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COMMUNICATION FROM THE COMMISSION

Toward a Programme of Strategic Measures in Aeronautical Research and Technology for Europe

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COMMUNICATION FROM THE COMMISSION

Toward a Programme of Strategic Measures in
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for Europe

This corrigendum replaces:

Figure B1 (page 29)
Figure B2 (page 30)
Annex C (page 31)
Annex E (page 33)
Annex F (page 34).

Corrected pages have been inserted.

Com. 244

SYNOPSIS

The aeronautical industry of the Community is a key sector of the European industrial base. Aviation makes a vital contribution to the civil life and commerce of the Community and aircraft and helicopter are indispensable elements of the military forces which contribute to the defence needs of Europe. The activities of the industry involve the continued advance of knowledge and technique over a wide range of high technologies, a process which yields important spin-off benefits to other sections of industry and to education: and the industry is a major exporter. For all these reasons, the Member Countries who have an indigenous aeronautical industry see that industry as having strategic importance and their governments give substantial support of various kinds.

At the present time the industry is performing successfully in both civil and military markets with a range of products which are fully competitive world-wide. The necessity for cooperation between companies in the development and production of major aircraft has been recognized for many years and the practice is firmly established in the European industry: the most notable illustration of this reality is provided by Airbus Industry. Despite these important achievements in adaptation to the changing market and to the increasing sophistication of the product, the position of the industry is by no means secure. The climate of competition is increasingly severe and nowhere more so than in the area of technology which provides a vital basis for product competitiveness.

The pace of advance of aeronautical technology is very rapid. This advance is stimulated not only by the direct competitive thrust of the world's largest companies and national governments but also by the formidable investments in Defence research and development, world-wide, which yield considerable 'dual-use' benefits to civil product design and manufacture. At the same time the sophistication and, hence, the intellectual and financial cost of making each major step is increasing. Failure to sustain a competitive, state-of-the-art, technology base would certainly be fatal to the prospects of the European aeronautical industry. However, the cost to individual companies of the acquiring technology by their own research efforts has become unsustainable: and the alternative of buying technology under licence from the main external generating sources of technology, the U.S.A. and Japan, is hardly feasible, given that the buyers and sellers in such transactions will be in direct competition with each other in the world market. To overcome this threat the industry must be stimulated and assisted to extend its cooperation at European level, which already exists in development and production, to the field of research and technology acquisition.

The Commission has examined this problem closely, with the assistance of a substantial study carried out in the industry. It has concluded that the market opportunities open to the industry over the next twenty years are good and that, if its level of competitiveness can be maintained, there are good prospects for the European industry to maintain its proportion of the world market, despite the emergence of new or stronger competitive suppliers. The situation regarding regeneration of the technology base is less satisfactory: currently, the effective level of research and technology acquisition activity achieved by and for the industry is not sufficient to build up the base of new and improved technologies which will be needed to allow the recognized market possibilities to be realized. If this shortfall and loss of trading opportunities are to be avoided, a major reinforcement of research and technology acquisition is needed. The Commission has concluded that this reinforcement must include a new, greatly enhanced, level of cooperation in research and technology. The enhanced effort must be strategically focussed upon key elements for the future technology base as defined by industry in the light of long term product trends. It must also harness the whole range of aeronautical and related talents and interest throughout the Community including those in universities and small/medium enterprises.

By this Communication, the Commission wishes to :

i. inform the Community Institutions, Member Governments, the aeronautical industry and the aeronautical research community of its conclusions;

ii. give notice of its intentions of making concrete proposals for action in the near future.

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Toward a Programme of Strategic Measures in Aeronautical Research and Technology for Europe

INTRODUCTION

For some time, the Commission has been concerned about the long term adequacy of the technology base of the European aeronautical industry. The industry trades in a single world market and in products whose technological characteristics have decisive effect upon competitiveness. World state-of-the-art aeronautical technology is advancing rapidly and may be expected to continue to do so; the technologies for advanced supersonic transport, tilt rotor aircraft, fly-by-light, advance composite structures, hypersonic aircraft and propulsion are only a few examples of high points in the broad thrust of advance of technology. At the same time the cost of technological advance is very high in terms of financial and intellectual resources. Recent study work has shown that the current scale and method of regeneration of the aeronautical technology base in the Community are inadequate to meet the demands of the future. Some action is needed to remedy this deficiency. The route to be followed is clear. Cooperation, which has for many years been firmly established in the fields of development and production, must be extended into the key area of research and technology acquisition. This extension will challenge traditional attitudes, which see key technologies as too commercially valuable to share, but the industry is prepared to launch on this venture and the Community should play its part in providing encouragement and assistance.

In this Communication, the Commission sets out its analysis of

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this situation, draws conclusions as to the need for action at European level and signals its intention of making concrete proposals for action in the near future.

1 - The European Aeronautics Industry

The companies which compose the European aeronautical industry have a proud history of contributions to aviation and its development from the earliest days of manned flight. Over the years the structure of the industry has changed with the progressive assimilation of most of the numerous small companies established by the pioneering entrepreneurs into today's large enterprises which trade on the world market. This evolution has both responded to and contributed to the steady and sometimes dramatic growth in the role of aviation in the economy and society of Europe.

In addition to the process of amalgamation within individual countries there has been a steady growth, over the past 30 years, in the practice of transfrontier cooperation between European companies for the development and production of advanced aeronautical products. This trend has been particularly strong in the manufacture of aircraft and helicopters where the point had already been reached some years ago where no major aircraft development was being undertaken in Europe which did not involve cooperation across frontiers. This process has become very well established and the aeronautical field now provides the preeminent example of large scale and efficient cooperation between independent companies in different countries.

The fruits of the European cooperation are considerable, both in terms of industrial achievement and in terms of political effect. Examples of successful cooperation products are to numerous to mention[1]. - ranging from the Gazelle helicopter to Airbus and including both military and civil applications. The benefits of these successes have not been confined to the material and economic. Notable, internationally recognized, achievements- Concorde, Tornado, Airbus, Alpha Jet, etc. - have promoted faith in the capacity of European partners to cooperate and have been powerful symbols of the European identity in the aeronautical field.

Aircraft and helicopters play a key part in the internal and external transportation systems of the Community. The operations of the aeronautical manufacturing and servicing industries, including those of a wide network of sub-contractors are economically important and, at the same time, represent one of the largest bodies of leading edge technology in the Community. Moreover, for many Member States, the aeronautical industry is one of the foundations of the national contribution to self and mutual defence. Thus, in view of the importance of these various aspects of aeronautical activity, it is not surprising that all governments which have indigenous aircraft manufacturing, servicing or operating industries accord their activities a substantial measure of government support.

The European aeronautics industry, comprising airframe, engine and equipment sectors, has achieved a most impressive increase in world market share in recent years. That share was about 5% in the early 1970's: in the mid 1980's that share of an increased market had risen to nearly 25%. Currently, the industry has an annual turnover of the order of 30,000 MECU per annum, of which rather more than half is accounted for by the airframe industry. Employment in the industry is a little less than half a million people of whom about half work in the airframe industry, about

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[1] Annex A gives an indication of the main cooperative aircraft programmes in the past ten years

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one third in the equipment industry and about on fifth in the engine industry. The contribution of the industry to exports from the Community is substantial, being some 30% of turnover.

As is discussed at greater length in Section 2.1, aeronautical products have a very heavy dependence upon advanced technology to provide attractive performance attributes, to improve safety and to improve the efficiency and economy of manufacture. The pressure to match the demands of the market, whether civil or military, and to maintain competitiveness has led the companies in the aeronautical industry to explore and exploit scientific and technological advances over a wide range of fields. This high level of activity in advanced technology gives rise to a wide range of technical 'spin-off' to other industries; typical examples are to be found in advanced fluid flow design, stress analysis of mechanical structures, the availability of advanced materials, automatic testing, advanced machining techniques, non-destructive testing, etc. The industry has also been a powerful stimulus to basic sciences and education.

For the future the possibilities for the industry are good but the challenge is severe. The Commission has joined with a group of major aircraft companies to fund a study of the future prospects for the industry. Within this study the market prospects for the industry were assessed. In brief, the study foresees an increase of some 40% in real terms in the average annual value of aircraft and helicopter deliveries in the next twenty years as compared to the average annual value of deliveries in the period 1980-86[2]. Competition to supply that market will continue to come primarily from the United States, whose aeronautical industry is founded upon a homogeneous home

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[2] Annex B contains a brief description of this market analysis

market approximately twice the size of the European market and whose clear determination to maintain a dominant position is evident. There are strong indications of an impending growth in the Japanese presence in the world aeronautical market. In addition, the strength of competition from growing aircraft industries in newly industrialised countries is visibly becoming stronger. Nevertheless, despite the intensifying competition, the study concluded that the European aeronautical industry can realistically aim to maintain or improve its current market share. This conclusion presumes that the various attributes affecting product appeal and economics are upgraded to maintain or increase competitiveness. Crucial among the attributes are those dependent upon availability of state-of-the-art technology. As is discussed more fully below, the study concludes that current patterns and levels of research and technology acquisition activity are insufficient to ensure availability of an adequate level of technology to match those future requirements.

2 - The Aeronautical Technology Base

2.1 The Importance of Technology

It is a truism to say that aeronautics involves high technology. The modern civil passenger aircraft represents the most sophisticated concentration of the products of high technology- in a range of fields including mechanical design, advanced material, aerodynamics, computation, sensor systems, combustion science, etc. - encountered by the average citizen in his day-to-day life. This concentration of advanced technology, found in both civil and military aircraft, is a direct consequence of the fact that the value and utility of an aircraft to its user or owner are strongly related to its technical characteristics and to the economics of design and manufacture. For an average airline the direct operating cost of its aircraft accounts for about half of its total costs. Direct operating costs[3] arise from fuel consumption, crew costs, maintenance and overhead costs and from aircraft depreciation and replacement costs. Each of these components of cost can be reduced by technological improvement. For example, crew cost have been reduced by the change to two crew operation through improved control, navigation and monitoring systems and by improvement of the man-machine interface; aircraft price dependant costs are being reduced through improved computer-based design and development methods, through advanced manufacturing methods and use of new materials. Fuel cost savings can flow from a large variety of technological advances -increased aerodynamic efficiency, reduced structural weight improved flight management systems, etc. As an illustration,it has been assessed that the operational cost savings which result from design improvements in Airbus 310-300 (exploiting technological advances in wing aerodynamics, use of composite materials, engine development, two-crew flight deck, improved brakes and tyres, electrical signalling, etc.) could amount to some 19 MECU per aircraft over a 15 year operating life: this saving is of the order of40% of the initial cost of the aircraft.

A broadly similar picture emerges of the economic benefits of technological developments applied to military aircraft. In this case the more common measure of cost is Life Cycle Cost[4], reflecting the fact that the rate of utilisation of military aircraft is, necessarily, significantly lower than that of civil commercial aircraft. In this case a high proportion of total cost is associated with the initial cost of acquisition and with

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[3] The components of Direct Operating Cost are illustrated in Annex C

[4] The components of Life Cycle Cost are illustrated in Annex C

maintenance costs. Consequently, among the major goals of technological advanco are reduction of design, development and manufacturing cost and reduction of scheduled and unscheduled maintenance operations.

Although cost considerations are very important they are not the only driving forces for technological advance. Safety characteristics are of the first importantance; and other considerations, also technology dependant, can be very influential in customer choice. In the case of civil aircraft operations such factors as noise generation, ride quality, short field operation, etc. may be very significant while, in the case of military aircraft the high importance of performances superiority, sensor superiority, damage tolerance, etc. are evident.

2.2 The Range of Aeronautical Technology

Design, development and manufacture of aircraft and helicopters engage a very wide range of scientific and engineering disciplines. The principal fields are those of aerodynamics and flight mechanic, structures and materials, guidance and control, thermodynamics, propulsion systems, system integration, acoustics, human factors, design tools and processes, manufacturing tools and processes, sensor systems etc., etc. Within these fields a large number of particular topics demand attention at any given time, the pattern of emphasis changing with time and the evolution of market demand - as, for example, when attention focusses on transportation over very long distances at hypersonic speeds or when pressure for near-city airports puts emphasis upon environmental effects and upon short take off and landing (STOL) technologies. A very important factor which shapes the overall pattern of technology needs and developments is the final concentration of the fruits of technological advance into a single, integrated, vehicle - the aircraft. This integration of highly sophisticated components and systems is a key feature of the field and must shape any approach to analysis of the research and technology situation.

2.3 Dual Use

Although some technologies in the aeronautical domain are particular to either civil or military use, the number of such technologies is rather small viewed against the whole field of interest. Equally, although some specific technologies are pressed to more ambitious limits in one domain than the other (e.g. drag reduction in civil aircraft, manoeuvrability in military aircraft), the general level of development and sophistication of technologies in the civil and military fields are very comparable. As a result of this close parallelism between the two domains of application, large parts of the aeronautical technology base - and of additions to the technology base - are capable of application in either the civil or military domain, giving rise to the term 'dual use' technology. This phenomenon of dual use has a number of important consequences for the competitive state of the European aeronautical technology base.

Firstly, the dual usability of technology developed for military purposes means that any country supporting very large programmes of aeronautical technology development for military purposes will, ipso facto, make a large contribution to the technology base upon which manufacturers of civil aeronautical products in that country may call. The United States is the dominant example of this linkage.

A second consequence of the dual use character of aeronautical technology is that military security restrictions on trade in certain technologies originated or applied in military applications may become an impediment to trade by other civil users of that technology. Concerns which have been expressed with respect to the operation of the United States Export

Administration Act illustrate this point.

Lastly, recognition of dual use points the message for European aeronautical technology that the technology base must, as far as possible, seek to integrate the fruits of military and civil research with the maximum of coherence and the minimum of duplication.

2.4 The Advance of Technology

The state-of-the-art of aeronautical technology, as of other technologies, is continually advancing. Because the level of technology contributes so directly to the attractiveness of aeronautical products to their purchases, the advance has the character of a race between the major competitors to supply the world aeronautical market; and between main military power blocks. Improved technology opens the possibility of new, more attractive products and superiority in technology implies a competitive advantage in the marketing of products or a military advantage in the case of developments for defence.

The advance of technology is accomplished by three principal mechanisms - research funded by aeronautical companies to maintain or enhance the technology base upon which they depend; research planned on a national basis with some degree of support from public funds based upon a view of the stragetic importance of aeronautics; and research, funded predominantly or wholly from public funds, to serve the perceived defence need for assured access to critical technology. Since the technology thus acquired has large elements of dual use capability and is usually applicable to a range of air vehicle types, the rate of advance of technology available for any particular new application tends to be a function of the agregate size of the efforts devoted to research and technology. Thus in a big country with many contractors and a high level of research and technology acquisition activity it is not a case of a large research output being diluted by division between a large number of contractors: rather, it is a case of a large research benefit being simultaneously available to each of the numerous contractors. Inversely, a small research effort in a country having few contractors is unlikely to be competitive.

The pace of technology advance in the world market at the present time is, in general, set by the United States which has large, active, aeronautical companies, a large national aeronautical research programme coordinated and part funded by the National Aeronautics and Space Administration (NASA) and a large research programme for military purposes funded by the Department of Defense (DoD). Precise quantification of the effective magnitude of this research effort is difficult but it has been estimated that for the airframe sector the effective expenditure on research and technology acquisition in 1987 was about 1400 MECU, rather more than three times the aggregate of expenditures in the various nations within Europe. The recent years have seen an intensification of United States' activity in this field. In part this has accompanied a spectacular rise in the turnover of the U.S. aerospace industry in the 1980's[5]. A bold reaffirmation of U.S. determination to retain a preeminent position in the aeronautical world was made in a report[6] prepared by a committee set up by the presidential science advisor, Dr. William R. Graham, in 1987 which defined new national aerospace goals- including long distance efficient supersonic transport technology, transatmospheric flight technology and new generation subsonic transport technology. The Strategic Defence Initiative has been another major source of support for technology advance.

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[5] Annex D illustrates the comparative trend of U.S. and E.E.C. aerospace turnover.

[6] Report "National Aeronautical R & D Goals: Agenda for Achievement", 26 February, 1987

The results of the strong U.S. activity in aeronautical research and technology are too numerous to detail. Some striking contemporary examples are provided by the X-30 hypersonic aircraft programme, the development of propfan propulsion, the development of tilt-rotor technology, the establishment of a vast computer facility (the National Aerodynamic Simulator Center), etc.

It is notable that these pace setting endeavours are characterised not only by challenging scientific and engineering problems but also by a very high cost for facilities and experimentation.

3 - Future Technology Requirements

The assessment of future needs for research and technology acquisition cannot be a matter of exact analysis. Part of the need can be related to well established trends in technology and to assessment of the future market opportunities of the industry: but another, important, part relates to less predictable lines of development stemming from, new scientific and technical advances, some of which ultimately lead to important new lines of system or vehicle development.

Assessment of needs and trends has been the subject of some major study efforts in recent years - most notably in the U.S.A.[7]. These assessments have shown the possibility, indeed the likelihood, of further major advances in most of the areas of technology which contribute to aeronautics. Some of these potential advances will, if achieved be so significant as to

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[7] A notable example is reported in "AERONAUTICAL TECHNOLOGY POSSIBILITIES: Report of a Workshop", January 1984, Aeronautics & Space Engineering Board, (U.S.) National Research Council.

reshape the future mix of products in the market. The majority will bring improvement which are essentially in the line of established pattern of progress and as such their importance and priority can be assessed in the context of market studies and industry product strategy.

The study referred to in section 1 has made an extensive examination of future technology needs for the European aeronautical industry. This examination pursued a sequential approach[8]. Having commenced with an analysis of present and future markets and assuming a strategy of seeking a presence in all market sectors (either on a European basis or in cooperation with third countries), the study then made to an analysis of potential technological contributions to competitiveness and from this derived technology targets in terms of generic product enhancements and technological capabilities.

Subsequent analysis was carried out to identify specific areas of research in which work is needed: this is discussed further in section 5.

As well as the specific analysis which led to the identification of areas of research and technology need, the study included an analysis of the volumetric need for research and technology acquisition for the future based upon the growth of market opportunity, which was described in section 1, and upon historical experience of technology requirements for each step forward in the evolution of the market. This examination led to the conclusion that the present effective level of research and technology acquisition activity in the European aeronautical industry is substantially too low to provide the technology base

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[8] Illustrated in Annex E

which will be needed as the basis for market success in the medium and long term.

Faced with this conclusion, the study recommended that measures should be taken to reduce this gap between the needs for technology and the present rate of generation of technology. Three, interrelated, measures were proposed

- a substantial increase in industrial cooperation research and technology;
- concentration of work in key areas of technology identified in new jointly agreed requirements;
- provision of additional funding resources to support enchancement of effort.

The Commission concurs with this recommendation.

4 - Options for Action

The European aeronautical industry is faced with a clear need to increase the volume and effectiveness of research and technology acquisition which sustain its technology base. Already the industry is devoting a considerable effort to research and technology. Companies clearly recognise the vital role of technology in maintaining a competitive position and devote as much resource as possible to building up the technology base to which each has access: but this is not enough. If compared with the pace-setting United States' aeronautical industry, the money expended on research and technology acquisition in the European airframe industry is only about one third of its great rival. Moreover, despite the fully established practice of transnational cooperation in development and production projects, the total resources expended in and for the European industry are seriously fragmented between companies and countries engaged in more or less independent programmes of research and technology.

Some attack upon this problem is essential. Whatever the merits or demerits of other courses of action, it is clear that continuation of the status quo is not a viable option. Even without the fragmentation of effort the comparative smallness of scale of the European effort is a severe problem: the study, referred to above, has estimated that the gap which is opening will be equivalent to about half of the current total activity in Europe within 5 years and will reach a size roughly equal to whole of current research and technology activity within a decade[9]. Add to this gap the loss of effectiveness through dispersion of effort and it is clear that a new approach is necessary.

An increase of cooperation in aeronautical research and technology acquisition is certainly needed. Present examples of cooperation are encouraging but limited. In the domain of government-led research there already exists the GARTEUR[10] cooperation agreement under which government laboratories of France, Germany, Netherlands and United Kingdom, supported by the national aeronautical companies, cooperate in research on a basis similar to Community concerted action. Closely related is the four country understanding for the design, construction and operation of the European Transonic Wind Tunnel. Some research cooperation takes place in the framework of the NATO Armaments Directors and Armaments Groups and under the auspices of AGARD[11]. There is also some intercompany cooperation in research and technology, established on a case by case basis in the light of the separate interests of the partner companies. Taken overall,

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[9] Annex F shows the trends of future research and technology requirements as assessed by the study

[10] Group for Aeronautical Research and Technology in EURope

[11] Advisory Group on Aerospace Research and Development

these activities make an important contribution to the European aeronautical technology base. But the small scale and the absence of strategic goals make their effect too limited to deal by itself with the problems discussed above.

On a wider, European scale, there are existing research activities in the European Community framework and projects within the EUREKA programme which also contribute to the European aeronautical technology base. The Community programmes BRITE, ESPRIT, EURAM, and RACE all contain elements which have valuable aeronautical applications and which should continue to be encouraged: however, the choice of such topics for inclusion in these programmes is generally made in the context of the generic technology being researched or incidentally in the context of a policy directed at goals other than aeronautics. Moreover the total volume of such actions, having aeronautical orientation, is quite small. EUREKA provides a framework for transnational inter-company cooperation projects, with particular emphasis upon technologies close to the point of market application; among projects already established are several with aeronautical objectives. Such activity is particularly well targeted upon industrial needs, being conceived and executed by companies themselves: however, it is recognised by industry that the pattern of activity thus established lacks a common strategic framework.

More can, and must, be done to make the European effort more effective. As Europe moves forward toward a single market, it cannot be sensible for an industry which, above all, needs to operate in a world market to remain fragmented in the key field of technology acquisition. The problem of commercial and national sensitivities cannot be overlooked. There are good reasons why companies have regarded their technical 'know-how' as a vital commercial asset, to be jealously guarded from competitors and, even, from project partners. However, the solutions and the practices of the past must be adapted to the challenge of the future. Programmes such as ESPRIT have given a clear demonstration of the capacity of a strong, strategically oriented, Community programmes of precompetitive research and technology to achieve two key objectives - the breaking down of habits of isolation between industrial research and technology teams; and the development of a dynamic, strategic, programme of work focussed upon goals established by thorough consultation involving both technology creators and technology users throughout the Community. Just such objectives are needed for European aeronautical technology. The Community must play its part in promoting such an evolution.

5 - A Strategic Programme

The study carried out by the group of major European aeronautical companies in conjunction with the Commission, to which reference was made above, included on in depth examination of the future technology requirements which can be foreseen against the background of assessed trends of market opportunity. This examination, as well as exploring the technological potential of various avenues of advance and taking into account the generic product goals related to future markets, applied a number of selection criteria including breadth of application, potential conflict of commercial interest and freedom from conflict with existing international cooperative actions. Resulting from this examination, a number of key technology areas emerged in each of the main disciplinary areas which compose the field of technology which is of concern to the air vehicle systems designer. These key technologies, group by disciplinary fields, are listed in Annex G. The number of fields of technology which are important to the future capacity of the European industry to design and make new aeronautical products is large. This wide spread of topics precludes any gross simplification which could equate the future of aeronautics with a convenient, small, number of new technologies. It is, however, a very fundamental feature of a field which is, inherently, very complex and highly multidisciplinary. This distinctive characteristic has important implications for the organisation and management of any strategic research programme. There is nevertheless, every reason for believing that the established methods of operation of Community programmes such as ESPRIT and BRITE, allied with methods of strategic analysis which have emerged from the study, can provide a practical and effective method for dealing with this diverse subject.

It is most important that any new initiative should reinforce, or build upon, existing national and international programmes and that the overall strategy for regeneration of the European technology base should be thoroughly coherent. Clearly, this should involve close and frequent consultation between those responsible for the strategic guidance of the Community and national programmes. Such concertation has already been demonstrated to excellent effect in other Community programmes and will be included as an essential element of any new programme.

Thus, it clearly emerges that a programme of research and technology acquisition in the fields of aeronautical technology, executed at European level, should be put in place as soon as possible. The nature of the work to be performed should be precompetitive, lying in the area between basic research and the commencement of product development. Details of the technical workplan will need to be worked out but its broad nature is already apparent from the study work recently performed. To secure and maintain the industrial relevance which is essential for the usefulness of the work, industry should be closely involved in the development of the initial and subsequent workplans which would guide the course of work under the programme. Well tried procedures would ensure major transnational industrial involvement in the execution of the work while, at the same time, opening opportunities for universities, research institutes, government laboratories and small enterprises to make their essential contribution.

6 - The Case for Action

It is clear that the European aeronautical industry is a very important and valuable component of the industrial strength of Europe. The contributions made by the industry to meeting the Community's needs for fast, reliable, safe and affordable transportation and for high capability aeronautical products for defence purpose are large and important. The industry's ceaseless pursuit of technological improvement and innovation makes it a fruitful source of technological "spin-off" and a valuable stimulator of academic pursuit of new knowledge. The quality of its products is high and its competitive performance in world markets is good. In consequence, the industry is seen as an essential, strategic, asset by the countries in which it is established.

Despite having these very positive attributes, the position of the industry is economically fragile and it is essential that its competitive position is not weakened by a failure to command state-of-the-art technology.

The industry's present mechanisms and methods of research and technology acquisition, though valuable and productive, are inadequate. Action now needs to be taken at European level to gain critical mass and reduce costly duplication of research efforts. Cooperation and a united purpose to pursue a common technological strategy are the key ingredients for success. Industrial commitment, too, is vital and this is strikingly present. There can be no doubting the commitment of major aeronautical companies to the goal of greatly strengthened cooperative research and technology activity in a European framework. The Community has the capacity to accept this challenge and must now move to provide the leadership and the necessary operational means. The precise mechanisms will need to be worked out in close consultation with national authorities, the industry, research institutes and universities. Because of the unique nature of the industry and its products it will be necessary to learn and adapt in the light of initial experience: but the basic methods already evolved from the experience of ESPRIT and BRITE can provide a solid foundation.

Once established, a strategic Community programme of aeronautical research and technology will bring a number of Community-wide advantages:

1. It will achieve a better utilisation of precious resources, not only financial but also of intellect, experience and test facilities.

2. It will provide a framework within which the capacity of universities, research institutes and small enterprises to contribute their special skills and abilities will be enhanced.

3. It will provide an ideal framework for the execution of pre-normative research related to future standards in the field of aeronautical technology.

4. It will provide a forum within which national and multilateral research actions can be reviewed in common, and together with the Community action, to achieve maximum overall effectiveness.

5. It will give yet further impetus to the process of intercompany collaboration within the Community. This collaboration of aeronautical companies is indispensable if success in the world market is to be maintained.

The Commission's view that action is needed is consistent with the European Parliament's view expressed in its recent resolution on the European aeronautical industry[12].

7 - The Way Ahead

The conclusion which must be drawn from the Commission examination of the state of aeronautical research and technology are clear. Considerable efforts are currently being invested in aeronautical research and technology in Europe and, at present, products derived from the technology activities of the past are achieving substantial success in both civil and military markets. This desirable situation will not persist unless a radically new approach is taken to the task of regenerating the European aeronautical technology base. In the market place a whole variety of new products and product types can be foreseen which will embody changes ranging from the substantial (such as major use of advanced composite materials) to the radical (such as tilt rotor technology and hypersonic flight); at the same time, projected levels of European research and technology acquisition fall substantially short of what is needed to replenish the technology base sufficiently to support the exploitation of future market opportunities. Size and strength of action are vital for success in aeronautical research and technology as in other aspects of the industry's operations; yet, confronted by the vast strength and scale of activity of its main competitors in the world market, notably America, the European industry remains largely divided between national interests in the field of research and technology. Continuation on this path can only lead to failure. A new, more efficient, approach is needed which can realise more fully the potential of the European aeronautical technology community as a whole. Such an approach can only be

[12] PV 33 II, 11, 1987-88.

successfully realised by the committed efforts of the industry itself but the Community can play a decisive catalytic role by creating the conditions for a new initiative and by organising and supporting the activity until it has become fully established at European level. The industry has indicated its support for this approach and the Commission must now act.

The Commission intends to put forward concrete proposals for a major Community programme of aeronautical research and technology early in 1990. It is the intention of the Commission to precede these proposals by an early proposal for a pilot phase of work, devoted to problems which have already been identified as needing prompt attention. The work to be performed in the pilot phase will have limited scope but will be representation of the wider field of work to be embraced in the main programme, will provide concrete examples from which to develop and validate the methods and framework of cooperation and will maintain the momentum towards the definition and realisation of the main programme.

The present Communication is being submitted to the Council in order to make clear the Commission's analysis and intentions with respect to European aeronautical technology and in order to provide a basis for preparatory discussions of the main issues raised.

8 - Conclusions

The Commission invites the Council:

- to accept the urgent need for a programme of Strategic Measures in Aeronautical Research and Technology for Europe;

- to agree the general outlines given in this paper;

- to approve the timescale for future action given above.

EUROPEAN COLLABORATIVE AIRCRAFT PROGRAMMES

	AS	AMD-BA	AIT	BAe	CASA	DORNIER	FOKKER	MBB	SABCA	OTHERS
CIVIL AIRCRAFT										
Airbus A300/310/320/330/340	●			●	●	●	●	●	●	
ATR 42/72	●		●							
Concorde	●			●						
Fokker F.27/Fo-50, F.28/Fo-100		●					●	●	●	●
MILITARY AIRCRAFT										
Jaguar		●		●						
Tornado			●	●				●		
Alpha Jet		●				●			●	
EFA			●	●	●	●		●		
Transall	●							●		
Atlantic -1/-2	●	●	●			●	●		●	
HELICOPTERS										
Puma	●								●	●
Gazelle	●									●
Lynx	●									●
EH 101									●	● ●
HAP - HAC/PAH 2	●							●		●
NH 90	●						●	●		●
A129 LAH					●		●			●

OTHERS: SHORTS, AGUSTA, WESTLAND,...

ANNEX B

Study of Future Market Opportunities 1987-2010

As part of the study by nine aircraft companies, an intercompany group examined the future market opportunities for the European Aeronautical Industry.

In brief, this examination started with an assessment of the trends in demand for air transportation, worldwide, over the next two decades. This assessment, looking at both civil markets (trends illustrated in Fig B1) and military, projects a total world market (excluding Warsaw Pact countries and China) of some 130000 MECU over the years 1987-2010, roughly equally divided between civil and military products.

In the next stage, a detailed examination was made of the market opportunities which could be open to the European industry in each of the main aircraft and helicopter categories, both civil and military. This examination yielded estimates of market sizes and the shares of those markets which could realistically be attained by European companies, given an adequate level of product technology. The results of this exercise are illustrated in Fig B2.

FIGURE B1

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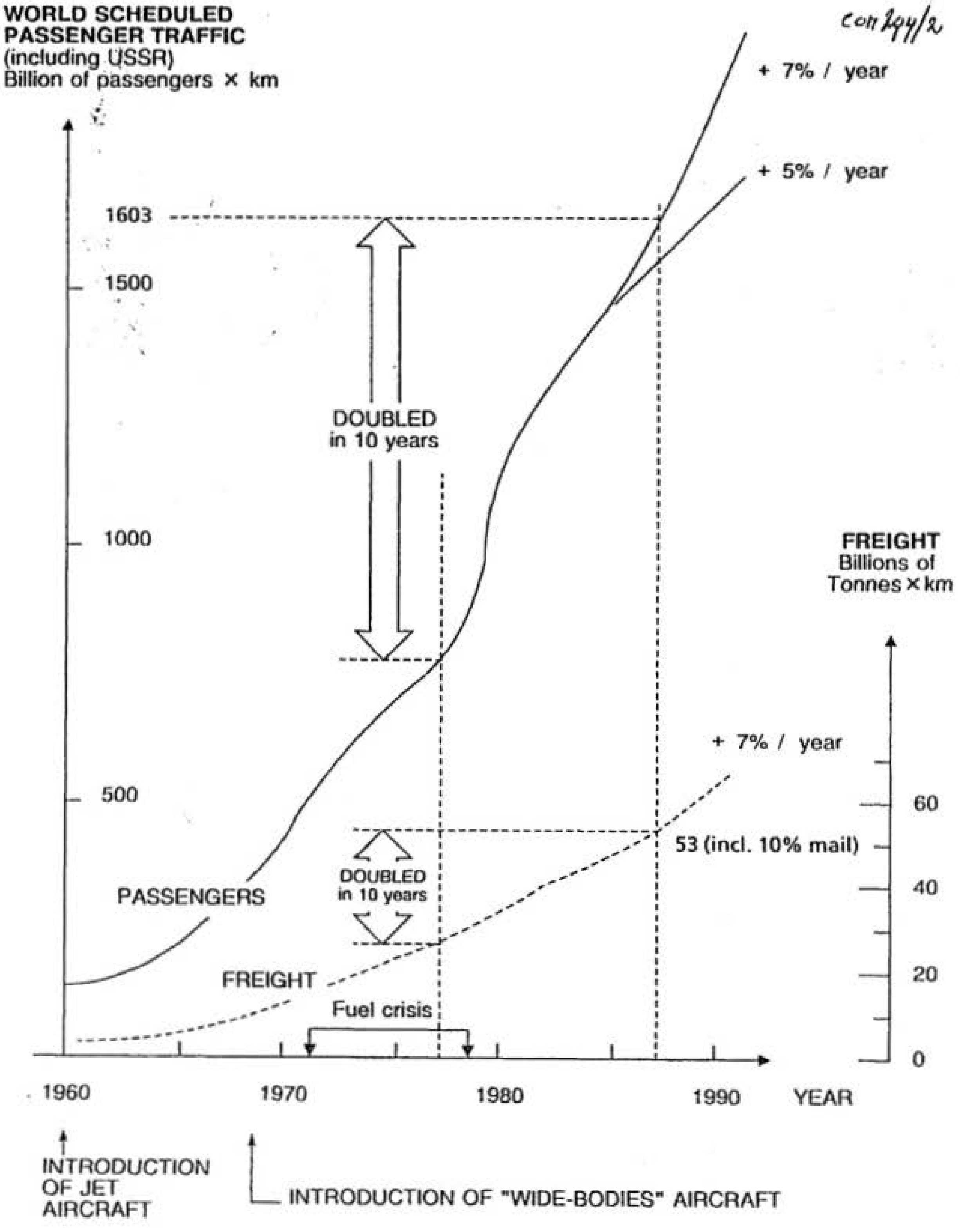

[Source: ICAO]

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FIGURE B2

Analysis of Aircraft Markets - Past and Future

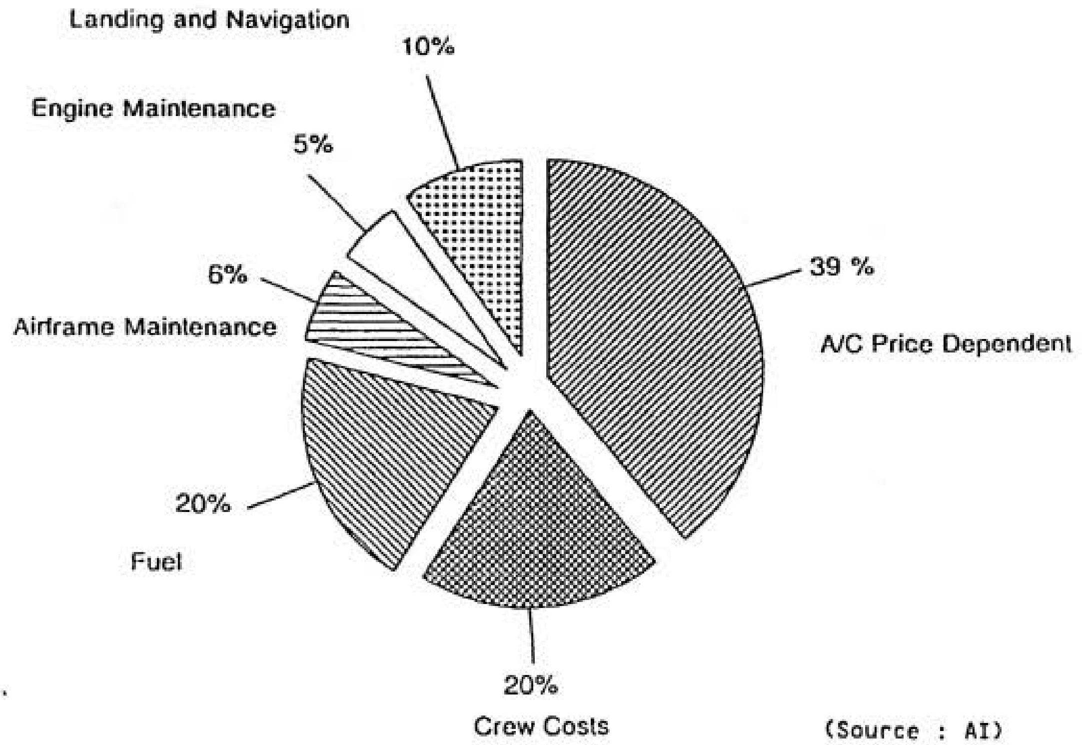
AIRCRAFT CATEGORIES	Aircraft Delivered 1980-1986					Forecast Deliveries 1987-2000				
	All Manufactures		EC Manufacturers only			All Manufactures		EC Manufacturers only		
	Units	Value (Bln. ECU 1987)	Units	Value (Bln. ECU 1987)	Value of Market Share %	Units	Value (Bln ECU 1987)	Units	Value (Bln. ECU 1987)	Value of Market Share %
CIVIL										
Commercial Transport										
360 Seats	228	19.03	0	0	0	1450	148	0-200	0-20	0-14
281-360	221	13.20	0	0	0	1650	109	550	36	33
201-280	438	21.56	283	14.77	68.5	1600	84	650	34	40
141-200	734	17.43	0	0	0	3250	79	1150	30	38
81-140	764	13.02	160	2.00	15.4	2050	34	750	12	35
51-80	2	0.02	0	0	0	2000	16	1250	10	63
20-50	794	3.46	530	2.07	59.8	2350	11	1050	5	45
15-19	967	1.80	226	0.50	27.8	1900	5	750	2	40
Supersonic						0-120	0-25	0-50	0-10	0-40
General Aviation										
Business Jets	2401	15.10	504	4.42	29.3	8600	60	2150	21.5	36
Private	16000	2.00	n.v.	n.v.	n.v.	70000	10	10500	0-1.5	0-15
Utility	n.v.	n.v.	n.v.	n.v.	n.v.	1600	5.4	800	3.5	65
Helicopters	5210	9.23	1980	2.69	29.1	12000	22	4800	8.5	40
Convertiplanes	-	-	-	-	-	600	9	150	1.5	17
CIVIL SUB-TOTALS		115.85		26.45	22.8		592 - 617		164 - 196	28 - 32
MILITARY										
Combat	6870	105.80	1650	27.65	26.1	22000	420	4800	74.0	18
Training										
Jet	1207	5.88	936	5.08	86.4	4000	30	2400	21.6	72
Turboprop	786	0.67	32	0.01	1.9	4000	4	0-500	0-0.5	0-13
Piston	596	0.15	344	0.09	60.0	1500	1	0-400	0-0.3	0-30
Transport										
Heavy	58	3.62	0	0	0	270	30	0	0	0
Large	209	2.90	25	0.33	11.4	1050	30	250	9.4	31
Medium	115	1.16	69	0.67	57.8	400	4	250	2.5	63
Light	452	1.07	153	0.36	33.6	1650	6	750	2.5	45
Special purpose	785	13.87	142	0.73	5.3	1900	55	450	6.3	11
Helicopters	4010	17.30	1820	8.10	46.8	19200	93	7700	37.4	40
Convertiplanes	-	-	-	-	-	1500	33	400	5.0	15
MILITARY SUB-TOTAL		152.42		43.02	28.2		706		160	23
GRAND TOTALS		268.27		69.47	25.9		1298 - 1323		324 - 356	25-27

NOTE : 1 Bln (1Billion) = 1000 Millions
1 ECU = 1,2 USD (1987 economic conditions)

[Source: EUROMART Study]

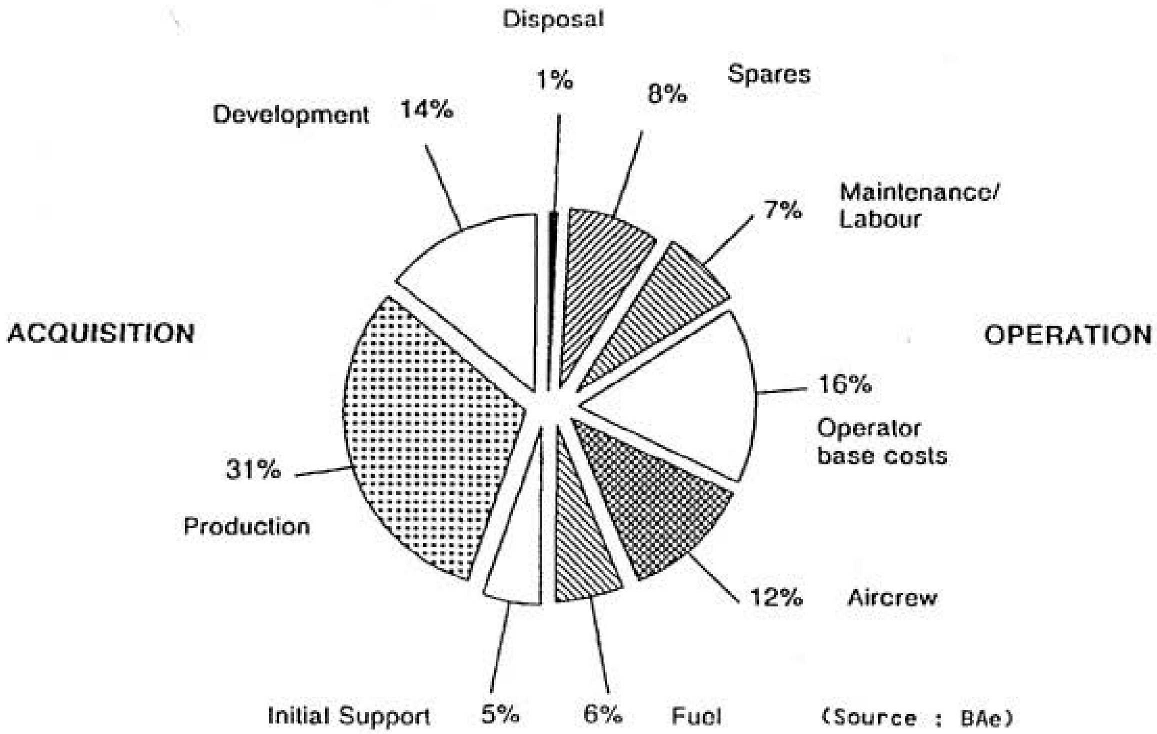
ANNEX C

DIRECT OPERATING COST BREAKDOWN
(Typical DOC for modern short-medium haul twin-jet)



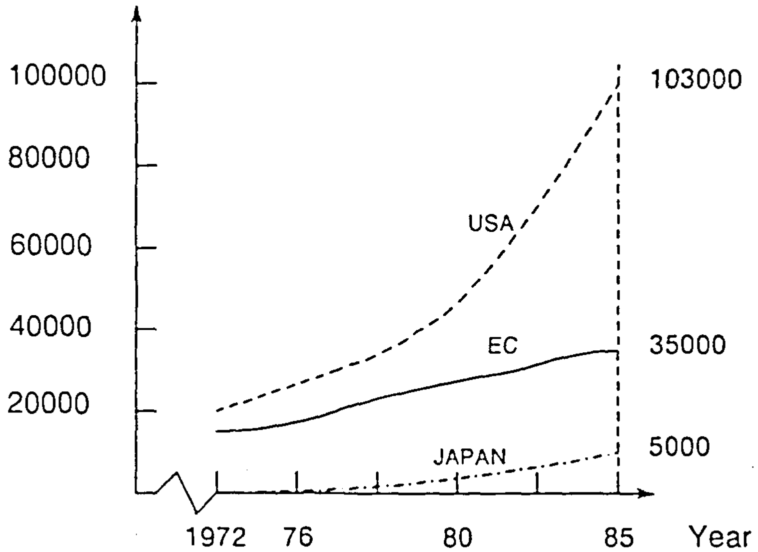
(Source : AI)

TYPICAL MILITARY AIRCRAFT LIFE CYCLE COST BREAKDOWN
(Assumes 25 Years In-Service)

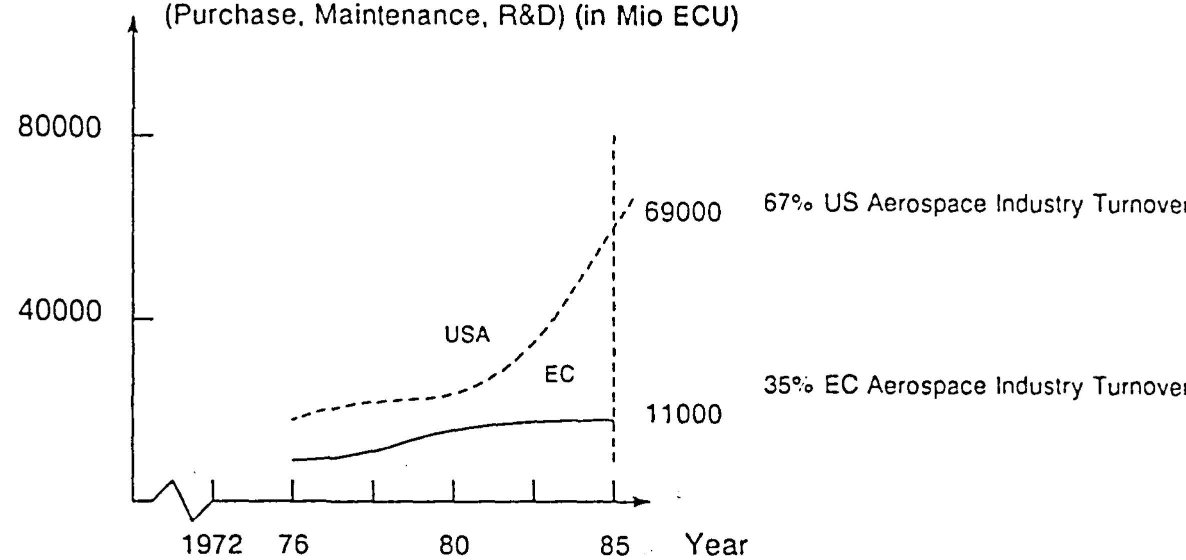


(Source : BAe)

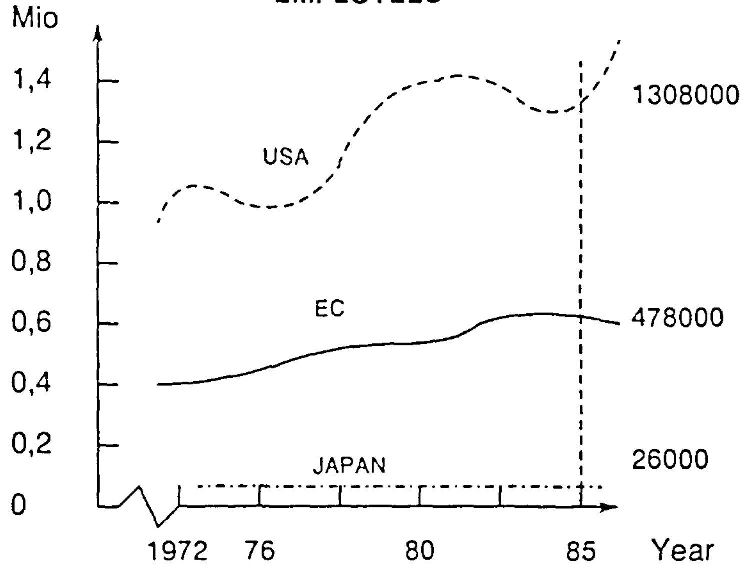
INCREASE IN AEROSPACE INDUSTRY TURNOVER(in Mio ECU)



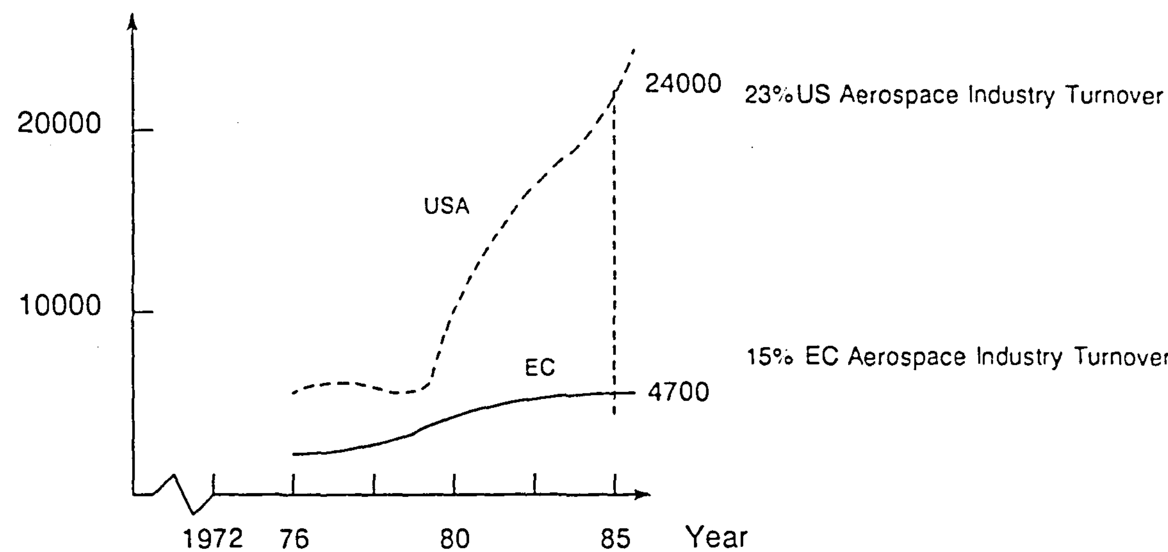
INCREASE IN PUBLIC CONTRACTS TO AEROSPACE INDUSTRY
(Purchase, Maintenance, R&D) (in Mio ECU)



AEROSPACE INDUSTRY EMPLOYEES



INCREASE IN AEROSPACE INDUSTRY R&D (in Mio ECU)



Ref. : The European Aerospace Industry EC Commission Rep.III/53788cm-Brussels-1/02/1988
National Science Foundation - USA

ANNEX D

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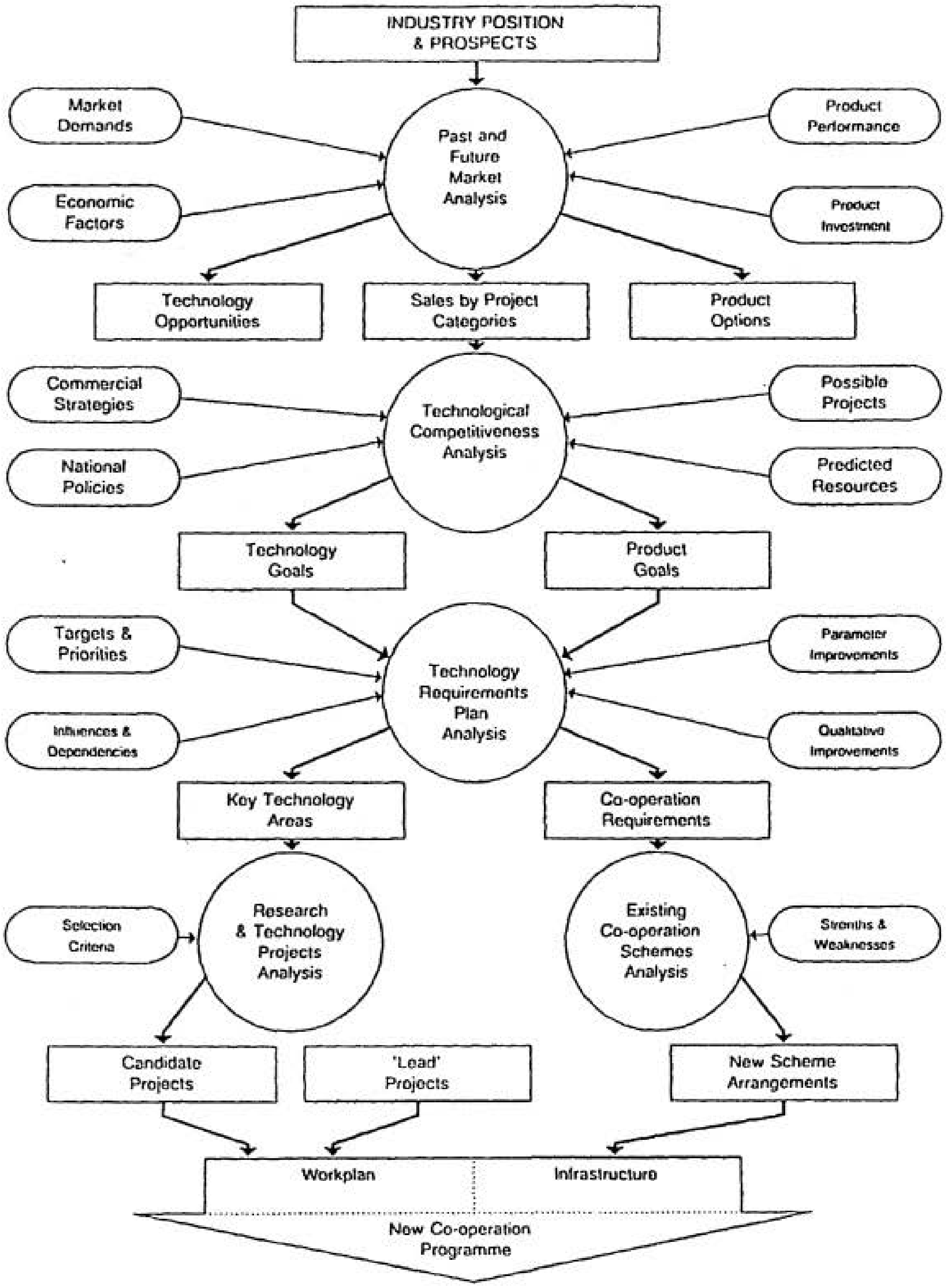
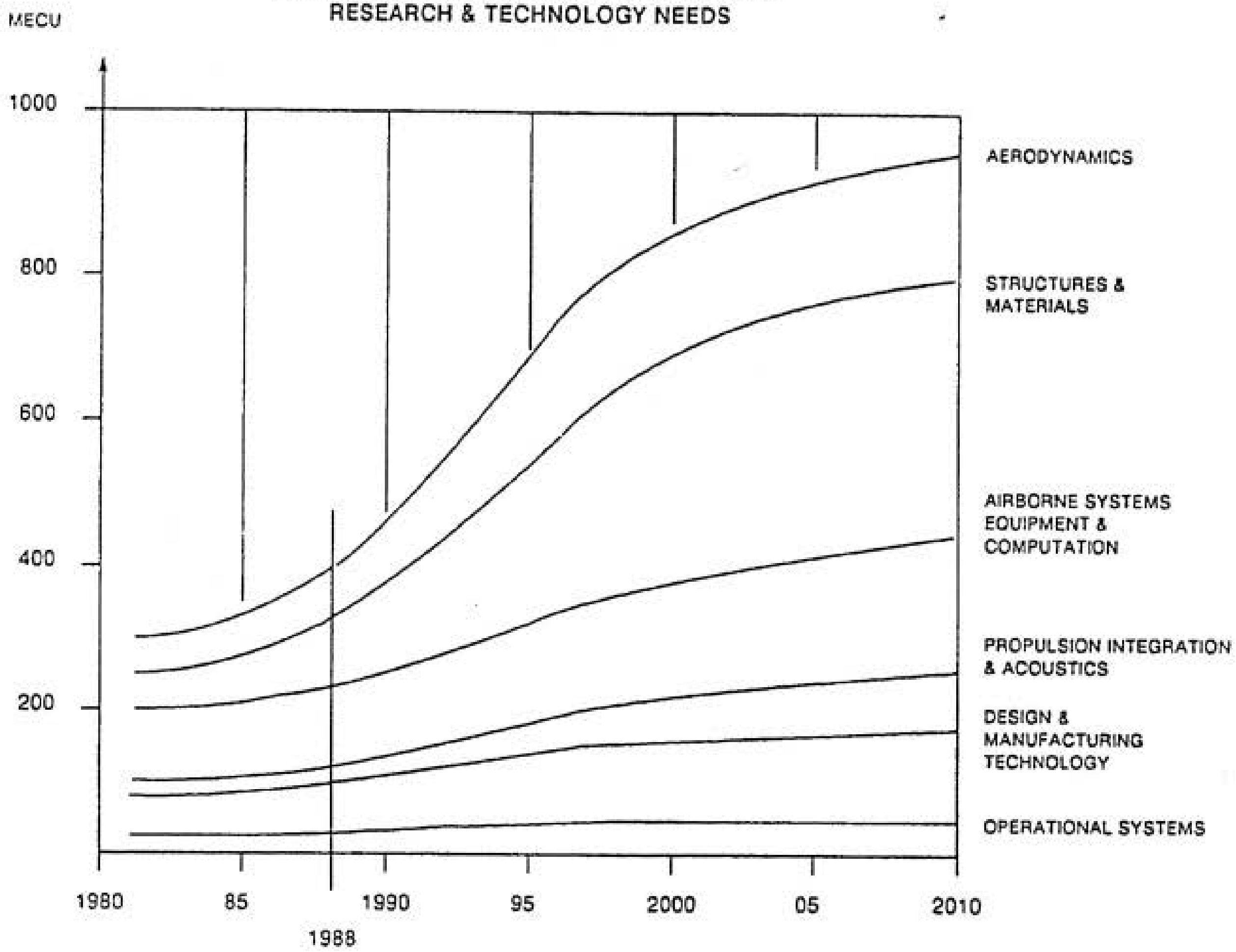
ANNEX E



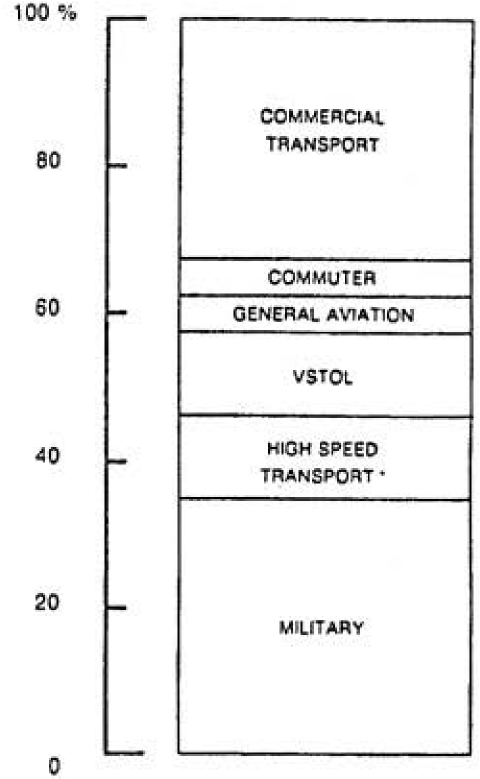
(Source : EUROMART Study)

SCENARIO OF FUTURE EUROPEAN AIRCRAFT RESEARCH & TECHNOLOGY NEEDS



(Source : EUROMART Study)

AIRCRAFT CATEGORY BREAKDOWN IN YEAR 2010



* ASSUME 50 % OF SST, 25% OF HST

ANNEX F

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APPENDIX G

KEY TECHNOLOGY AREAS

Key technology areas related to technology and product goals have been identified in the following categories:

DISCIPLINARY AREA		KEY TECHNOLOGY
Aerodynamics (including Flight Mechanics)	-	computational fluid dynamics,shape integration, high lift, drag reduction, air intakes, flight dynamics.
Structures	-	new concepts, new computational methods and tools, high-temperature structures, new experimental methods (verification and testing).
Materials	-	new metal alloys, composites, metal matrix, thermoplastics, high-temperature materials, related processing, etc.
Acoustics	-	external noise fields, cockpit and cabin noise, active noise control, measurement techniques, prediction methods, structure fatigue effects, noise shielding.
Computation	-	large-scale software, modelling, simulation, vectorial supercomputing.
Airborne Systems and Equipment	-	system architectures, new system concepts (all-electric aircraft) man/machine interface, advanced optoelectronic concepts, detection and recognition, software engineering, lightning protection, flight control, sensors, actuators.

Annex G (cont.)

DISCIPLINARY AREA		KEY TECHNOLOGY
Propulsion	-	engine/airframe integration, incorporation of new propulsion concepts (propfan, high bypass ratio, ramjets), fuel systems.
Multidisciplinary	-	cockpit integration, active control technology, structural mode control.
Design Technology	-	computer-aided design, methodologies and means leading to an increase of design productivity and integration with manufacturing processes.
Manufacturing Technology	-	computer-aided manufacturing, computer integrated manufacturing, flexible manufacturing systems, advanced manufacturing and inspection systems(robotics, non-destructive testing).
Operational Systems	-	air traffic control, overall fleet management, advanced navigation concepts.