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Some Observations of European Collaborative Projects

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SOME OBSERVATIONS OF EUROPEAN COLLABORATIVE PROJECTS

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ABSTRACT

International collaboration on aerospace projects has been a way of life in Europe for many years. The paper will deal with some of the reasons for this association in development and manufacture and describe some of the relevant management organisations.

A brief review of the existing projects and their programmes will be made with particular emphasis on the MRCA programme. This represents the present phase of work using the variable wing sweep principle, research on which started in the late 1940's and included some Anglo-American co-operation via NASA. The variable sweep concept survived a series of national and international programme studies and political situations before reaching its present stage.

Europe is currently measuring its capability of remaining a first line source of aerospace equipment and some observations will be made with regard to the future in this respect.

INTRODUCTION

Europe today is a collection of sovereign states - (of which Great Britain is an off-shore island) - with a long tradition of resourcefulness, inventiveness and ingenuity in both the aesthetic and martial arts. The growth of the nation-state is a European phenomenon and it was from Europe that our ancestors set out to colonise the world - the principal driving-force being the quest for trade and gold.

Unless you have a captive market - which quite literally was often so in those days (slave-trade) - you have to offer something which your customer wants and more importantly cannot make, or obtain, for himself at a cheaper price. Since the new-found world was abundant with raw materials, the mother countries of Europe - led by Britain - were spurred into the development of technology some two centuries ago since when we have relied on our technical expertise in order to earn our living in the world. Coming now to more modern times it is interesting to re-

call that even in 1935 the British aircraft industry was twice the size of its US counterpart.

Although European inventiveness has shown the way in practically all technological progress from the railway engine to the space rocket, we have generally been ill-poised to reap the rewards - particularly of our more recent endeavours - which have gone to the USA with its greater pre-occupation with production for a large domestic market.

The 'horse-less' carriage is an example from an earlier era. Gottlieb Daimler, Lanchester, Turcat and other Europeans may have set the technical scene but it was Henry Ford who supplied the market.

In aeronautics too, Europe has often pioneered in technology (swept wing from Germany, jet propulsion, radar, VTOL etc) but we have failed to reap the reward by quantity production. The sharing of resources, particularly financial, and extension of the market are the driving reasons for Aerospace collaborative partnerships.

EUROPE TODAY

Sharing work in Europe is not a recent innovation; in 1910 an Anglo-French project, the Zodiac, was shown at an exhibition in Olympia, London and the Bristol Boxkite, which stemmed from a French Farman design was being produced at the rate of two per week. The Vickers No.1 monoplane was designed in partnership with another Frenchman, M. Pelterie.

Figure 1 shows many current partnerships for airframe and helicopter manufacture, which have worked with varied, but in general, satisfactory degrees of success; these associations are not limited to European partners. Figure 2 shows the similar situation which exists among the engine companies as there also does in missile and space activity. One interesting feature shown on these two networks is that manufacturers can be in collaboration on one project and in opposition on another. There are no formal associations for the long term continuity

of Aerospace programmes, although Airbus Industrie is a move in this direction; other current associations could develop this way.

The number of employees in the major companies of the European industry are shown on Figure 3 which also compares three of these airframe companies with the large American companies. The comparison might suggest one reason why Europe is striving to get together in some manner to pool its resources, to match US competition. It also highlights a likely problem which we in the U.K. could be up against when negotiating with European partners, that of the relative sizes of our industries. U.K. has the complete capability to "go it alone", but the capital resources are not there to back the investment required, even if the political environment allowed.

Historically, Europe's share of world trade has been of the order of 30%, (Figure 4.) (10% BAC, 10% Fokker, 10% other - Civil a/c). This trade excludes China, the Soviet Union and the United States own military market, the U.K. has consistently contributed about half of that of all Europe put together. It is the aim of any "United Europe" approach to Aerospace to keep or even improve on this performance, providing the world market and the opportunity are there.

A total involvement in all Aerospace activity is an essential in providing a balanced base. Guided Weapons, Space, Military Aircraft and Commercial Aircraft within one overall organisation allows for the peaks and valleys of each to be smoothed and for the fusion of the different technologies across the board to be beneficial to each. However, to keep this paper within bounds, Military and Commercial aspects only will be dealt with.

A collaborative military project usually has political as well as commercial overtones; as often as not the allocation of work is controlled politically or strategically, rather than on a wholly commercial basis.

Collaboration in Europe, see Figure 5, has so far included such projects as the Transall, Breguet Atlantique, Jaguar, MRCA and Alpha Jet and has demonstrated a remarkable degree of success in the compromise of each country's own Operational requirements.

The advantage of European programmes for Military Aircraft stems from the fact that Governments are the customers and that it is almost impossible to get an international programme going at all unless

there is a firm production commitment by each of the participating Governments; for example the Jaguar has a British/French commitment for 400 aircraft, over 200 of which have already been delivered to the two Air Forces. In addition Export production is in hand for two other countries. The MRCA production requirements total 807 aircraft, 385 for RAF, 322 for the German Air Force and 100 for the Italians. Export interest is already being shown.

None of these however resulted from a NATO specification, perhaps the nearest was the Breguet Atlantic sponsored by the Federal Republic of Germany, Belgium, France, Holland, U.S.A. and NATO; the two latter did not take part in the manufacturing activity. The UK on this occasion chose the Nimrod to meet its own special requirements, for very good operational reasons but to the annoyance of the sponsoring countries.

About 1961-1962 NATO Basic Military Requirements Numbers 3 and 4 were issued to meet the need for a short take off and vertical landing tactical aircraft and for its support aircraft. Although participation in design and manufacture across national frontiers featured as a requirement, after a full scale competition, technical evaluation and a winner chosen, the project fell by the wayside, a triumph for Nationalism.

Defence budgets can and do alter these programmes and we are now in a period of stringent economy. It is important therefore that each participating country takes due cognizance of the requirements of the broader market in arriving at its operational requirements, to make the product attractive to customers other than itself. Provided this is done sensibly it can be of benefit to the home customer by virtue of a cheaper product.

The longer production runs of collaborative projects leading to lower unit cost, contrasts sharply with some of the purely national projects which had been conducted on the "drip feed" or never-never basis, whereby successive stages of the programme were contracted for without there being any commitment whatever to the next stage.

For the production of Civil Aircraft, the attractions for International collaboration are quite different, the collaborating Governments feel unable to instruct their own national airlines to buy. There is no dramatic increase in the starting orders, as in the case with Military Aircraft. In fact there is no certainty that there will be any starting

orders from the joining countries. Airlines, although they may be wholly or partly state owned, have to operate in a highly competitive environment and if they are not using equipment that is as good as their competitors can buy in the free market, they will lose their competitive edge - at least that's the airline view!

Fewer partnerships, Figure 6, have so far been established for Civil Aircraft but those that have, have so far demonstrated that they can produce technically good aircraft. However, airlines have historically bought from a single manufacturer; consortium built aircraft are new to them and one of the big tasks has been to earn customer confidence in these consortia.

MANAGEMENT OF COLLABORATIVE PROJECTS

One essential feature of collaboration is to get the difficult, but absolutely necessary, matter of programme management right and this subject could well merit a paper on its own. A summary will suffice here.

Two basically different methods of organization for the projects that have been discussed have so far been tried. Concorde is controlled by a series of committees whose members include nationals of both participating countries and responsible to a joint national authority at ministerial level. Jaguar and MRCA are run by industrial companies set up in one or other of the participating countries acting under the laws of the 'host' country and responsible to policy organizations comprising members of the nations concerned. The policy organizations are responsible for providing the industrial companies with the necessary finance drawn in pre-determined ratios from each participating nation's treasury according to the work-sharing agreement.

Figure 7 sets out the Concorde organization down to the industrial working level on the airframe side. The engine firms follow a similar pattern.

It is important to stress that there is no such thing as a French Concorde or a British Concorde. Two assembly lines exist, one in Toulouse, the other in Filton, but each Concorde is assembled from components and equipment 50 per cent of which are built and supplied by France and 50 per cent of which are built and supplied by U.K. Each aircraft is, therefore, a truly joint effort.

At no time has one man been established as leading the Concorde Project. The

top man in each of the four industrial companies (two airframe, two engine) and the two Government Project Teams can be identified at any one time. But the Government Project Leaders are the servants of their respective Ministers so it can be said that eight people are in charge.

The Concorde organisation and management is fully recorded in a book, 'Organizing the Transnational' by Milton S. Hochmuth written under the auspices of the Centre for International Affairs Harvard University. The author is obviously confounded by the technical success of a project in which in theory the management could not work.

Such an organisation is obviously not the best for quick decision making but the undoubted technical success of the project might quite well be attributed to the microscopic attention given to solving the many requirements and professional pride of the participants.

The Government organisation for Jaguar is shown on Figure 8 with the airframe industrial company Société Européenne de Production de l'Avion E. C.A.T. (SEPECAT). SEPECAT has no staff of its own but draws on the facilities of the parent companies. The company is registered in France under French contract law. Rolls-Royce/Turbomeca is the company registered in England under British contract law to control the engine production. Work sharing is, like Concorde, equally split between the two countries. The Jaguar programme is one of the most rapid of military aircraft programmes of modern times. In three years from definition to supersonic flight.

Jaguar was evolved as a result of two requirements, one in France and the other in the U.K., both being studied by the respective services and design teams in 1964. The formal agreement for a joint project was not signed until May, 1965 when technical co-operation between Breguet and BAC started towards an agreed aircraft design.

At this time the two engine companies - Rolls-Royce and Turbomeca - also began their design collaboration. Prototype manufacture did not start until October, 1966 and less than two years later, in September 1968, the first Jaguar built in two countries, but assembled in France, flew for the first time.

The MRCA is controlled by the British, German and Italian Governments, Figure 9, and the industrial companies Panavia (airframe) and Turbo-Union

(engine) and Mauser IWKA (gun). Panavia, and Mauser are registered in Germany and Turbo-Union in England. Capital arrangements are in the ratio BAC-42½ per cent; Messerschmitt-Boelkow-Blohm 42½ per cent; Fiat - 15 per cent.

Panavia has a permanent staff, its members being seconded from BAC, MBB and Fiat, and draws on the facilities of those parent companies.

The Airbus Industrie organisation is shown on Figure 10. Airbus Industrie acts as main contractor for the whole program. The policy of Airbus Industrie is directed by a Supervisory Board which consists of members from Aérospatiale, CASA, Fokker, Deutsche Airbus and Hawker Siddeley. The policy decided upon by the Supervisory Board is effected by the Chief Executive and four Directors for Production, Technical Affairs and Co-ordination, Financial Affairs and Commercial Affairs; the latter means sales and after-sales activities. Airbus Industrie signs the contracts with its suppliers which are the companies AS, Hawker Siddeley, Fokker, General Electric and others, and it signs the sales agreements with the airlines. Airbus Industrie is also responsible for training and for after-sales financing. Airbus Industrie is a Groupement d'Intérêt Economique (G.I.E.) which is a particular company structure unique to French law.

The U.S. practice of prime contractor and sub-contractor is not presently suited to Europe - principally because of national pride! There are too many companies in existence and too few projects in prospect and Governments (rather than industrialists) need design leadership to be vested in their own country from time to time in order to justify their voters' money.

In a developed Western democracy where the Defence Budget is always subjected to close scrutiny - and rightly so - the situation is high-lighted in the military aircraft programmes. I need only mention in passing the abortive attempt to build the Anglo-French Variable Geometry Aircraft (AFVG) where one partner elected to go-it-alone. Nationalism dies hard in the military sphere but progress is being made and the recent EEC Action Programme for the European Aeronautical Sector includes proposals for both military and civil aerospace which goes beyond inter-governmental collaboration and points the way ahead in Europe.

WHERE NEXT

My next Figure (Figure 11) is a

chart of some of the Organisations concerned with the Aerospace future in Europe together with the countries who are members of these.

The Commission of the European Communities (EEC) - Action Programme for the European Aeronautical Sector, was the subject of a lecture in December, 1975 at the Royal Aeronautical Society in London by Christopher Layton.

The work of the report surveyed all of the aspects, motivations, market, financing methods, employment and productivity, research and technological development etc. leading toward proposing a common policy for the aircraft industry. Quoting from the Report:-

"If the Community's aircraft industry is to have any future, we must go beyond the stage of intergovernmental co-operation between differing, and still national, aerospace policies.

To this end, sponsorship of the aircraft industry should be exercised by the Community".

It goes on to enlarge on this by saying:-

"The Council would make the major policy decisions on programmes, financing and conduct consultations with users, producers, trade union and national authorities, to bring all large civil transport aircraft construction activities into a coherent programme, optimising the use of resources, to arrange a joint research programme etc." There is a great deal of background in the document, it is a commendable and enthusiastic effort; enthusiasm and positive thinking is an important ingredient toward a prosperous future, but there must be doubt on time scale, time to reach agreements, more important to make decisions. This paper is not the proper medium to comment further.

N.A.T.O. - has 15 permanent members, but the Military Committee which makes recommendations on military matters is represented by only 13 members. Iceland has no military forces and France withdrew from the military organisation in 1966.

The Western European Union - has seven members and was formed to provide for co-ordination of defence policies and co-operation in economic social and cultural matters.

A.E.C.M.A. - the European Association of Aircraft Manufacturers is represented by the equivalent in 10 countries of our S.B.A.C. It also includes Eurospace as a member. The aims of AECMA and an appraisal of the prospects of the European Aerospace Industry is documented by a lecture by Mr. Greenwood, President of AECMA and Chairman of B.A.C. given at the Royal Aeronautical Society in April, 1975.

The European Civil Aviation Conference - is an inter-governmental organisation which has the objective of promoting the co-ordination, the better utilization and the orderly development of European air transport.

The European Space Agency - was in May, 1975 formed out of the earlier ELDO and ESRO organisations to promote co-operation in space research and technology for peaceful purposes.

Eurogroup - is a group of 10 countries intent on getting joint procurement and programme co-operation.

Each of these is, in some way or another, working toward improving the European member countries Aerospace business; I wonder what the net effect of this effort might be.

For many years now governments and industry together, have produced a situation where Europe has collected a 30% share of the world trade, half of this from the U.K. alone. In Military Aircraft, this is largely the result of collaborative projects. On the civil side, from successful uni-lateral products, Caravelle, B.A.C. 1-11, Trident and F-28. Whatever else happens, nothing must put a brake on the smooth running and the industrial implications of these. Ideally, the aim of these European organisations should be to develop on this process and help toward removing some of their imperfections.

We have some successful military aircraft programmes going well now and the Air Staffs of some of the European countries have already gone a long way in discussion toward the writing of OR's suitable for their joint use and for the wider market; hopefully this will lead to the next big purchase from European rather than from U.S. sources.

European Airlines have historically bought mainly from U.S. sources, (Figure 12) but encouragement to buy from European manufacturers will only be as a result of there being available in Europe equipment to meet their requirement, at the right time and for the right price. Six companies in three countries and the

national airlines of these countries, British Airways, Air France and Lufthansa are currently working together toward achieving this aim.

The Group of Six Activity started on 2nd September, 1974 following an Inter-Company Agreement between SNIAS, BAC, Dornier, H.S.A., MBB and VFW/Fokker. Following a Joint Communication to the three interested Governments of 18th November, 1974 the Principals of the Six Companies agreed to establish an Executive Board to supervise an Exploratory Phase to October, 1975.

This activity is not an aeroplane project it is a study group to seek and define an opportunity - if there is one - and to determine the requirements to meet such an opportunity.

Its guidelines were to undertake discussions with the three National Airlines, B.A., A.F. and Lufthansa regarding their joint requirements for future short medium haul requirements (E.A.O.R.'s) and study the market in other airlines throughout the world. To examine the prospects of meeting these requirements from European resources with particular emphasis on derivatives of existing aircraft and where not possible to examine the prospects for a new design. To assess overall efficiency, including manufacturing productivity and consider what improvements could be effected and examine what types of organisation might be used.

Conclusions reached in this phase of the work show that:-

Current European aircraft provide a sound base for development.

Europe has a proven technological capability, but its competitive position must be improved.

The world market indicates encouraging prospects to the end of the century.

The conclusions also state reservations over the credibility of collaborative arrangements and points to the urgency in agreeing a joint policy.

The objective of the next stage of the investigations is to make definitive recommendations on a joint European product policy by mid 1976.

Over the years B.A.C., Fokker, H.S.A. and S.N.I.A.S. have demonstrated their ability to penetrate the markets of the world (Figure 13). Hopefully, the organisations just referred to will help

to improve the percentage of European aircraft in European fleets.

So far I have not really mentioned Concorde. It is a technically excellent aircraft, free from competition outside of the USSR but it is inconceivable that it will go all that long without United States competition it is a key aircraft of any European family and must be part of any long term plan. A supersonic transport long term future is I believe inevitable, but I think dependent on broader collaboration than European alone, collaboration also with American partners.

I have deliberately refrained from writing much about European Companies joining American Companies as an alternative to, or part of, developing the European Industry; the subject of the paper being European collaboration. In looking toward the future however Europe must not close its eyes to the fact that this alternative exists; American associations and their consequences must be studied and considered. We are fully aware of U.S. competitive ability, we don't know as much as we should about the rules for working together which would satisfy us and be to the benefit of both parties. Taking in sub-contract work from this area - if available - for example would help us to understand each other better and could lead to more permanent associations. Some collaborative work with U.S.A. but which must include a degree of design responsibility could supply some of the bricks for developing European Aerospace. Getting our house in order toward a strong European industry is an important feature in any future broader International collaboration to the benefit of all parties concerned.

Aerospace requires such enormous resources, that the large projects such as supersonic transport and space transport, i.e. space shuttle, - lead almost inevitably to broader sharing of work. For Europe even to decide which areas it should work in or which it should avoid, a close liaison understanding with the U.S. would be of great value to both sides. That engineers on both sides of the Atlantic can work together successfully and with respect for each other was borne out when a British Aircraft Corporation team worked with the North American Rockwell team in 1970-71.

Military Aircraft requirements are different, for example, the requirements which met the need of Vietnam would not have suited the environment in Europe, but even here certain arrangements across the water are sensible. U.S.A. for instance bought Harrier.

Because of necessary Government involvement political pressures cannot be avoided but as a matter of principle collaborative projects should not be undertaken for reasons of political convenience. Each project must be viable in the conditions in which it is being built, but ideally also be capable of satisfying the broader requirements and capable of achieving a worthwhile share of the world market. Collaborative projects must also be undertaken for the benefit of all parties concerned.

Possibly the best way toward a future prosperous European Industry is to build up on our existing collaborative partnerships towards more permanent bodies; with governments, through their various agencies, assisting by writing specifications more acceptable across the board and suitable for world wide markets. Provided that commercially competitive civil aircraft can be built in Europe, governments should encourage their national airlines to look more generously to this market. There appears to be a clear need to move toward broader international collaboration particularly in the very high resource absorbing projects, particularly space and the supersonic transport.

Modern facilities of transport and communications makes distance no longer a barrier or inconvenience in arranging partnerships and Aerospace has played the major part in reaching this state. It is almost natural that we should seek and develop common interests. Compared with MacDonnell Douglas' world wide component supply lines (Figure 14) those of our current European partners represent little more than a Western seaboard activity.

APPENDIX

VARIABLE WING SWEEP. EARLY RESEARCH WORK - TO MRCA

Variable wing sweep research is one example of innovation and probably the longest programme spanning as it does from the early research in 1945 through many start, stop projects and studies, some across International boundaries, to the 1st flight of MRCA in 1974. For the research worker, engineer and technologist the programme has been both fascinating and rewarding and a short survey of this work follows. It deals only with the work done by Vickers and later BAC Limited because of the author's close association with it. The historical milestones are:-

1946	Miles M52 manned experimental supersonic aircraft prototype stopped.
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1956 to 1949 Barnes Wallis Variable Geometry (variable sweep and variable incidence) studies and experimental models built.

1949 to 1959 Unmanned Wild Goose and Swallow flying, detail mechanical and bearing test work, general operational aircraft studies and some missile studies - all embracing variable wing sweep.

1952 Manned variant of Wild Goose (J.C.9) stopped at advanced state of build.

1955 Variable sweep design to OR 330 (Recce Bomber) studied.

1957 U.K. Defence White Paper against manned aircraft.

1958 Vickers and Ministry of Aviation team visit NASA Langley for discussion with the late Mr. John Stack and team.

1958 Feasibility studies to OR 339 (TSR2).

1959 V.S. Research moved from R&D (Barnes Wallis) to Vickers Design Office.

1959/60 Joint NASA, MOA and Vickers studies. Feasibility study ER 206 to Naval/Airstaff requirement OR 346.

1960 Vickers merges with British Aircraft Corporation.

1961 NATO BMR 3 Proposal.

1962-3 Studies to OR 356 and AW 406 RAF/RN requirements. Studies to convert fixed wing aircraft into V.S. experimental flying test beds.

1963-4 Detail design of V.S. experimental aircraft to an operational configuration (Type 593).

1964 Decision not to proceed with the experimental aircraft approach. Work transferred from B.A.C. (Weybridge) to BAC (Preston) Division.

1963 to 1965 Variable wing sweep trainer/light tactical aircraft studies.

1965 to 1967 Anglo-French V.S. project (A.F.V.G.).

1967 France abandons project.

1967 to 1968 U.K. holding operation (UKVG).

1968 A.C.A. - M.R.C.A. work begins.

1974 M.R.C.A. 1st flight.

Toward the end of the 1939-45 War Barnes Wallis (now Sir Barnes Wallis) became involved in research toward supersonic flight. Initially this work was associated with the Miles M52 a research vehicle with straight thin wings of low aspect ratio. Unmanned models, rocket propelled were dropped from a Mosquito aircraft in 1947 and reached M=1.02. He soon realised the configuration clash between subsonic long range and low speed requirements demanding high aspect ratios and the ideal swept back low aspect ratio needs of the supersonic wing and that the variable configuration solution (the Polymorph) should be his design aim.

First studies were around a configuration called Wild Goose (Figure 15) a solution where the tailplane was dispensed with longitudinal stability resulting from the interaction of the body pitching moment and small changes in wing sweep. Roll control was by use of asymmetric wing sweep. Many novel wing suspension schemes were evolved, some including an independent variable incidence control (Figure 16). The final solution for this phase was a single pivot mounted inside and using the structural depth afforded by a 3:2 ratio elliptical section fuselage, the axis of the pin being set at an angle to give the appropriate requirements of incidence and dihedral over the sweep range. To achieve the necessary target L/D of 9-10 required laminar flow over a large part of the body length and the configuration was abandoned for this reason.

The next configuration "Swallow" (Figure 17) was in effect the Wild Goose fuselage flattened to a delta form with wings appended at the base. Theoretical and model work gave hope that an L/D of about the right order was feasible. The configuration demanded a different approach to wing suspension as the pivot point would be contained within the wing geometry (Figure 18). The solution chosen used a spherical pivot bearing and arcuate wing root pads providing a three point non-redundant suspension with a large structural arm to reduce bearing loads. Space does not allow detail discussion on this or the Wild Goose sus-

pension but a great deal of bearing development, types of sealing and arrangements for carrying services round the pivot, was done.

Pilot-less models, weighing about 1000 lbs. and 30 ft. span were flown, propelled by a cold motor rocket - hydrogen peroxide expelled under pressure through a catalyst. A similar though more powerful rocket system propelled a launching trolley. The models "took off" when the trolley reached launching speed and the lift generated by the wings exceeded the weight, as measured by an automatic spring release. The aircraft flew a circular course "piloted" from a central position some mile or so from the aircraft at all times. Part of the control, the roll signal was handed over to another pilot located at the far end of a conventional runway. This second Roll Pilot "banked" the aircraft into a level position over the runway and when ready signalled the central and now Pitch Pilot to land the machine. Later Swallow Models took off and landed from a runway in the conventional manner using its own undercarriage.

This phase of the work proved that these rather unorthodox configurations could be flown quite easily but a manned version of the Wild Goose was in an advanced state of build when it was stopped in favour of the pilot-less experiments. A lot was learnt about mechanisms, automatic pilots, ingenious methods of remote flying but perhaps less than hoped about the design characteristics for an operational aircraft.

The U.K. Government shared the cost of this work with Vickers, but when their support ceased in 1958 Vickers sought to continue with the work through the Mutual Aid Weapons Development Programme (M.W.D.P.) which was already assisting the funding of the Bristol Siddeley Pegasus deflecting jet engine. This led to a team visiting NASA Langley in November, 1958. Work at Vickers was transferred from the Barnes Wallis research area to the military project office at Weybridge (soon to become BAC) under the overall control of Sir George Edwards and for a year or so there was a joint study with NASA. One of the arrangements that emerged is shown on (Figure 19).

Many studies were made to British requirements to a joint Naval and Air Staff target when Variable Sweep was compared with other fixed wing arrangements. Later a project was tendered to the NATO BMR 3 requirement, (Figure 20) which also had a vertical lift capability. This requirement fell down because of European local Nationalisms.

A number of proposals were made to get flying experience by converting existing aircraft into variable sweep experimental machines, the most notable of these being a modification to an English Electric Lightning aircraft. It would have improved the Lightning's airfield performance but little else but its purpose was intended for practical experience and not Type improvement.

In parallel an entirely new experimental aircraft was projected (Figure 21) (Type 583) having a configuration and envelope size to allow development to an operational role and the design and programme went into considerable detail. Although the relative cost of this and the Lightning modification was in the order of 10:1 the more expensive model was chosen by M.O.A. to be the more valuable as a research tool, but it was expensive and not proceeded with. Thus the practical experience of mechanisms and structures which could have been provided by the cheaper Lightning modification, was lost. The official reason for not proceeding with an experimental aircraft was that it was considered that enough wind tunnel, structural and mechanical test work and analysis was done to give confidence that a Variable Sweep operational aeroplane was practical when the operational need arose.

Many operational studies followed, the work having now been transferred to the Preston Division of the British Aircraft Corporation (earlier English Electric and producers of Canberra and Lightning aircraft). International collaborative activity started again with a joint Anglo/French requirement (AFVG) which stopped after about two years of work when the French withdrew; later to embark on their own unilateral V.S. Mirage project. Following a holding operation initial work began on an Advanced Combat Aircraft (ACA) involving UK, Germany, Italy, Belgium, Netherlands and Canada (Figure 22).

Figure 23 shows the International Family Tree leading to MRCA and the International Panavia Company, by which time Belgium, Netherlands and Canada had dropped out of the project.

It might appear from what has been written here that Variable Wing Sweep has been the driving force behind the MRCA design. It is the other way round Variable Wing Sweep is a necessary feature to enable the requirements of the interested Air Staffs to be met and before confirming this configuration for the design comparative fixed wing studies were made (Figure 24) there are right and proper reasons and opportunities for

adopting this feature.

Such is the ancestry of this latest European Military project which is now well into its development phase. Although space does not allow comment acknowledgment must be made of other UK work particularly at Folland the work by Messerschmitt (Me F1101), Bell and Grumman in U.S. around 1950, of the US F-111 and the U.S. supersonic airliner work.

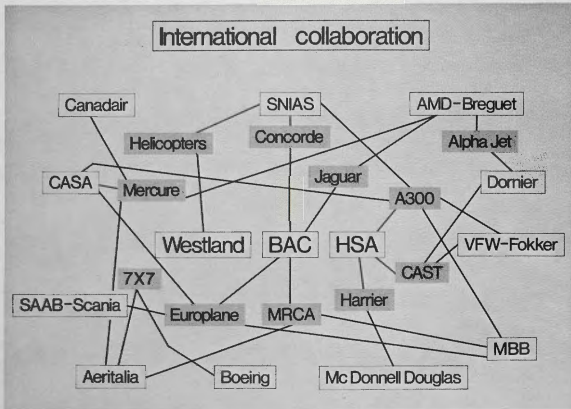


Figure 1. Collaborative Aircraft Projects

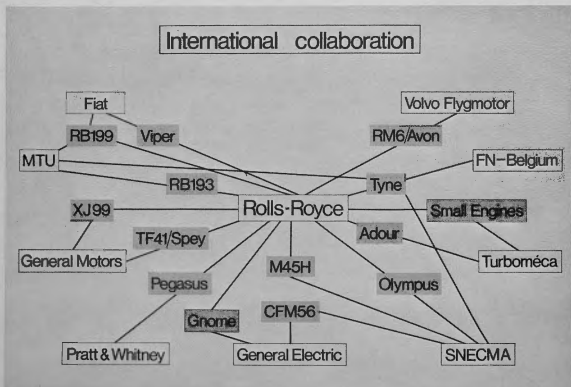


Figure 2. Collaborative Engine Projects

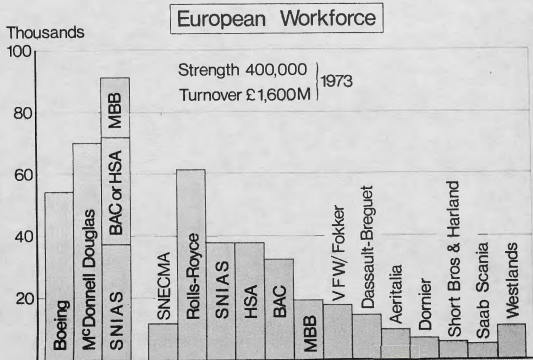


Figure 3. Size of Aerospace Companies

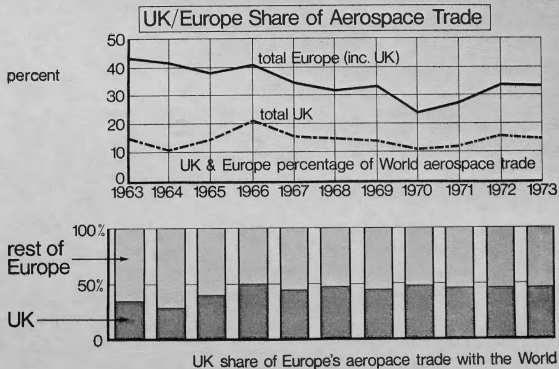


Figure 4. Performance of U.K. and European Industry

Some European Military Programmes



SNIAS, MBB, VFW./Fokker
178 produced



SNIAS, Breguet Dornier Fiat Sabca
87 produced



BAC, Dassault/Breguet
Production 400 (+200 deliv)



Dassault/Breguet Dornier
Production 400



BAC, MBB, Aeritalia
potential production 800

Figure 5. Some Collaborative
Military Aircraft

Some European Civil Programmes



BAC - SNIAS
Production-16 Ordered-9



SNIAS-MBB-VFW/HSA CASA
Production 80 Ordered 32



Fokker / VFW
Production 2permonth Ordered-110+

Group of Six ? (Seven)
SNIAS, BAC, HSA, MBB
Dornier VFW/Fokker (Dassault)

Study Group

Figure 6. Some Collaborative
Civil Aircraft

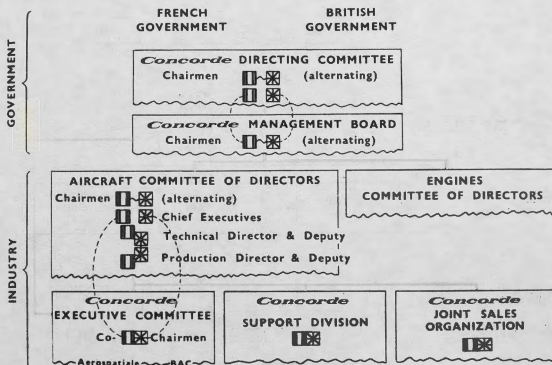


Figure 7. Concorde Management Structure

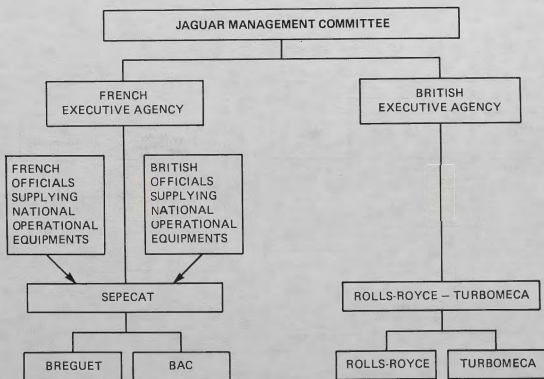


Figure 8. Jaguar Management - Structures (S.E.P.E.C.A.T.)

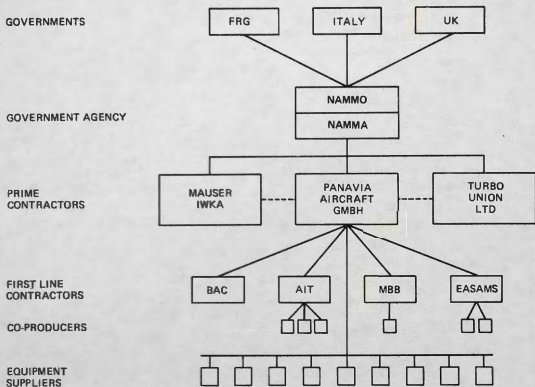


Figure 9. M.R.C.A. Management - Structures (Panavia)

A300B AIRBUS INDUSTRIE ORGANIZATION

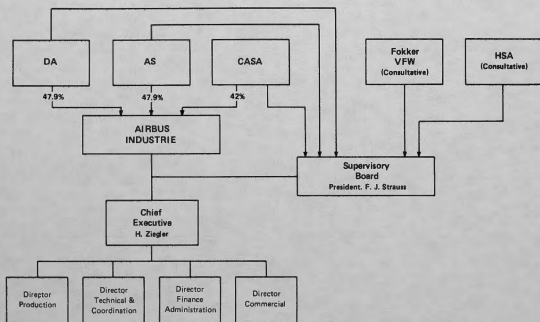
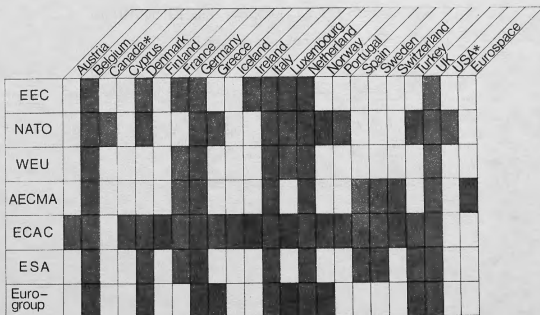


Figure 10. A-300 Management Structure (Airbus Industrie)



* Non European

Figure 11. Some European Aerospace organisations

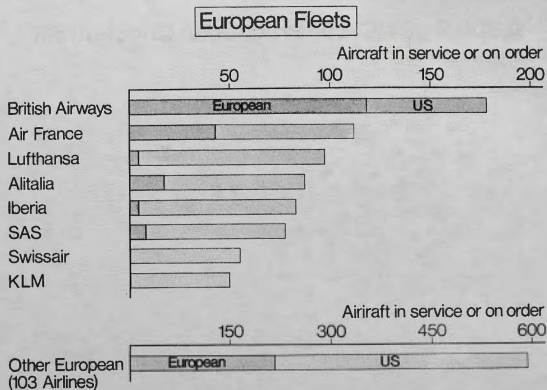


Figure 12. European Airline Fleet - Supply Sources

Sales by European Manufacturers

-By Country of first delivery

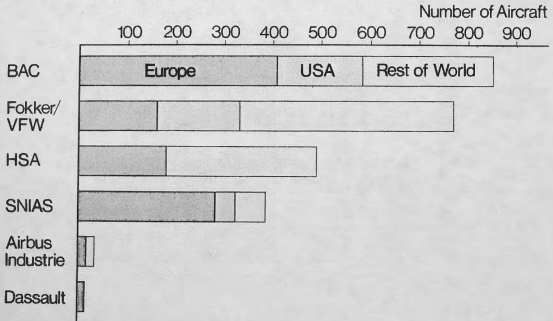


Figure 13. European Manufacturers - Market Penetration

A 300 B vs DC-10 Production Concentration

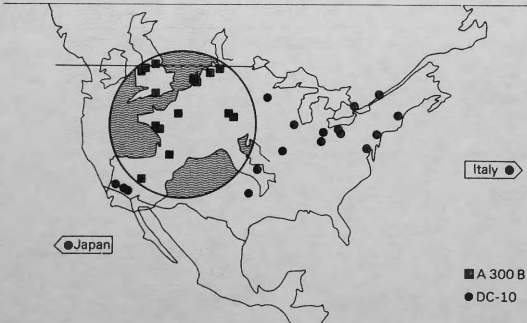


Figure 14. Industrial Supply Lines - Comparison

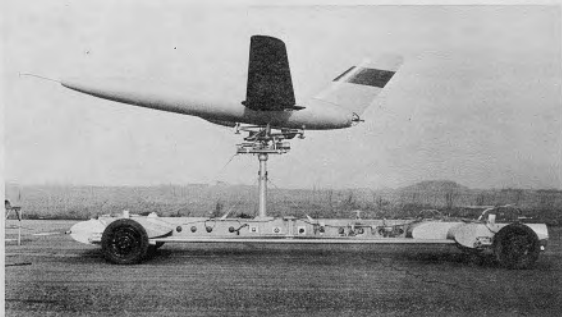


Figure 15. "Wild Goose" and Launching Trolley

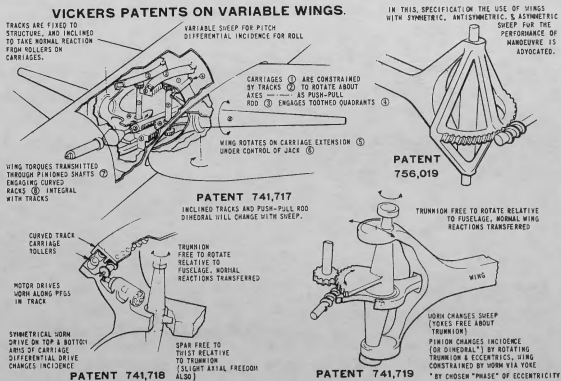


Figure 16. Variable Geometry Wing Suspensions

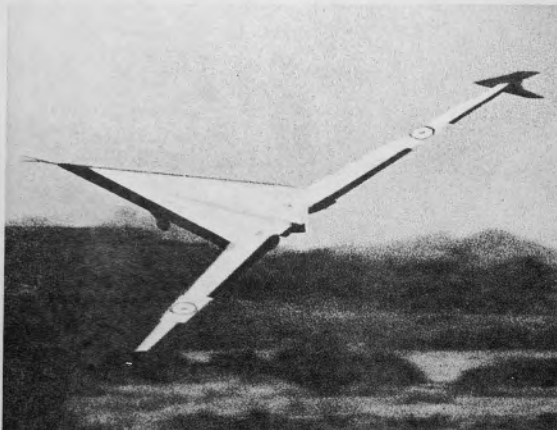


Figure 17. "Swallow" - Unmanned Flight

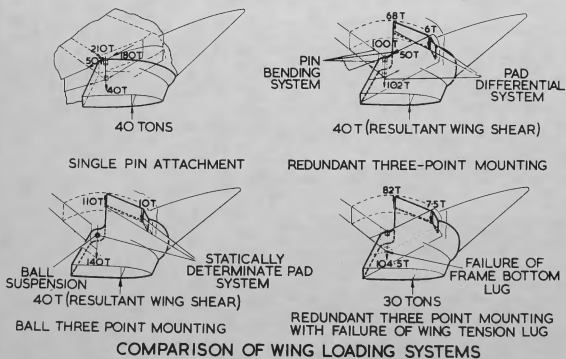


Figure 18. Variable Sweep Wing Suspensions

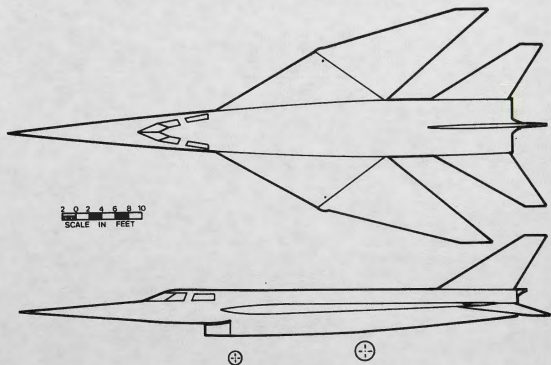


Figure 19. N.A.S.A. - Anglo -
U.S. Study Configuration

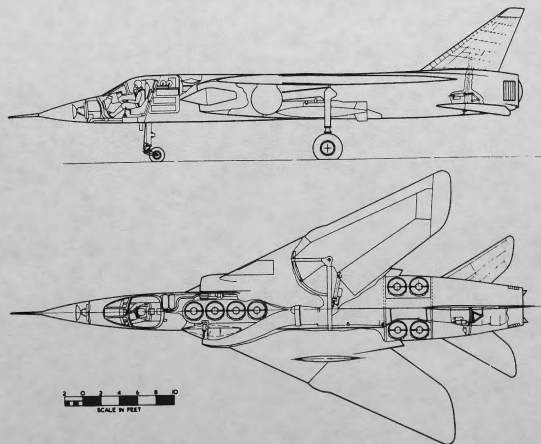


Figure 20. N.A.T.O. B.M.R.3. -
Proposal

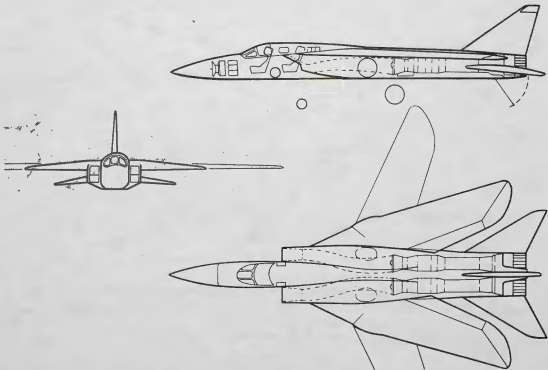


Figure 21. Research Aircraft -
Type 583 Study



Figure 22. M.R.C.A.

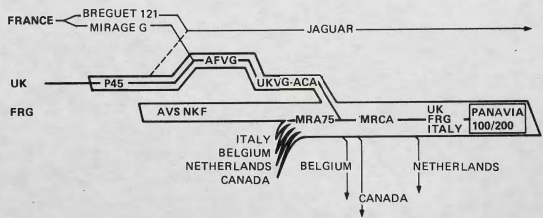


Figure 23. M.R.C.A. International Family Tree

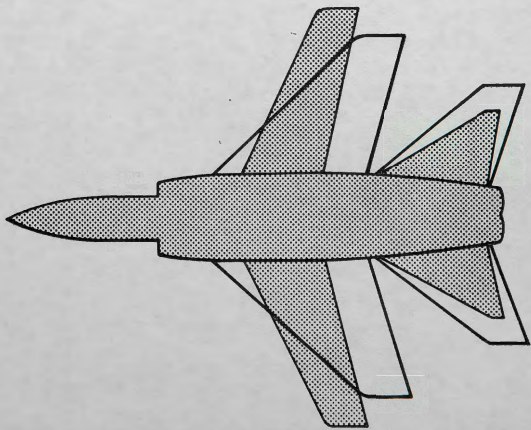


Figure 24. M.R.C.A. V.S. Versus Fixed Wing