA programme was Belgium. For the European nation, with a very limited scale budget, off-set opportunities were an essential part of any major weapons purchase. Whilst Anglo-German disagreements over project leadership continued for several months in 1968-1969, France offered Belgium excellent off-set terms to purchase the Dassault Mirage S, an aircraft suited to the Belgian operational requirement of air superiority.[6] The result was the decision of the Belgian government to opt out of the MRCA project in 1969.

Co-production did not offer Belgium the kind of incentives the government sought for commiting its future defense expenditure to a programme which would produce an aircraft not ideally suited to Belgian military needs. Instead, licensed production of a system designed elsewhere combined with adequate cost off-sets were more directly relevent to the smaller nation.

Political advantages of co-production appear not to have had any importance in this case. The participation of Belgium in the European/U.S. F-16 programme reveals the central concern of the Belgian government

> Belgian government and industry officials are more than satisfied with... the amount of F-16 work placed in that country... the value of the off-set contracts placed in Belgium exceeds the procurement cost of the 116 aircraft it has ordered by about $400 million.[7]

While the Canadian and Belgian governments withdrew from the MRCA programme before the project definition phase was underway, the Netherlands remained as a member until July 1969, by which time efforts had begun to obtain agreements on aircraft specifications and work-sharing. The loss of the Dutch partner was to be the last withdrawal suffered by the co-production effort, and the reasons for the Dutch action again reveal uncertainties over the military, industrial and economic results of the venture.

The Netherlands government's disenchantment with the progress of the MRCA programme originated with the compromise agreements made by the British and West German partners over operational requirements, without consulting the Italian or Dutch members.

> Basically, the Dutch believe the MRCA will be optimized for the British and the Germans, and that technical compromises will be made at the expense of the other countries in the consortium.[8]

The Dutch air force had originally specified a need for a single-engine, highly-manoeuvrable fighter aircraft with a Mach 1.8

maximum speed. However, in March 1969 the British and Germans agreed to a twin-engined configuration which they justified as necessary in order for the aircraft to be capable of fulfilling the long-range strike/interdiction role demanded by the RAF. Instead of the "...fairly simple fighter plane with outstanding manoeuvrability..." envisaged by Dutch Defence Minister de Toom[9], the MRCA was beginning to appear as a more complex aircraft with a minimum weight of 40,000 pounds.[10]

In operational terms, the military and political compromises requiredtomake the MRCA programme acceptable to the two major partners were such that "...the MRCA was regarded as too complicated and as technically unsuitable for the requirements of the (Netherlands') Air Force."[11] The Air Force had determined that larger numbers of relatively inexpensive aircraft were preferable to a few complex and expensive systems in fulfilling their NATO commitment, but the result of the Anglo-German compromise was to raise the estimated unit price of the MRCA from $2.5 million to $4.8 million. Lieutenant General Wolff, commander-in-chief of the Dutch Air Force and himself an advocate of European collaboration, expressed the view that

> We can get a limited capability (using the twin-engine design) for our needs, but we are paying for all the other compromises.[12]

The multi-role capability of the MRCA, required in order to meet the differing operational requirements of the main partners in the project, thus meant to the Dutch government that an unacceptably high price would be paid for a system which was not

optimised for use by their own air force.

The concerns discussed above were not the only problems which were seen to exist in the MRCA programme and to bode ill for its future. Netherlands officials privately expressed their anger at the way in which the administrative costs of the Panavia organization established to oversee the venture rose from 2.5 per cent. to 5 per cent. of total programme costs.[13] The agreement on a twin-engine configuration, aside from increasing the cost of the programme, also caused postponement of the intended delivery date of the aircraft from the original goal of 1975-76 to a new date in 1977-78.[14] The Dutch Air Force, however, was seeking a replacement aircraft which would be available by the middle of the decade. Finally, the defence budget in the Netherlands, estimated and accepted on an annual basis, left little room for long-term commitment to a programme whose costs were already seen as escalating against the wishes of the government. Faced with pressing demands from other sectors of public expenditure and with a limited budget, the MRCA programme appeared as a poor military and financial risk without any commensurate political benefits.

The examination of the initial membership of the MRCA programme illustrates the difficulty of reconciling varying national operational requirements and political or economic goals when membership in a co-production effort is higher than two or three states. When clashes of interest occur, as they inevitably will, and a government sees that its own objectives are not being

met, then in the absence of wider incentives to continue participation the result is the withdrawal of that government. In the present case study, the MRCA was viewed as failing to satisfy the operational requirements of Canada, Belgium and the Netherlands, and to do so at an acceptable financial cost. All three governments were sceptical of the compromises made by the British and German partners, which they believed were being made at their expense. Thus in achieving the common requirements and acceptable specifications necessary before a formal agreement to co-produce the Multi Role Combat Aircraft was possible, the project lost three of its original members and their potential orders.

The fact that Britain, West Germany and - after some doubts - Italy remained in the MRCA programme might be taken as indicating that at least these three nations possessed common operational requirements for the aircraft to be built. In reality, this was not the case as the three nations sought to build an aircraft to replace a variety of predecessors with a wide range of missions.

The Royal Air Force requirements called for a twin-engine aircraft with a range of at least 800 miles, advanced avionics systems for long-range, all-weather low-level flight capability, and a two man crew consisting of a pilot and a systems operator. The Luftwaffe and the Italian Air Force both sought a single-engine aircraft with a 200 mile range, advanced avionics for Short Take-Off and Landing (STOL) capability, and a single crew member. Missions varied from long-range strike/interdiction to

close ground support, and high speed interceptor/fighter. The performance characteristics, as outlined above, varied considerably between these missions and in some cases were radically different. Given these varying requirements, it is perhaps more surprising that the MRCA programme continued than had it been discontinued altogether.

The West German industrial combine Entwicklungsring Sud (EWR) continued to develop its advanced NKF aircraft even as it was investigating the MRCA specifications, in case the latter project ultimately fell through. The NKF was viewed as being tailored specifically to the Luftwaffe requirements (as above) whereas the MRCA was labelled as "...a compromise aircraft to meet the requirements ofallconsortium members."[15] The agreement on a common design, reached in March 1969, was the result of an important concession on the part of the German government:

> The resulting twin-engine configuration represents a significant German compromise which very likely will put the (FRG) $2.5 million flyaway price goal out of reach.[16]

Despite the increase in unit cost - which ultimately led to Dutch withdrawal - the German government deemed the MRCA project sufficiently important for other reasons that they were willing to continue development with the British, even if the Italian government also decided that cost escalation had become too great to continue the project.

The twin engine design and emphasis on the long-range mission were concessions on the part of West Germany. However, the British also had to accept a situation which was far from the

ideal of the RAF. W.B. Walker stresses that Britain had to agree

> ...to build a multi-role aircraft, one that would to some extent overlap with the operational abilities of the Jaguar, while they only needed a single-role aircraft (Strike/Recconnaissance) They agreed to build an aircraft that was, for them, unnecessarily complicated in order to secure the collaborative agreement. (Walker,1974,p.285).

Neither the West German nor the British governments obtained their 'ideal' aircraft in the definition phase, whilst the Italian government did consider joining the Dutch in the development of a cheaper aircraft more suited to its own requirements. Despite these problems, all three nations remained as partners. Deeper political and economic incentives were by this time closely associated with the continuation and completion of the MRCA programme.

One of the most widely acknowledged political motives for British participation and German willingness to compromise in the Tornado project centered on the former nations' application for membership of the European Economic Community. British Prime Minister Harold Wilson faced strong opposition from the French government which was blocking the application.

> ...the MRCA was used by the Labour government in the late 1960s to demonstrate to the Germans and the Italians the strength of the British resolve to join the Common Market; it was believed... that the road to the Common Market passed through Bonn, not Paris. (Walker,p.286).

This sentiment was also expressed by West German and Italian

government and industry officials. The strong German support for the Rolls Royce engine (discussed below) existed mainly "...because the project is becoming deeply rooted in Germany's sponsorship of Britain's entry into the Common Market."[17]

The Italian concern for maintaining good relations with Britain for reasons connected with the political balance in the EEC was stated explicitly by the former Italian ambassodor in Paris, Pietro Quaroni;

> ...the French have never given up the hope of transforming the Common Market into a French sphere of influence... If my country and others strongly desire Britain's membership of the Common Market, it is because we believe that, in this way, the internal balance of power in Europe would be more assured.[18]

Research has not revealed the kind of direct link between this desire and the MRCA project which has been seen in the German case, but given this latter example and the Italian government's willingness to accept the changes in the programme made without consultation between itself and the two major partners, it appears likely that such considerations were extant. Prime Minister Wilson's visits to Rome and Bonn in January and February 1967 to discuss technological co-operation between those countries, and Britain's entry into the EEC, coincided with the initial expressions of interest in the co-production of the new European combat aircraft.[19]

European political manoeuvres were a major influence in the establishment and continuation of co-operation between the three members of the Tornado organization. However, other political or

economic concerns also existed, and these appear to have impacted on the programme to varying degrees. A member of the West German Parliamentary defense committee stated that

> If we do not pay for research and development, we will be blacksmiths. The majority (of committee members) wants to keep the advanced part of the industry alive, even if it costs us a lot more.[20]

Either the U.S. McDonnell Douglas F-4E International Phantom or a modified G2 version of the French Dassault Mirage G1 might have been cheaper, more immediately available, and more exactly designed to Luftwaffe specifications. However, licensed production of either system would not offer any opportunity for the German aerospace industry to obtain either systems-management or basic design experience, both essential to the development of a more efficient and competetive industry. The West German government was therefore willing to pay the extra costs of a co-production programme if this might mean achieving these domestic economic objectives.[21] Although the example presented above deals with German government incentives, similar concerns may be identified in the remaining partner nations, and these will become clear in Section 3 part ii). dealing with government direction and lobby-group pressures in the MRCA programme.

The belief that there existed the possibility of considerable cost-savings through co-production does appear to have been prevalent in government thinking during the early stages of the programme. In a House of Commons debate concerning the decision to pursue the MRCA project, British Defence Minister Healey

justified the venture on the grounds of cost- and technology-benefits:

> By sharing the cost of developing and producing this aircraft, the European countries concerned will meet their defense needs much more cheaply than anyone of them could do on its own. Technically it can help to provide a solid foundation for the future of the aerospace industry in Europe...[22]

By allowing a large section of the European aerospace industry to operate on a European rather than a national scale, or a series of national scales, Healey argued that it would be possible to obtain savings through economies of scale. The Defence Minister also expressed the hope that the increased collective domestic market which co-production would create, and the previous efforts of the members, would allow the consortium to export further numbers of the aircraft to third countries "...even in competition with anything the United States can produce."[23]

The potential for an increased market and exports was valued by the Italian industry as well as by the British government. Until the late 1960s, the Italian aerospace industry depended on government contracts for Air Force work for some 70 per cent. of its aircraft sales. Only 10 per cent. went to the domestic civilian aircraft market, and the remainder was exported. The MRCA programme was therefore seen as a means of breaking out of this cycle of dependence and giving the industry the chance to obtain technological exertise and production capabilities which the financially-strapped and politically unstable national governments had so far been unable to provide.[24]

The three remaining members of the consortium co-producing the MRCA were all concerned with political and economic objectives wider than the programme itself, but with which it was closely connected. The British government was seeking entry into the EEC, while the West German and Italian governments were supporting her application despite French opposition. The MRCA programme offered each government an opportunity to display their commitment to co-operation and solidarity through another channel. This political motivation appears as the main common thread in the continuing partnership of these nations even after the departure of Canada, Belgium and the Netherlands. Other possible incentives did exist: cost-savings and industrial development were discussed by both government and industry. However, where extra costs had to be paid in order to secure the broader political or industrial/economic, all three governments appear to have been willing to do so. Maximum cost-saving benefits were not the primary purpose of the co-production effort.

National Bargaining in the MRCA programme.

Having examined the influences on the membership of the MRCA consortium as it emerged in late 1969, it is necessary to assess the relative influence of domestic pressures and the effect which these pressures had on the the progress and shape of the programme. The domestic political and economic goals of the

national governments, and how co-production fitted these objectives, will be compared to the aims and preferences of industrial and political lobby groups. This will then provide the broader background against which may be considered the more detailed aspects of the MRCA work-sharing agreements (presented in part iii). below).

A crucial problem which faced all British governments throughout the 1960s and 1970s in establishing their defence priorities was the combination of relative stagnation of the economy, increasing demands from sectors of public expenditure other than the military, and the rapidly rising cost of replacing obsolete weapon systems as technology continued to improve.

> It is not only government decisions which set the level of resources available (for defence); it is the outcome of economic performance as a whole and the way in which demands for shares of the national wealth are met as a result of the balance... between social and political forces. (Smith,1980, p.119).

An analysis of the British defence budget during the period encompassed by the MRCA programme, and the decade prior to the project, reveals how this balance altered and the impact which this had on defence procurement policies.

Table I) in the Statistical Appendix for the case study illustrates the relative stability of the defence budget over several years when measured in constant terms. As a percentage of Gross Domestic Product (GDP) defence expenditure stabilized at around 5 per cent. after declining from the artificially

higher level caused by the Korean War. This appears to indicate that the defence effort has remained stable. However, Table II) places this stability into a different perspective. As a percentage of total public expenditure, the defence budget has declined considerably, from about 19 per cent. to some 11 per cent., whilst social welfare spending has increased in all major areas such as social security benefits, education, and health services. Defence no longer received priority in budget allocations.

Secretary of State for Defence Roy Mason argued in his 1974 Defence Budget that

> This is an age which places a very hogh premium on economic well-being, economic improvement, and the regular raising of standards in education, health, and social security... the balance between (social welfare and defence) has had to be struck in the main by political judgement.[25]

In making its decisions on budget priorities, the government consistently favoured the demands of the voters over the requirements of the military. Under such circumstances, stability in defence spending was perhaps the best which could be hoped for by military planners.

As Table III) indicates, the strain placed on the defence budget increased over time. Equipment costs rose from 35 per cent. to 41 per cent. of total military expenditure in a five year period. Research and development, and the production of new equipment, accounted for 74 per cent. of these rapidly-rising costs. Stability in the defence budget meant that while manpower

spending also declined from 47 per cent. to 42 per cent. of expenditure, strains arose as manpower totals did not similarly decline. Under these circumstances, defence planners were faced with the urgent need to identify a cheaper alternative method of procuring new major equipment. Co-production offered itself as one of these alternatives.

The Labour government's Defence Review of 1964 gave notice of future government policy on defence procurement. Along with the planned fifth Polaris submarine and new attack carriers for the Navy, three national aerospace projects suffered cancellation - the already advanced, 750 million pounds (sterling) TSR-2; and two research projects, the P-1154 and HS-681.[26] In 1967, plans to purchase the U.S. F-111k aircraft "off-the-shelf" were similarly scrapped. To replace all of these projects, it was intended to seek a joint European project, initially with the French, since

> "...the United Kingdom would not in future feel bound to compete comprehensively and independently at the highest levels of arms technology or in operating some of the most complex and costly weapons systems." (Greenwood,1977,p.200).

Denis Healey's statement here might be taken as a clear recognition of the inability of the British - or other European governments - to continue national development programmes. Given this decision, the choice lay between purchase of U.S. systems, licensed production, or some form of collaboration.

In addition to the possible desire for cost-saving benefits,

another problem faced by government and industry officials alike was the excess production capacity of the British aerospace industry. During the later 1960s, the government undertook a study of the aerospace industry to evaluate its needs. The potential impact of this concern upon the MRCA programme was recognised as early as 1969:

> Another factor that has emerged in the engine competition is the queston of where the British industry sees its most urgent need for work. If the assessment indicates that the airframe sector has more excess capacity than the engine industry, Britain could relax its strong push for the Rolls engine in exchange for a larger share of the airframe or even a combination of airframe and avionics.[27]

At its peak, the Tornado programme was estimated to involve a total of 36,000 jobs for the British aerospace industry. The continued strong support of the Rolls Royce engine may therefore indicate that excess capacity was seen to be most pressing in this part of the industry.

A notable sign of a policy aimed at maintaining existing employment levels, even though those levels were artificially high, is the relatively poor productivity of the aerospace industry compared to the rest of Europe. Tables IV) and V) in the case study Appendix give an indication of aerospace productivity in Europe by nation and by major company. Britain appears as the least productive of the larger industrialized nations, while only the Aeritalia company shows a lower productivity than British Aerospace. Rolls Royce is one of the three or four least productive companies after these two. An

assessment of the British aerospace engine company, nationalised in 1971 following bankruptcy, was critical of this aspect of government policy:

> As a nationalised compamy under the control of the government-owned National Enterprise Board, and with the strong union pressures common in the United Kingdom, Rolls-Royce is clearly a jobs-oriented rather than a profit-oriented company.[28]

With a ratio of employees to revenues higher than most major European aircraft engine manufacturers, the pressure to obtain the MRCA powerplant contract for Rolls Royce clearly reflected government concern with the problem of maintaining employment in an industry marked by surplus capacity.

West German collaboration in the MRCA consortium held some similarities and some striking differences to the motives or goals of the British government. Potential cost-savings was one common concern, as the MRCA was favoured over the national NKF project of EWR,

> "...mainly because an opportunity would exist to split develpment costs, estimated at $250 million to $500 million for each aircraft."[29]

Whether or not such savings existed in reality was less important than the belief that they could be obtained.

The Brandt government in West Germany (1969-74) viewed the aerospace industry as a growth leader in the economy and as a potential source of valuable technological innovation. Dr. Schomerus of the Economics Ministry explained the wider implications of this view:

> "The general feeling is that aerospace is part

> of the infrastructure of any industrial region. Europe should be in a position to produce this infrastructure itself."[30]

Hence the government was willing to accept the costs of the MRCA programme on the basis of the idea that co-production would help to improve technology in a general sense.

The selection of the Rolls Royce RB.199 engine over its U.S. competitors still offered the German engine-manufacturing combine of Motoren und Turbinen Union (MTU) the opportunity of considerable expansion. Possessing an initial capacity for only 15 per cent. of the engine work in 1969, MTU obtained from Rolls Royce an offer of 52 per cent.[31] As a result, investment in new tooling was required by MAN Turbo and Daimler-Benz, joint owners of MTU.

A selected list of German component and equipment companies involved in the MRCA co-production work appears as Table VI) in the Appendix. An analysis of the West German aerospace industry in 1980 came to the conclusion that the trinational Panavia Tornado programme "...contributed significantly to West Germany's components and equipment industry..." and that

> With about 40% of the equipment of the Tornado manufactured in Germany... the demands of the trinational program led to a major infusion of high technology in the German aerospace industry.[32]

Along with the Franco-German Alpha Jet, the MRCA programme was expected to provide 40 per cent. of West German arospace industry work by the late 1970s.

The West German government sought to expand its aerospace industry capacity in order to become a valuable partner in future

collaborative ventures. In the sense that the MRCA was viewed as an important part of this policy of industrial development, the German government was pursuing goals similar though not identical to those of Britain. However, in another sense the two governments' policies differed considerably.

The German economy at this time was undergoing consistent growth, and overly rapid expansion in any industrial sector was activly discouraged by the government in order to guard against the possibility of labour or employment problems in a future recession. In direct contrast to the situation in Britain,

> There has never been a push for make-work in the (German) aerospace sector. Until recently, employment was less than 1% and, in a German economy that was by far the strongest in Europe, the aerospace industry was a minor influence.[33]

Despite this cautiously restrictive policy, employment in aerospace-related industries rose from 16,000 in 1960 to a peak of almost 50,000 by 1970, although the required total for the late 1970s was estimated to be 40,000. The MRCA programme was seen both as a means of assissting in the planned growth of the aerospace sector, and as a means of assuring future work levels. This policy was quite different to that of the British government, but both bodies nevertheless saw co-production of the MRCA as the means to achieve their objectives.

A final economic incentive and problem for the West German government was of a partially domestic and partially international character. West Germany was seeking some means of

disentangling its domestic industry from the restrictions imposed through offset obligations with her allies for the latter's stationing of troops in that country since 1945. In February 1967, Chancellor Kiesinger agreed to the purchase of British defense equipment consisting of 22 Westland SH-3 helicopters as a means of meeting similar offset obligations to that nation.[34] After 1968, however, these payments were to be settled through the MRCA programme, as the selection of the RB.199 engine was predicted to "...solve Germany's offset obligations to Great Britain for the next ten years."[35] Although this still left open the question of settling offsets with the U.S., the new Anglo-German agreement offered the latter nation a means of opening upindustrial links within Europe and gaining a greater degree of freedom from reliance on U.S. sources of supply for important defence equipment or materials.

The third nation in the trinational Panavia consortium heading the MRCA programme was a smaller industrial or aerospace power than the two main partners. Since the postwar period, growth of the aerospace industry in Italy had been slow due in large part to unstable governmants and a lack of government policy to foster growth in that sector. The workforce engaged in aerospace-related employment was the smallest of any industrialised nation in relation to the total national population - 18 to 20,000 fulltime workers in a population of 55 million, with only 7 per cent. of that figure working in R&D compared to the norm elsewhere of 15 to 20 per cent.[36] Using

such a small development sector, and with little management experience in advanced systems, the industry had undergone few advances and very little growth until the 1960s.

The decision taken by the Italian government in 1969 to create Aeritalia, an amalgamation of the Fiat airframe division and the aerospace sector of Finmeccanica (a group of state-owned companies), was the first attempt by the government to provide more stable political and financial support to the aerospace industry. Government interests were protected, and direction exercised, by the government-sponsored Instituto per la Ricostruzione Industriale (IRI), a body similar to the British NEB established in the early 1970s.

Under the IRI, Aeritalia was to be closely "...tied to (the government's) policy of shifting industry to under-developed regions in the southern part of the country."[37] Faced with severe domestic economic difficulties and high umemployment rates, expansion of the aerospace industryunder government guidence was hoped to be a means of providing more jobs in the most depressed areas and of creating an impetus to economic development. The similarity of these 'make-work' policies to those being pursued in Britain with Rolls Royce and BAC is further highlighted by comparing the figures for productivity in the two nations' aerospace sectors. As Tables IV) and V) indicate (see Appendix), only Aeritalia with nearly 30 per cent. of the Italian aerospace workforce, has productivity levels lower than the two nationalised British companies. Comparison of the

figures for Aeritalia with those of the privately-owned Agusta company similarly indicate that the government was more concerned with employment than with productivity and profit-making, as the latter company obtained twice the output in sales per worker than did Aeritalia. The Italian Air Force initially entered the MRCA programme with some reluctance due to fears over the cost of the scheme and the apparently cavalier attitude of her partners towards Italian requirements. By 1971, however, it was reported that

> Now the situation has changed, since the MRCA is looked on first as a means to develop aerospace technology, and second as a piece of military hardware.[38]

The primary concern with non-military benefits from the MRCA programme was also recognised by leading Italian politicians. The small size of the aerospace industry in that country meant that every major Italian aerospace-producing company was involved in the co-production work. Table VI) also gives a selected list of the main Italian companies involved in the MRCA project. The MRCA scheme therefore provided new jobs for the Italian industry, and helped to assure continued steady work levels for numerous individual companies.

Italian industrial participation in the co-production programme can also be seen to have served the further purpose of providing the industry with a relatively easy means of obtaining valuable technological and management experience. Although the nation's share of MRCA development and production work was

limited to 15 per cent of the total programme work, it still had access to all economic and technological aspects and a full share in project management. The aerospace industry was thus "...getting a maximum of know-how at a minimum cost."[39]

Up to this point in the examination of the MRCA programme, emphasis has been placed upon the problems, incentives and goals of the national governments. However, it is important to assess the impact of other, non-governmental influences on the decision to undertake a collaborative development effort, and on the eventual shape taken by the MRCA programme. The attitude of the aerospace industries in each nation towards collaboration generally and co-production of the MRCA in particular, and the possible influence of other pressures such as party-political disputes, are all aspects of the national defense aquisitions process which must be evaluated before the case study can be completed.

Despite the reluctant recognition by the Society of British Aerospace Companies (SBAC) that Britain "...was being driven more and more into collaboration, whether we like it or not..." as the development costs of advanced aircraft increased "...beyond the financial capabilities of any one country[40], there still remained throughout the British industry in the 1960s and early 1970s a strong opposition to the concept of joint European collaboration. Such opposition may have been partially a reflection of national industrial egotism and a belief that Britain should continue to

'go it alone' in aircraft development, but it was also the result of other more relevent concerns.

The SBAC Report of 1972 expressed criticisms of the MRCA agreements arranged by the three national governments. The Society viewed with concern

> ...the present collaborative arrangements set up by the government and then presented to industrial firms on what they consider non-commercial terms...[41]

In the same year, the British Electronics Engineering Association voiced criticisms openly directed at the MRCA programme, deploring the

> ...government-inspired trend in the programme, in which the British have come into line with German and Italian government policy to build up an electronics industry that one day will be a commercial and technical force.[42]

The British industry saw itself as losing ground to potential future competitors, and the fact that design leadership of the MRCA programme was ceded to the less experienced German industry appeared to be another sign of this loss.

The major British aerospace industry leaders and groups appear to have been initially either skeptical of, or hostile towards, the idea of collaborative development programmes. The MRCA project particularly received a generally critical response, as foreign industries were viewed to be making advances at the expense of the British. Those who opposed involvement in the co-production scheme nevertheless seem to have been unable to cause any change in government policies. The importance of government

defence contracts to the industry left them with little choice;

> It has worked out to getting 2% of something or 100% of nothing, and we have gone for the 2% because we have no other choice if we are to stay in the (MRCA) game.[43]

Although this may have been the case, it is also true that the government in turn was at least partially responding to the need for continued employment in the aerospace sector. Research has failed to indicate any direct pressure exerted by specific groups (for instance labour or union bodies) for 'make-work' efforts, but the government cannot be said to have been acting without some constraints or pressures. Economic difficulties and high unemployment rates exercised a considerable influence on government choices of the detailed agreements, if not the general policy choices, in deciding the nature of defence aquisition programmes such as the MRCA.

A second major issue in the British aerospace industry during this period serves to further reveal the ability or otherwise of the aerospace leaders to influence government policies with which they disagreed. This issue was the proposed nationalisation of the main aerospace companies in the early 1970s.

Industry Secretary Anthony Benn argued that the difficulty for individual companies to fund long-term development projects - the RB.211 had driven Rolls Royce to bankruptcy - was such that public ownership was essential to guarantee firmer financial support and to ensure that jobs were not put at risk.[44] The idea of government ownership was not received with broad approval: a leading aerospace journal expressed its concern that

> In contrast (to France), the British government has lost its nerve at almost every crucial milestone of advanced technology and not only squandered its research investment but foreclosed its future for another market cycle.[45]

It was believed, correctly, that government ownership meant an emphasis on jobs rather than competetiveness and profits. As with the choice to turn towards collaboration, however, there was little was achieved in the attempt to oppose government policies. Where industry's views clashed with those of the government, the former gave way.[46]

A clear contrast existed between British and West German aerospace industry leaders' attitudes towards collaboration and co-production. Rebuilding after the Second World War, the new German aerospace sector was faced with rapidly-escalating costs of R&D and production for advanced combat aircraft. The effect on industry attitudes was clear;

> ...from its postwar beginning the German industry organised as a participant in international programs first with the United States, largely as a result of offset payment problems, and second within European bilateral and multi-national programs.[47]

The situation was similar in Italy, where the relatively new, and small, aerospace industry did not possess the capacity to undertake independent national development of an advanced-technology combat aircraft.

A useful study of West German government and industry attitudes towards co-production of the MRCA is presented by Alfred Mechtescheimer.[48] The author argues that industry leaders

sought to co-operate closely with the government in collaborative projects, as strict export restrictions on the industry left it heavily dependent on government contracts and state-sponsored R&D work. Aerospace leaders wanted contracts to be planned and carefully spread out to ensure a steady workload and to avoid heavy redundency payments to workers.[49]

Thefragmented German aerospace companies had acceded readily inthe 1960s to government pressures for mergers in order to create a more competetive industry. When Messerschmidt and Boelkow merged in November 1968, it was done in anticipation that "...this company, with 12,300 employees as the largest in the country, would be awarded the prime advanced fighter contract."[50] This belief was not to be disappointed; following the additional merger with Hamburger Flugzeugbau, owned by the Blohm group, the new MBB combine became the prime German contractor for the MRCA programme.

MBB remained the largest West German aerospace industry company involved in the MRCA programme, but it was not the only major company involved in the work. Out of the ten largest aerospace contractors in the Federal Republic, Mechtescheimer lists six as taking part in the co-production effort: MBB, Siemens, VFW-Fokker, AEG-Telefunken, MTU, and Industriewerke-Karlsruhe. Together these six accounted for some 60-65 per cent. of all domestic aerospace production (Mechtescheimer,1977, p.166). Whilst the domination of the aerospace sector could have given these companies considerable influence in determining

future policies, this is difficult to estimate since industry and government policy preferences were similar in supporting international consortia for the production of aircraft.

The ability of the aerospace industry effectively to lobby the German government was also weakened by sharp divisions within the Bundesverband der Deutschen Luft- und Raumfahrtindustrie (BDLI), the largest aerospace lobby group consisting of some 80 companies. Disagreements arose between the larger electronics and micro-chip companies and smaller high-technology producers, especially over the allotment of supply contracts for MRCA work by the MBB combine. Under these circumstances the BDLI could not claim to be representing the general interests of its members.

Defence Minister Schmidt expressed his governments' attitude towards industrial lobbyists, stating in 1970 that

> The defence minister will not premit being pressured by any industrialist. It is not the function of the Bundeswehr to nourish certain industries in Germany. (Mechtescheimer,p.163).

This should not be taken simply at face value, but as a statement of official government policy it is a further indication that industrial lobbying appears not to have been of great influence in deciding the type of defence aquisition programmes undertaken by the government. A list of aerospace industry interests which were ignored by the government includes cancellation of the independent research work on STOL aircraft; purchasing U.S. F-4s as interim aircraft for the 1970s, thus reducing the amount of money available to industry in the MRCA project; and the

continued enforcement of the tightest military export restrictions amongst Western European NATO nations. Mechtescheimer concludes that West German industrial interests were in fact better represented in the MRCA programme by the willingness of the British government, the RAF, and British Aerospace to make concessions in work-sharing agreements than by the domestic industry itself. In most cases, industry and government interests coincided closely enough to minimise areas of disagreement; otherwise, industry does not appear to have directly affected national procurement policies where it differed from government preferences.[51]

The Italian aerospace industry possessed little influence over the government in that nation; approximately 70 per cent. of aerospace contracts came from the government. Its main client was the Italian Air Force, which was itself politically uninfluential. However, as was the situation in Germany, industry and government views on defence production policies generally converged:

> Close air support is the only area in which we can consider a national programme. In other areas, such as air superiority and interceptor aircraft, the problems are such that we have to look toward international collaboration to meet our requirements.[52]

Aeritalia, directly controlled by the government, was both the largest aerospace employer in the nation and the prime contractor for Italian MRCA work; friction between government and industry was thus minimised.

Whereas government-industry relations in Britain were often

marked by dispute over the necessity and value of collaboration as a means of aircraft development, Germany and Italy displayed much greater co-operation between these two bodies. The main British participants in the MRCA programme were the nationalised companies of Rolls Royce and BAC; and although the MBB and Aeritalia combines were not nationalised in this sense, they were both subject to government control, especially Aeritalia. Despite the differences indicated above, the largest aerospace companies in each nation were subject to government direction and were channelled towards co-production.

A second potential domestic influence on the MRCA programme and on procurement decisions generally was the pressure exerted by political opposition groups. In Britain since the 1960s, both main political parties were obliged by financial restraints to pursue similar policies of reducing defence commitments and seeking cheaper alternatives to national development programmes for high-cost weapon systems. Political opposition to collaboration came mainly from the Labour left-wing groups represented in the literature by Mary Kaldor, Dan Smith, and the Labour Party Defence Study Group. It is difficult to assess the impact of this group upon the Labour Party but given the continued parallels between Labour and Conservative Party policy choices, it appears to have had little recognisable effect.

In West Germany, defence policy was traditionally bipartisan, and the decision to undertake co-production of the MRCA was made during the period of the 'Great Coalition' or all-party

government. An outcry by the left wing of the SPD - consisting of 7 MPs - in February 1973 was concerned specifically with the failure of the government to release cost details of the programme as it had promised to do in 1970. A secret party ballot in October 1974 resulted in 86 per cent. of SPD MPs voting in favour of continuing German participation in the consortium. Criticism from this party largely ceased after this date.

The anti-nuclear stance of the FDP in Germany led to its criticism of the long-range bombing capability of the Tornado. The fact that the party had been a member of the Great Coalition in 1967 and had assisted in establishing the project, coupled with its traditionally pro-industry leanings, again served to stifle any effective opposition. Criticsm from the CDU/CSU was also minimal for similar reasons.[53] The Parliamentary critique of the MRCA programme

> ...was overall all irrelevent and served mainly the parties' military experts' P.R. opportunity. (Mechterscheimer, p.183).

The decision of the Italian government to support the development of the aerospace industry, especially in the poorer southern regions, was accepted by most elements of the party political groupings. General governmental instability rather than specific opposition to collaboration was the main obstacle to a consistent approach to defence policy;

> ...social unrest forces the government to direct technological funds to politically acceptable but short-term welfare programs. These factors dilute both the impetus and prestige of the aerospace industry.[54]

Premier Aldo Moro, head of the Christian Democrat/Republican Party government in 1974 argued that Italian economic recovery and industrial expansion could only occur in the context of international collaboration, but that other nations would only accept Italian partnership if that country "...showed itself capable of reducing its own bureaucratic paralysis."[55]

Where debate over the MRCA programme did occur in the three partner nations, it usually came as the result of cost escalation problems, or what were argued to be such problems by its opponents. Criticism in the U.K. developed from the Labour group mentioned earlier and others who believed that social welfare needs were still being neglected:

> If we made the great so-called sacrifice of foregoing all of (the MRCAs), most of our housing, pensions, education and health service difficulties would be greatly eased...[56]

In West Germany, Defence Minister Leber was forced in February 1973 to defend his governments' expenditure for the MRCA on national television. The debate did not, however, arise from party divisions. Instead, it arose due to acrimony between the defence and budget ministries over further, long-term financial commitments to the development phase of the programme.

The MRCA unit price had doubled from $3.0 to $6.5 million since 1969, and together with the other main co-production programme - the Alpha Jet - it was estimated that some 40 per cent of the nations' total defence budget would be consumed by development and production of these aircraft for an extended

period of time. Leber defended the programme with the argument that theTornado would be no more expensive to Germany than the purchase of a comparable U.S. aircraft, whilst it also provided a unique opportunity to upgrade the domestic airframe and avionics industry and lessened dependence on outside sources of supply for defence equipment.[57]

Debate over funding in Italy was lessened by the fact that the government did not have to make expenditure commitments early in the programme, and its share of total development costs was relatively small - approximately $140 million. Nevertheless, as mentioned earlier, public pressures for increased socialwelfare spending meant that the government was cautious not to publicly discuss its participation in the programme.

Relations between government and industry in Britain over the idea of European collaboration tended to be more conflictual than was the case in either Italy or West Germany, where the newer aerospace industries were organised from the postwar period to become involved in such collaborative ventures. Where views and interests clashed in Britain, the government appears to have prevailed. The heavy dependence of the industry upon government contracts, and nationalisation of the two main airframe and engine companies, further reduced this possible source of opposition which tended to be vocal rather than effective. The general congruence of views between the governments and industries in the other two nations makes analysis of possible

industrial influence difficult, but at least in West Germany the government appears to have exercised the dominant influence. When debate occurred over either the wisdom of collaborative policies or the question of cost-escalation, it tended to be ineffective in causing any changes in policy with which the government did not agree. The desire to maintain or to expand industrial capacity and to preserve existing, or create higher, levels of employment certainly acted as strong influences on the shape and detailed nature of the MRCA programme in its work-sharing agreements. Without government acceptance, however, industry appears to have had relatively little direct influence upon the co-production programme.

iii). The MRCA-Tornado work-sharing agreements.

Two themes underlie the examination of the work-sharing agreements reached by the three members of the Panavia consortium. Firstly, to what extent were contracts awarded on the grounds either of equity or efficiency ? In other words, what was the real importance of cost-saving criteria in comparison with political considerations ? Secondly, to what extent was the programme an example of European development ? A stated goal of the British government was the exclusion of U.S. companies and equipment from the programme. The answers to both of these questions can then be evaluated in the final section of the case study, which assesses the programmes' achievements and

then attempts to relate the case study itself to the questions and problems left unanswered in the literature review.

The initial dispute between Britain and Germany over project leadership in the MRCA programme was never fully resolved in favour of either nation. Instead, the Panavia organisation was created with each nation awarded voting rights. In arguing their case, the German government pointed out that its expected order was the largest of the three at some 600 aircraft (subsequently reduced to 300) and that by taking delivery ofthe aircraft first it was also taking the largest risk.[58] In its final form, the voting arrangements left Germany with 50%, Britain with 30%, and Italy with 20%.

The British argument had been that while the German industry had no prior managemant experience in such projects, British aerospace had been working on the TSR-2, Anglo-French Variable Geometry and U.K.V.G. programmes which had directly preceded the MRCA. However, one of the tacitly-recognised goals of the MRCA programme was to provide the German industry with precisely this experience. The final agreement, in favour of the German aims though not completely so, was based at least in part upon the desire of the British government to obtain good relations with Germany for European political reasons - the application to the EEC.

The three main areas of work-sharing requiring agreements betwen the partner nations were the engine, airframe, and

avionics. Based upon the financial burden born by each nation, a general ratio of 42.5/42.5/15 per cent. of total work was accepted by Germany, Britain and Italy respectively. However, this did not settle the details of the main contracts and sub-contracts, and considerable 'horse-trading' occurred between each nation.

The initial competitors for the MRCA main powerplant were the U.S.-designed General Electric GE-1 and Pratt & Whitney JTF16 engines, and the British Rolls Royce RB.199. The GE-1 was withdrawn from the competition in early 1969, ostensibly due to the short time-span given for submission of detailed bids (60 days) and a fear that proprietary data could be lost if Rolls Royce obtained the engine detais.[59] However, there may have been another reason for the decision. The second major aerospace engine contract under tender at this time was that for the proposed A-300B Airbus; prior to selection of either engine industry commentators speculated on a possible compromise between the U.S. and Britain.

> There is widespread belief that a gentleman's agreement has been reached that one aircraft will have a British engine and the other an American powerplant.[60]

At the time, the General Electric CF-6 was the favoured entry in the A-300B bidding, and the RB.199 in the competition for the MRCA contract. No clear evidence of such a compromise has been located, but this does not render such a trade-off implausible. More detailed research into industrial sources would be required

to provide a definite answer to this question.

While the U.S. government declined to press the case for the JTF16 engine due to British determination to keep the MRCA a European venture, the latter government continued to support the Rolls Royce contender. On this occasion, the RB.199 became the focal point of wider political manoeuvring, as was indicated by one West German government official involved in defence policy;

> Our concern for the Rolls Royce engine... is purely political. The Common Market will dry out unless the British come in. We are now forced to work with the British in fields not covered by the Common Market, and advanced technology is one of them.[61]

Combined with considerations of Anglo-German offset payment advantages, this proved sufficient for the German government to add its weight to the Rolls Royce bid.

In contrast to the concerns of the governments, the German MBB combine favoured the remainng U.S. alternative. The estimated price of the RB.199 engine in 1969 was $450,000 compared to the more costly JTF16 at $750,000 per unit. However, develoment time for the Pratt & Whitney engine was estimated to be at least one year less than the British contender, and in contrast to the experimental nature of the RB.199 the U.S. air force could certify the technological capability of P&W to design and produce an engine matched to MRCA specifications.[62] Despite these advantages, the JTF16 was set aside and in September 1969 the engine contract went to Rolls Royce.

Selection of the RB.199 did offer Germany's MTU excellent work-sharing proposals: 52% for MTU compared with 32% for Rolls

Royce and 16% for Fiat. Despite this, it is evident that the selection process was determined by the desires of the national governments based on political goals or domestic economic concerns, rather than by criteria of efficiency or potential development costs. The RB.199 was a European engine, but it was also marked by technological uncertainties and the potential for costly delays in development time.

The division of responsibility for development and production of the airframe for the MRCA was comparatively free from controversy of this nature. Only one development contract created real debate, but it is of importance in answering the question of motivations behind work-sharing agreements.

When the West German industry was allocated the responsibility for developing the wing pivot for the variable-geometry MRCA, previous British research experience on two such variable-geometry aircraft (AFVG and UKVG) and actual design work on the TSR-2 was ignored in favour of providing German industry with the chance to obtain new R&D capabilities. In the event, MBB turned to the U.S. which had faced its own problems in developing the F-111 and F-14 aircraft. Expertise in complex electron beam-welding was purchased from the Grumman company.[63] One of the most complex airframe design problems was thus solved not in Europe, but through importing U.S. patented technology.

The third main area of work-sharing agreements concerned the complex avionics systems required to meet the multi-role demands of the Tornado. With over 50 subsystems required for tasks such

as flight control, navigation, weapons delivery and defensive aids, and STOL capability, the avionics package was estimated to make up over 40% of the total MRCA unit price. Concern with cost and efficiency is thus a question of considerable importance.

Decisions regarding the awarding of avionics contracts involved a process of acceptence almost as complex as the avionics itself. Each bidder was required to submit a two-part proposal, with one part covering technical data and the second dealing with price, delivery and management details. Both sets of proposals had to be submitted to the three main contractors - MBB, BAC and Aeritalia/Fiat - and to the avionics group established to oversee this section of the project, Avionica Systems Engineering GmbH. The latter group then distributed the proposals to its three national partners; EASAMS of Britain, ESG of West Germany and SIA of Italy. Finally, the technical proposals were also to be submitted to the national defense ministries receiving the aircraft.[64]

This administrative tangle, necessitated by the trinational membership of the programme, was further complicated by the requirement that work should be shared approximately in the agreed ratio of 42.5/42.5/15. In addition, the companies offering bids were asked to submit not only proposals matched to MRCA specifications, but also alternative non-compliant equipment which might prove more attractive for other reasons, such as lower price or better performance. Combined with the difficulty of matching the varying national requirements, the selection

process was thus a protracted, and in itself expensive, exercise.

After its exclusion from the MRCA engine work, the U.S. was exerting greater pressure for some part of the avionics package. On this occasion, British and German views clashed, as Britain continued to insist on exclusively European participation;

> The West German defence ministry strongly favours a close relationship with the U.S. in MRCA avionics and argues that, with such an association, the newest technology would be incorporated in the fighter. There would also be competetive pricing and German industry would gain a manufacturing competence it does not now have.[65]

The latter goal was shared by the German avionics combine ESG, which also sought to avoid having the avionics contracts dominated by British companies.[66]

The result of these considerations and disputes was heated controversy over the selection of various subsystems. Problems which arose over the choice of the ground-mapping and terrain-following radars are sufficient to illustrate this controversy. and its outcome. The apparent subject of debate was the optimum operating frequency of the radars. The Luftwaffe sought a Ku-band for both subsystems, basing its requirements on the General Electric mapping radar and the Texas Instruments terrain-following radar , both of which were installed in the F-111. The RAF, however, specified a Ka-band mapping radar and an X-band system for terrain-following.

> By a not-so-strange coincidence, Britain's Elliott Automation had earlier developed a Ka-band mapping radar while Britain's Ferranti Ltd. had an X-band terrain-following radar.

> This made the Elliott/Feranti equipments the only contenders for the (RAF's) Air Defence Version of the MRCA.[67]

Italy, which originally specified a third set of preferences, agreed to accept the West German requirements as the need to hold down rising avionics costs pushed the consortium towards purchasing already-existing systems rather than developing new ones.

The final choice of systems is discussed in the evaluation and conclusion following the present section of the case study. However, it appears clear from the ideas and examples presented above that criteria other than industrial or technical efficiency and cost were used by both Britain and Germany in presenting their avionics requirements. The complex bidding process and the disputes over the type and source of supply of several avionics subsystems resulted in a 5-month delay in the programme, adding further to development costs, while the inability of the Avionica group to solve these problems led to it being abandoned in 1972.

Section IV). Conclusion

i). A Brief Evaluation of the MRCA programme.

Although it is not the purpose of the present paper to give a detailed analysis of either the performance characteristics of the Tornado aircraft or the success of the consortium and the programme which produced it, such an assessment may still usefully fulfil two functions. First, such an evaluation may

help to indicate the effects which political or other influences have upon the efficiency of co-production programmes in terms of the end result or product. Second, it may also help the reader in forming an opinion as to the viability of such programmes as a possible means of at least partially meeting the NATO policy goal of equipment standardisation.

B.O. Heath, a BAC director closely linked to the Tornado programme, presented his own evaluation of the aircraft which appears to be a model of achievement. The MRCA either met or exceeded its test requirements in several areas, including maximum g. at super- and subsonic speed; structural strength; alignment time; take-off mass and distance; maximum speed at sea level; and high- and low-altitude handling. Service ceiling and maximum speed at high altitude were also 'closely approached'.[68]

This list of achievements demonstrates that many of the agreed programme goals for aircraft performance were successfully met. However, it does not tell us whether these goals were such that the MRCA could fulfill the roles sought by the three air forces and the German navy. On this point, Smith argues against the abilities of the aircraft;

> There is one problem with multi-role aircraft, indeed, with any multi-purpose machine: they tend to do each task less efficiently than aircraft specialised for that task. (Smith, 1980,p.133)

Whether the aircraft is able effectively to meet the demands of the various missions required of it is in military terms the relevent question, not whether it achieved the compromise levels

worked out by the national governments.

Heath provides an analysis of the MRCA thrust-to-weight ratio (T/W), one of the central characteristics in assessing the ability of the aircraft to perform as an air combat fighter. Figures 1) and 2) in the case study appendix illustrate the authors' findings. Heath describes the T/W ratio as 'adequate', arguing in its defense that

> ...were the T/W of a specialist fighter to have been combined with those key characteristics really needed for MRCA-Tornado, a 70,000lb aeroplane - too costly to have even started - was indicated. (emphasis added) (Heath,1979,p.332)

Implicit in this statement is the admission that the MRCA in fact does not meet the requirements of an air combat aircraft when compared to specialised aircraft such as it might be expected to face in a real conflict. As Heath's findings indicate, the MRCA lacks manoeuvrability compared to other NATO aircraft such as the F-15 and F-18, or even the F-4 Phantom. Smith argues that the participating governments may have recognised the unsuitability of the MRCA for the air combat mission as early as 1970,[69] and Heaths' statement seems to support this view.

The German government's acceptence of a twin-engine, two-man crew aircraft was initially taken to indicate that its original requirement for a close support aircraft was being compromised to satisfy the British long-range strike mission. However, the development of streuwaffen, or area bombs, for use against tank attack meant that the heavier long-range aircraft role could still be used for close support and also now had a greater

payload capacity. [70] This circumvents much of the criticism against the MRCA's ability to perform this task, but still leaves out of consideration one problem:

> ...close support aircraft must operate in the face of dense opposition from surface-to-air missiles, anti-aircraft guns and enemy fighters; the preferable aircraft would be both cheaper and more rugged than the Tornado. (Smith,1980,p.134)

There may thus be some reluctance to commit the MRCA to the role of close support, although it is capable of fulfilling the German requirement.

The role for which the MRCA appears to be optimised (as the Netherlands' government suspected) is the long-range strike/ interdiction requirement of the RAF. These seem to have been the 'key characteristics' referred to by Heath and mentioned earlier.

> What the RAF has got, what it has wanted and been fighting for ever since the 1957 defense White Paper threatened the future of manned bombers, is a modern, sophisticated, high-speed low low-level bomber. It will be noted that the Federal German air force has got the same thing; for the FRG Tornado is a back-door entry to the long-range bombing mission... (Smith,1980,p.p.134)

Regarding the common MRCA variant, this appears to be the mission for which the MRCA is best suited in terms of performance characteristics and cost.

Smith is again critical of the ADV Tornado developed solely for the RAF. The British Ministry of Defense, Smith claims, argued that although as an aircraft the Tornado ADV would be

little better than the existing F-4 Phantoms then in service, " `the weapon system is a complete step ahead' ..." (Smith,p.134). According to this view, improvements were not in the aircraft itself, but in the radar, missiles, and main computer. However, Hartley also discusses a British government evaluation of the U.S. F-14, F-15 and F-16 aircraft as alternatives to the MRCA;

> At the time, the evaluation showed that the F-14 was the closest substitute but that it was a costly aircraft, probably 50 per cent. more expensive than the Tornado. (Hartley,1983, p.172)

Neither the F-15 nor the F-16 were felt to be able to meet the long-range, all-weather capability or the complex U.K. air defence tasks required of the Tornado ADV, although the latter aircraft was cheaper.[71]

Although the common Interdictor Strike (IDS) variant of the MRCA seems to satisfy the RAF operational requirements and could also - though perhaps expensively - meet the close support role sought by the Luftwaffe, the Italian air force does not appear to have obtained the system best able to fill the role of air combat fighter. This is the area of least satisfactory performance. The RAF Air Defence MRCA, whilst not ideal, may be better suited to its role than the alternative U.S. aircraft. This author believes that while the performance of the MRCA fails under closer examination to meet the high praise of Heath's work, it is a better system than either Smith or Walker have concluded. For the Italian air force, however, one must conclude that in

operational terms the MRCA may well be inadequate.

In considering the general success of the MRCA co-production programme, the relevent criteria for evaluation are those of cost-savings and control of cost escalation, the achievement of estimated delivery dates, and the avowed intention to keep the project an exclusively European effort. National political or economicgoals are less relevant, other than in their effect on the criteria mentioned above, as evaluation of these goals will differ between nations and even between groups within a nation.

In his analysis of joint aerospace projects, Hartley mentions a difficulty of assessing cost-savings from such ventures;

> ...there is a danger that nirvana or ideal, but never achieved, U.K. cost levels will be compared with actual costs for joint projects, ignoring the realised costs on British programmes. (Hartley,1980,p.159)

As was seen in the earlier parts of the case study, the U.K. aerospace industry - for example - cannot be assumed to be 'efficient' in this manner, as government intervention for employment purposes, non-competetive bidding, and support for domestic industry against cheaper foreign suppliers all reduce the efficiency of an industry already operating below the MES in production.

Assuming a 'collaborative premium' or cost increase of 40 per cent. on R&D and 10 per cent. on production, Hartley estimates that co-production of the Tornado still offered Britain a cost saving of 360 million pounds sterling compared to the possible costs of a comparable national project. The only similar

national development effort, on the TSR-2, was cancelled because the British government could not afford to meet future progamme costs. On the basis of the three nation's share in the project, Hartley places total programme cost-savings at between 850 million and 1.9 billion pounds sterling (in 1976 prices).[72]

Trevor Taylor provides a brief assessment of the logistics system established for the MRCA programme. The common procedures, training programmes for suppliers, and trinational pooling of orders for spare parts introduced and supervised by the Panavia Product Support Directorate has successfully reduced the cost of logistic support. Compared again with a similar national provisioning scheme, Taylor estimates these savings to have been between 40 and 50 per cent. per member in the consortium.[73] These figures, the authors admit, are best seen to seen to represent orders of magnitude rather than exact amounts. Despite this, they still indicate the existence of substantial cost-savings which are attributable to the co-production programme.

Hartley also provides a comparison of cost-control or cost escalation on several joint ventures, including the MRCA, compared to independent national projects in Britain and the U.S. The main points of his analysis are reproduced as Table IX) in the case study Statistical Appendix. Hartley found that while cost control on the Anglo-French Jaguar project was the most successful of the ventures, Tornado compares well with other joint projects and is also better than its cancelled British

predecessor TSR-2 or the U.S. F-111.[74]

Despite the relative success of cost control on the MRCA programme, the time taken to develop and produce the first operational aircraft is clearly a handicap in co-production and the choice of a multi-role weapon. Compared to similar national projects in the U.S., Tornado took over twice as long to develop than the F-111 or the F-15; and compared to the average development time for a U.K. aircraft, an additional 3 years and 8 months was required.[75] The technical complexities of the multi-role concept required to fit the Tornado to diverse national requirements, added to delays in reaching contractual agreements over work-sharing, delays in RB.199 engine testing, and schedule stretch-outs by the national governments extended the total development time of the MRCA to 12 years (1968-1980). Such a delay must have cut into the operational life-span of the Tornado once it reached service, especially given the rapid advances being made in aircraft technology and anti-aircraft defences. As mentioned earlier, this aspect of the MRCA programme probaly indicates one of the most important disadvantages of co-production efforts in advanced-technology systems.

The final avowed goal of the MRCA consortium, or at least of the British governmant, was to maintain the exclusively European nature of the programme. Whatever the motivation of the British government in seeking this objective, the attempt was a failure. The purchase of U.S. technology by MBB of West Germany for

development of the variable-geometry wing box has already been mentioned. Early in the project development phase, it also became clear that the cost of designing an entirely new avionics package for the aircraft would result in unacceptable cost escalation. It was thus necessary to seek 'off-the-shelf' systems. The bid by Britain's Elliott Automation and Ferranti companies for the ground-mapping and terrain-following radars, discussed earlier, came to twice the cost of comparable systems offered by Texas Instruments and Rockwell Corporation - both U.S. companies. At German insistence, and despite strong British opposition, Texas Instrumants won the radar contracts.[76] Within the next year, other avionics contracts went out to Litton Industries, Honeywell, and the Astronautics corporation respectively for the Attitude Heading, Air Data, and Bearing computers. European industries were unable to match U.S. costs for advanced avionics systems.

ii). The literature and the MRCA-Tornado case study.

One of the most important conclusions concerning the ideas expressed in the literature review and the analysis of the MRCA co-production programme is that in determining the nature of collaborative or co-production efforts in Europe, criteria of specific operational requirements, industrial efficiency, and cost-savings appear to be secondary to those of national governments' political and/or economic policies. Greenwood's warning that too many attempts to assess the advantages and

problems of collaboration ignore the "political parameters" which may demand second- or third-best solutions to programme efficiency thus seems to be correct.

Specific concerns, such as surplus capacity in Rolls Royce, were certainly addressed by government decisions and the broad background of industrial demands provided a number of incentives for seeking co-production, yet the direct influence of individual pressure group interests on government policies appears to have been of secondary importance. The types of demands and the domestic economic situations varied between nations in the MRCA project, as did the attitude of aerospace industries towards collaboration.

Difficulty of cancellation is a feature of co-production which industries may see as an advantage, but this does not seem to have been consistently sought by the companies involved in the MRCA work. A number of industry groups and spokesmen in Britain, where the existence of surplus capacity might have led to non-cancellation being a prized objective, were instead seen to have actively and vocally opposed collaboration. By contrast, industry officials in Italy hoped that government involvement would help to secure the future of such projects.

Much of the literature refers to the need for political will before standardisation can be undertaken; the same can be said for co-production. Without the wider political incentives which motivated the British, German and Italian governments to continue to pursue the joint venture, it is unlikely that considerations

of project cost-savings or potential military benefits from commonality of equipment would have been sufficient for the consortium to maintain its momentum.

The case study indicated that those authors who claim that co-production and collaboration lead to increased programme costs are correct. National interests outweigh concerns with least-cost suppliers; differing operational reqirements can create technological difficulties and higher R&D costs; programme delays are likely; and administrative costs tend to rise. However, compared to a national programme to develop a similar advanced aircraft, the MRCA programme offered its members the chance to divide these costs and to spread them over a larger number of units. Assuming that a comparable national project would be required and that it would not be cancelled partway through, the MRCA resulted in valuable savings for each nation in system-cost and programme-cost. This occurred despite the failure of the group to secure additional production through exports outside of the consortium.[76]

Did the multi-role concept of the MRCA serve as a 'hedge against uncertainty' for defence planners, or did it create additional uncertainties ? If one considers the desire of the European governments to maintain or to develop national defence-industrial capacity and capabilities as an insurance against the possibility - however remote - of U.S. disengagement of forces from Western Europe or NATO, then the MRCA programme provided valuable work for the three national industries involved in the

scheme. From this point of view, the cost of the programme might be seen as the price required to obtain a prudent measure of security in defence production.

In the opinion of the present author, the multi-role concept appears to have been dictated by the need to reconcile several different operational requirements as the only means of obtaining the co-production agreement. Against this, it should also be stated that the need to design a multi-role system pushed the programme against technological barriers and created difficulties in meeting the specialised performance standards required for the several roles officially performed by the aircraft. It thus created some uncertainty over the ability of the aircraft to meet the full range of operational demands placed upon it.

Notes

Section 2

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5. Callaghan, T. "Standardisation: Le Defi Americain a 1'Europe." NATO Review No.5, 1978, p.26.
6. Hartley, K. NATO Arms Co-operation. (London, George Allen & Unwin, 1983) p.161.
7. Taylor, T. "Standardisation: the Dimensions and Implications of a Policy Issue", Journal of International Studies Autumn 1978, p.118.
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13. Tucker, G. "Towards Rationalizing Allied Weapons Production." The Atlantic Papers (Paris, Atlantic Institute, 1976.) vol.1, p.10.
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2. AW&ST, November 4th, 1968, p.22.
3. Speech by Canadian Defense Minister Cadieux, Keesing's Contemporary Archives January 3-10th 1970, p.23753.
4. Lindsey, G.R. Letter from G.R. Lindsey, Chief, Operational Research and Analysis Establishment, Ottawa. July 16th, 1985.
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6. AW&ST, June 2nd 1969, p.160.
7. AW&ST, May 2nd, 1977, p.59.
8. AW&ST, May 27th, 1969, p.27.

9. Dutch Defense Minister Hendrikus J. de Toom, Keesings, August 2-9th, 1969, p.23492.
10. Heath, op. cit.,p.331.
11. Keesings, op.cit.
12. AW&ST, June 2nd, 1969, p.160.
13. ibid, May 5th, 1969, p.27.
14. ibid, August 11th, 1969, p.116.
15. ibid, November 4th, 1968, p.22.
16. ibid, April 7th, 1969, p.23.
17. AW&ST, op. cit.
18. Quaroni, P. "European Integration", Survival, No. 12, December 1970, p.402.
19. Keesings, August 19-26th, 1967, pp.22205-22206.
20. Anonymous source, AW&ST, April 7th, 1969, p.23.
21. General Johannes Steinhoff, c-i-c of the Luftwaffe at the time, stated that
"The competence of the West German industry is a definite asset, and it is important that the industry exploit its potential as a developer as well as a producer of aircraft."
AW&ST, June 2nd, 1969, pp. 196-197.
22. Keesings, June 14-21st, 1969, p.23406.
23. ibid.
24. AW&ST, June 5th, 1972, p.31.
25. Mason, R. "Setting British Defence Priorities", Survival, No 5, September 1975, p.219.
26. ibid, p.224.
27. AW&ST, June 9th, 1969, p.32.
28. ibid, September 6th, 1976, p.63.
29. Unnamed sources; Kolkum, E. AW&ST, November 4th, 1968, p.22.
30. AW&ST, April 24th, 1972, p.39.
31. ibid, September 8th, 1969, p.20.
32. ibid, September 1st, 1980, p.117.
33. ibid, April 24th, 1972, p.34.
34. Keesings, March 30th- April 6th, 1968, p.22618.
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37. ibid, op. cit.
38. ibid, March 8th, 1971, p.29.
39. ibid, April 28th, 1975, p.26.
40. Smeeton, Sir Richard. Director of the SBAC. AW&ST, September 7th, 1970, p.14.
41. AW&ST, January 10th, 1972, p.19.
42. ibid, op. cit.
43. Edwards, Sir George., Director of BAC. AW&ST, September 7th, 1970, p.14.
44. ibid, November 11th, 1974, p.23.
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directed companies.

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49. Mechtescheimer, p.164.
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52. Unnamed official from Aeritalia's Combat Aircraft Division. AW&ST, January 23rd, 1978, p.60.
53. Mechtescheimer, pp.182-185.
54. AW&ST, June 5th, 1972, p.9.
55. Keesings, February 10-16th, 1975, p.26959.
56. AW&ST, July 14th, 1969, p.56.
57. ibid, February 26th, 1973, pp.21-22.
58. ibid, September 23rd, 1968, p.17.
59. ibid, May 19th, 1969, p.25.
60. ibid, September 1st, 1969, p.23.
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62. ibid, September 8th, 1969, p.19.
63. Taylor, T., Defense, Technology..., 1982, p.179.
64. Klass, P.J., AW&ST, April 26th, 1971, p.55.
65. Kolkum, E., AW&ST, September 29th, 1969, p.20.
66. AW&ST, September 7th, 1970. p.78.
67. Klass, P.J. op. cit.,p.57.
68. Heath, B., op. cit., p.332.
69. Smith, D., The Defense of the Realm in the 1980s, (London, Croom Helm, 1980.), p.134.
70. AW&ST, September 7th, 1970, p.38.
71. Hartley's own estimates give a unit cost for the F-14 of 13.1 million pounds sterling; for the F-15, 8.2 million pounds; for the F-16, 3.1 million pounds; and for the ADV Tornado, 8.5 million pounds. (All figures quoted in 1976 prices. Hartley, K., op. cit., pp.172-73.
72. Hartley, op. cit., p.161.
73. Taylor, op. cit., p.162.
74. Hartley, p.170.
75. ibid, pp.166-169.
76. AW&ST, August 16th, 1971, p.64.

Section 4.

1. The first export sale of the Tornado ADV was made to the Sultanate of Oman in mid-August, 1985. Eight aircraft only were ordered, not enough to prolong the Tornado production programme. Fairhall, D. Manchester Guardian Weekly, August 25th, 1985.

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Table I).

U.K. Defence Expenditure for Selected Years, 1955-1974.

Year	Defense Expenditure (1977 prices) £m.	Index No. 1960=100	Defense Expenditure (1970 prices) $m.	Index No. 1960=100	Defense Expenditure (as % GDP)
1955	1567	94.6	6379	108.2	8.2
1960	1657	100.0	5893	100.0	6.5
1965	2091	126.2	6256	106.2	5.9
1970	2444	147.5	5850	99.3	4.9
1971	2815	169.8	6159	104.5	5.1
1972	3258	196.6	6654	112.9	5.3
1973	3505	211.5	6554	111.2	5.4 (est.)
1974	4148	250.3	6686	113.4	5.4 (est.)

(Greenwood,1977,p.191.)

As Table I). above indicates, defence expenditure in the U.K. underwent a slow but steady increase if measured in current prices, and a somewhat slower rise when measured in constant (1970) prices. However, as a percentage of GDP, defense expenditure suffered a drop - even ignoring the 1955 measure after the Korean War - from 6.5% to a level of around 5% in the early 1970s. Governments were increasingly unwilling to commit more than this to defense, and instead looked to use the funds in other sectors.

Table II).

Comparison of Public Expenditure (1977 market prices).

Selected Sectors Only.	1958		1963		1968		1973	
	£m.	%	£m.	%	£m.	%	£m.	%
Military Defense	1543	18.6	1892	16.2	2443	12.8	3097	11.4
Social Security Benefits	1345	16.2	1988	17.0	3340	17.5	5119	18.9
Education	785	9.4	1282	11.0	2182	11.4	3508	12.9
NHS	728	8.8	1035	8.9	1688	8.8	2644	9.7
Industry and trade	543	6.5	791	6.8	2016	10.5	2322	8.5

(Greenwood,1977,p.194.)

Table II). again illustrates the point that although the defense budget increased steadily throughout the 1960s and into the 1970s, as a percentageof total public expenditure it fell throughout the period, from 18.6% to 11.4%. In its place, social security benefits, education and NHS expenditure allrose. There wasa fundamental shift in government priorities away from defense expenditure and towards social welfare in the U.K.

Table III).

Division of Military Expenditure by Main Categories, 1975-79.

	1975	1976-7	1977-8	1978-9	1979-80	Average
Manpower	47%	45%	45%	43%	42%	44%
Equipment total	35%	36%	37%	40%	41%	38%
a) production of new equip.	n.a.	38%	42%	44%	44%	42%[a]
b) production of spares.	n.a.	31%	27%	27%	26%	28%[a]
c) R&D costs	n.a.	31%	31%	29%	30%	30%
Other[b]	18%	19%	18%	17%	17%	18%

(Smith,1980,p.112)

[a] - averages here for 1976-7 and 1979-80 only.
[b] - buildings, stores, and miscellaneous equipment.

Table III) clearly indicates the impact of rising equipment production costs on the U.K. defence budget. While manpower cuts have been made, they do not match the declining proportion of the defense budget allocated to this use.

Table IV).

NATO aerospace industries in 1970 - sales and productivity.

Country	Sales[a]	Total Employment	Productivity[b]	Concentration Ratios % [c]
U.K.	2216	235,100	9426	35.9
FRG	1291	56,206	22,969	40.2
Italy	317	29,500	10,746	29.9
France	2131	103,364	20,616	31.8
USA	24,896	1,116,000	22,308	8.9

(Hartley,1983,p.29)

[a] - millions ECU, 1975 prices.
[b] - sales per man, ECU, 1975 prices.
[c] - largest firm's employment in each nation as a % of the industry's total employment.

Table IV). illustrates the low productivity of the U.K. aerospace industry, and that of Italy, indicating that in these nations government 'make-work' policies may be prevalent. The contrast between concentration ratios in Europe and the USA is also notable. The European aerospace industry has obliged to turn towards mergers of the largest national companies to enable each nation to compete more effectively. These companies are often either directly controlled by the governments, or else dependent upon government defence contracts.

Table V).

Major Aerospace companies in NATO, 1980

Company	Sales (m. ECU, 1983 prices.)	Employment	Productivity (sales per man, ECU, 1983.)
USA			
Boeing	6772	106,300	63,707
McDonnel Douglas	4358	82,550	52,792
Pratt & Whitney	3874	70,000	55,343
General Electric	1800	24,000	75,000
Europe			
British Aerospace	2378	77,500	30,684
Rolls Royce	2102	58,800	35,748
Aerospatiale	2244	34,422	65,191
MBB	1309	26,287	49,797
MTU (engines)	276	6,594	41,856
Dornier	401	8,454	47,433
Agusta	378	9,358	40,350
Aeritalia	233	11,500	20,261

(Hartley,1983,p.108)

Table V). especially shows the low productivity levels of the British and Italian companies, where creation of employment has been a government priority in industrial policy.

Table VI).

a). West German aerospace companies involved in MRCA production.

Messerschmidt-Boelkow-Blohm	-	prime contractor.
Siemens	-	laser range finders, radar and I.D. air surveillance.
Motoren und Turbinen Union	-	prime engine contractor.
Teldix	-	Navigation systems and head-up display.
Bodenseewerk Geratetechnik	-	control and stability system.
Abex	-	hydraulic pumps.
Apparatebau Gauting	-	fuel pumps.
Nord-Micro	-	engine components, flight controls.
Otto Fuchs Metallwerke	-	metals and alloys.
Alfred Teves	-	wheels and brakes.
Litef	-	onboard computer.
Frankejura Industrie	-	ball bearings, roll ends.
Rohde and Schwartz	-	direction finders, test-sets for avionics.

Other general contractors

VFW-Fokker
AEG-Telefunken
Industriewerke-Karlsruhe

(AW&ST, Sept 1st, 1980.)

b). Selected Italian companies involved in MRCA production.

Aeritalia	-	prime Italian contractor.
Macchi	-	weapon and fuel pylons.
Piaggio	-	leading-edge slats.
SACA	-	flaps and pylon housing.
Siai	-	structural components.
Fiat Aviazione	-	prime Italian engine contractor.
Others		
Aeronavali	-	airframe.
Microtechnica	-	} General equipment
Selenia	-	} and
Magnaghi	-	} avionics.
Autovox	-	avionics.
Marconi Italiana	-	avionics.
Alfa Romeo.	-	engine.

(AW&ST, June 5th, 1980.)

Table VII).

Cost control on joint ventures; selected data.

Project.	Total cost (m.)	Cost escalation.
Joint projects.		
1). Concorde (UK-France)		
Total cost increase 1962-73	895	
Development cost escalation:		
a) Current prices 1962-73		6.27
b) Constant prices 1962-73		2.23
c) Current prices 1962-80		6.67
2). Jaguar (UK-France)		1.10
3). Lynx helicopter (UK-France) Escalation in R&D costs, 1967-73, constant prices.		
a) Airframe		2.06
b) Engine		2.80
4). Tornado (UK, FRG, Italy)		
a) Unit production cost 1973	2.90	
b) Unit production cost 1981	11.40	
c) Escalation in unit production costs, current prices		3.93
unit production costs, constant prices		1.27
R&D costs to 1976, constant prices		1.40
Comparative data; national projects		
5). TSR-2 (UK, 1959-62)		
R&D cost escalation, constant prices		2.80
6). F-111 (USA)		1.98

(Hartley, 1983, p.170)

Figure 1).

Combat wing loading vs. T/W ratio.

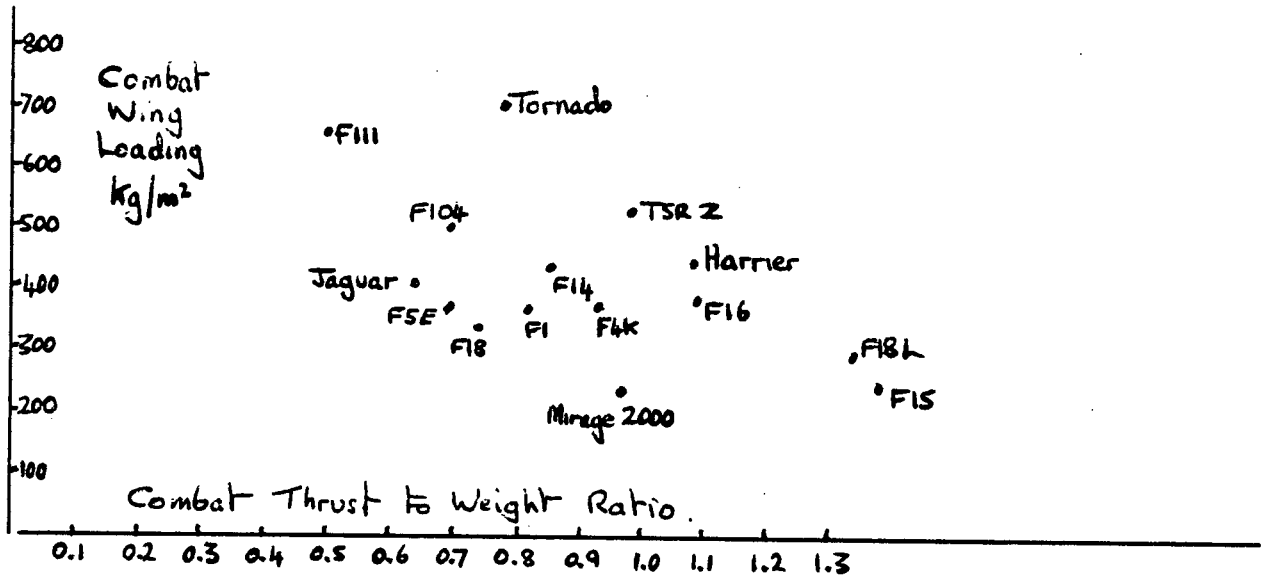
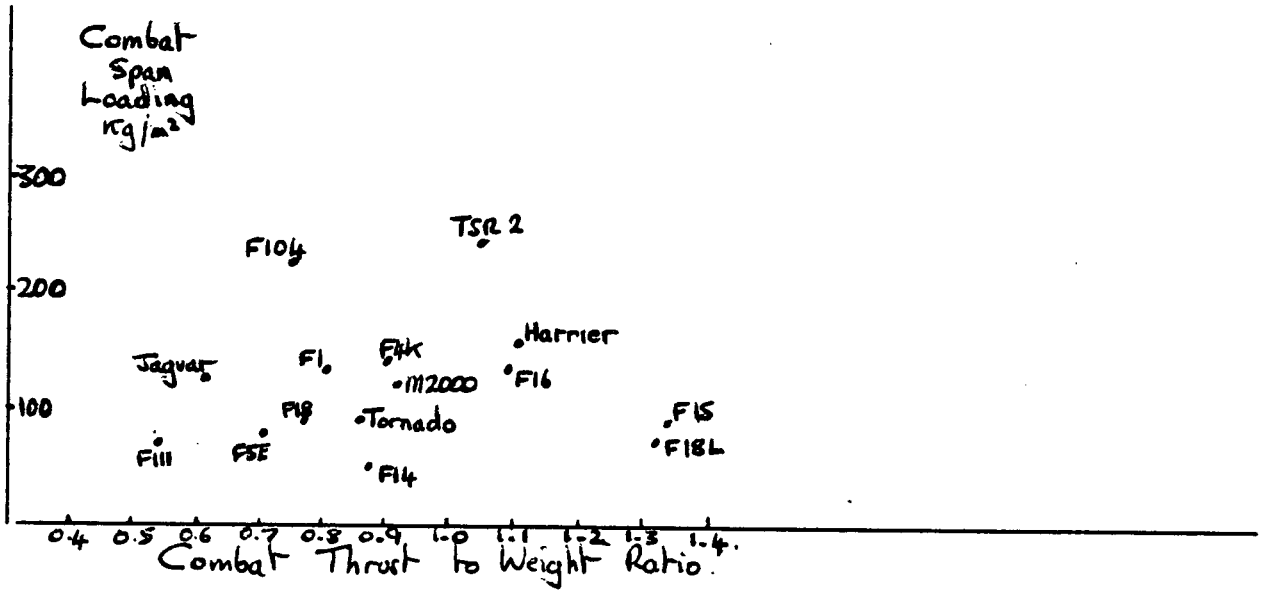


Figure 2).

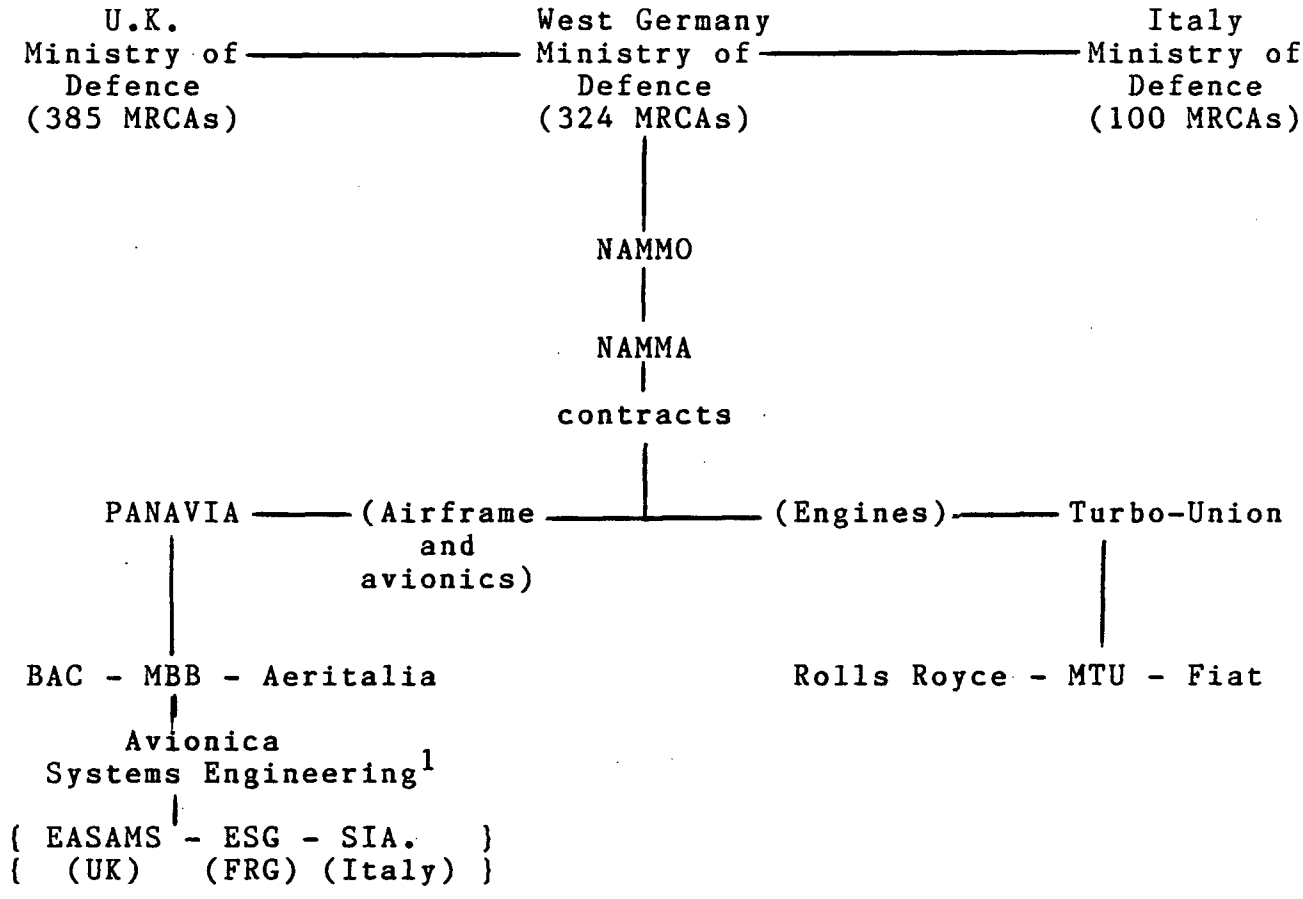
Combat span loading vs. T/W ratio.



(Heath, 1979, p.332.)

Figure 3.

Organisational framework of the MRCA-Tornado programme.



[1] Dissolved in 1972: avionics management then led by EASAMS.

KEY

NAMMO	-	NATO MRCA Management Organisation.
NAMMA	-	NATO MRCA Managemant Agency.
BAC	-	British Aircraft Corporation.
MBB	-	Messerschmidt-Boelkow-Blohm.
MTU	-	Motoren und Turbinen Union.
EASAMS	-	Elliott-Automation, Space and Advanced Military Systems.
ESG	-	Elektronik-System G.m.b.H.
SIA	-	Societa Italiana per l'Avionica.