COMMISSION OF THE EUROPEAN COMMUNITIES

STUDIES

The aeronautical and space industries of the Community compared with those of the United Kingdom and the United States

GENERAL REPORT **Volume 1**

COMPETITION INDUSTRY – 1971 – **4**

Survey carried out on behalf of the **Commission of the European Communities** (Directorate-General for Industry)

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July 1969 / No. 7042

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STUDIES
Competition Industry No. 4
BRUSSELS 1971

THE AERONAUTICAL AND SPACE INDUSTRIES OF THE COMMUNITY COMPARED WITH THOSE OF THE UNITED KINGDOM AND THE UNITED STATES

VOLUME 1 The aeronautical and space research and development

VOLUME 2 The aeronautical and space industry

VOLUME 3 The space activities

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INTRODUCTION

CHAPTER I

The aeronautical and space research and development

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INTRODUCTION

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Introduction

1. SCOPE OF THE SURVEY

The Directorate-General for Industry of the Commission of the European Communities called for a study of "Research and development in the aeronautical and space industries of the Community as compared with those of non-member countries"(in particular the United States and the United Kingdom)[1].

The problem of research and development is therefore to be approached mainly from the standpoint of its industrial consequences and implications, having regard firstly to the structure of the Community's aerospace industry and secondly to government policies in this field.

The characteristic features of the aerospace sector are:

- an industry employing advanced technology and engaged in R&D, which not only forms an integral part of the productive process but is also in some cases the actual final product (as in the case of space activities);
- the preponderant role of the government as the source of funds for the bulk of R&D work, as the main purchaser of the industry's products and, in some cases, as a direct participant in production through investment in the firms concerned.

This involves a whole series of interrelationships between research and development, the industry and the market, in the sense that R&D suggests the product to the "market", directly or indirectly. The market, in turn, has a double power

[1] Document dated 14 December 1967.

of decision; on the one hand, it selects the products which it considers best and orders them from the industry; on the other hand, it can in many cases influence the line taken by R&D (or at least by some part of it) by opting for one research policy rather than another, and thus indirectly influencing the industry.

In order to understand these phenomena, we must first analyse and study the present and former composition of:

- the aerospace industry in the member countries of the European Community. Its present structure as a basic element of the problem; its former structure as an indication of development trends in the different branches, which are inevitably long-term trends because of the inherent nature of aerospace products;
- the market actually covered by the products of the aerospace industry of the EEC (including the results of R&D) or not satisfied by what the Community industry can supply;
- the organization and use of the R&D facilities available within the EEC.

Because of the long-term character of aeronautical and space activities, it is possible to work out:

- for the industry: future development prospects, R&D requirements in the different branches and the form in which such results may be obtained.
- for the market: the lines along which the market itself and R&D policy may be expected to develop;
- for R&D firms: development prospects and the future direction of research work.

Because political and economic systems and industrial strategies vary from state to state, the study outlined above can only be carried out on a country-by-country basis.

In addition, however, the special feature of the aerospace industry (and especially its market) call for an international comparison in order to:

- define the relations between countries as regards R&D, the industry and the market;
- assess, by comparing the situation in the various countries, the possibility of formulating judgments and determining essential parameters for an overall evaluation of the problem.

To this end, our survey is concerned with research in the member countries of the European Economic Community, using the United Kingdom and the United States for purposes of comparison.

2. AIM OF THE SURVEY

The aim of our study can be defined as identification of the problems revealed by an analysis of the present structures of the aerospace industries of the European Community, and of development prospects in the seventies, as compared with the American and British industries, with a view to formulating possible policies for intervention by the Community as such or by the member governments.

3. METHODS

3.1 General Approach

The subject of our study was so complex and so vast that it was felt advisable to approach the problems relating to R&D, the industry and the market in the countries concerned in two stages, as follows:

- Desk research

  There is already a very large body of specialized and non-specialized literature on aerospace problems.

  We experienced no particular difficulty in obtaining this material, in most cases directly in the countries under review.

  However, in view of the length and purpose of our study, a number of reserves must be made concerning the nature and applicability of the bibliographical material.

  First, the data are by no means complete, partly because of the military secrecy which inevitably surrounds some activities in this sector and partly because some countries keep no adequate statistics.

  In the latter respect it should be noted that in many cases figures for the industry are not broken down by branches, that some statistical series cover short periods only and that some figures are completely lacking, even for the industry as a whole.

  Secondly, the data collected are not homogeneous for two reasons:

  - the aerospace industry is of such a nature that its limits cannot be precisely defined. Because they also work on missiles and space equipment, the actual aeronautical industries (airframes, engines and equipment) are in practice closely involved with other branches of production and primarily with the electronics industry.

This being so, the scope of all statistical findings must be defined in advance; this is in fact done in every country but the specific items vary according to the varying importance attached to each by the so-called collateral branches[1].

Furthermore, it is objectively difficult to gear the apparatus for the collection of statistics to an industry such as aircraft production, which is characterized by rapid technological changes;

- particular aerospace activities and/or technologies are of relatively limited importance to certain countries; in such cases, the relevant statistics are not collected except as part of a bigger and more significant aggregate.

The data obtained by desk research are therefore subjected to a close critical scrutiny in an attempt to produce series comparable as regards both content and period for the various countries.

This necessarily involved:

- a restrictive definition of the aeronautical industry to include primarily the typical branches already mentioned;
- limitation of the statistical series, essentially to the period 1960-67.

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[1] The aircraft industry is a typical example of this.

At the same time, the more general approach to the problem allowed us to extend our study of the facts and the problems associated with them beyond the limits defined above.

- Direct enquiries

The information and data acquired by desk research enabled us to make a first assessment of the basic scale of the problems, to interpret past events and present facts and to identify certain development hypotheses at both branch and company level.

The basic purpose of the direct enquiries addressed to ministries, corporations, organizations, associations, airline firms, companies and research centres in the various countries covered by our survey was to confirm these preliminary facts and to ascertain the views, ideas and strategies of public and private operators in the aerospace sector. The original estimate of 78 meetings was slightly exceeded and 82 interviews in fact took place.

The breakdown of interviews is as follows:

- by country

United States	20
Belgium	10
Netherlands	2
United Kingdom	10
France	14
West Germany	10
Italy	16
Total	82

- <u>by operators</u>

Ministries	10
Corporations, organizations and associations	19
Firms	41
Airline companies	8
Research establishments	4
	82

Some of the corporations and firms listed were interviewed more than once over a period of five to ten months.

The interviews were of the "guided" type and were based on the data collected and the working hypotheses formulated through desk research.

The questionnaires, which varied in approach according to the authority concerned[1], were so framed that they could be used to express wider views in more detail. The interviewee was given a specific subject, with plenty of space for a final reply and for additional details, if so desired. Much use was made of this opportunity to deal with both the technical and the economic aspects.

Some use has been made of the replies in this report, without specific mention of the individual or corporation concerned. This fulfils the undertakings given to the Directorate-General for Industry of the European Community and to the authorities interviewed, to whom SORIS wish to express their grateful thanks.

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1 Specimen questionnaires are given in Annexes A and B.

3.2 Detailed Methods

R&D activity

R&D activities were analyzed at two levels:

- R&D establishments

  The most important institutions (national and international public research establishments, factory and cooperative centres) were analyzed from the standpoint of capital assets and staff and of results achieved.

  The following points were covered in each case:

  - present and past specialization;
  - internal organization;
  - technical and financial resources;
  - personnel;
  - outstanding results, in terms of staff and technical and financial resources or in terms of influence on the development of the aerospace industry.

- R&D organization

  The following points were covered:

  - national government organizations concerned with the commissioning, support and coordination of R&D and its results, and, wherever possible, the forms of such coordination (finance, research contracts, etc.);
  - international organizations;
  - industrial coordinating bodies;
  - relations between existing coordinating bodies.

The policies of governments and firms were analyzed on the basis of the information collected.

The influence of the various forms of coordination on the development of the aerospace industry were studied country by country.

Apart from showing the present position and its relation to the past, the overall picture so obtained enabled us to identify some of the strong and weak points, as well as some of the gaps, in the three-sided structure, comprising R&D, the industry and the market, to which the survey is directed.

The elements which emerged at this stage were also used to study the fall-out of aerospace R&D and hence the role of the aerospace industry in the national economy.

The industry

The aerospace industry was studied at two levels:

- The industry as a whole

  The position of the industry at present, and over the last ten years, was examined country by country, covering such aspects as turnover and investments, labour force, degree of concentration of firms and specialization of industrial groups, financial structures.

  The progress of the aerospace industry in the various countries was also compared with that of industry in general and from the standpoint of its contribution to the growth of the national economy.

  The primary data were also used for an analysis of the aircraft industry by branches (airframes, engines, equipment).

In view of the special features of the relationship between R&D, the industry and the market, space activities were studied separately and in great detail.

- Individual firms

  Case histories were compiled for the firms of most significance in relation to the structure of the industry in each of the countries investigated, or most representative of different strategies in the case of the United States.

  The purpose of this part of the study was to ascertain firms' policies and results to date and to identify, in each country, the various aspects of the progress of the aerospace industry as a whole.

The market

Demand over the last ten years was analyzed separately for each type of product.

More detailed attention was given to military and civilian demand, subdivided into EEC, United Kingdom, United States and the rest of the world.

Consideration was given to government military purchasing policy and to the activities and tendencies of flag carriers.

With a view to suggesting a possible future trend in addition to a historical survey, data were collected from each country or group of countries for types of aircraft already produced or in the pipeline.

Lastly, we estimated the size of the market in 1980 by combining our analysis of forecasts of the growth of passenger and goods traffic with that of the future development of types of aircraft (number of passengers, speed, range).

4. PLAN OF THE REPORT

The report reflects the methods used in the course of our survey. It is in two parts, namely, the General Report and the Annexes to the General Report, comprising five and ten volumes respectively.

General Report

Volume 1 - Introduction
Chapter 1 Aeronautical and Space Research and Development

Volume 2 - Chapter 2 Section A. The Aeronautical and Space Industry

Volume 3 - Chapter 2 Section B. Space Activities

Volume 4 - Chapter 3 The Aircraft Market

Volume 5 - Chapter 4 The Technological Balance of Payments
Chapter 5 The Role of the Aerospace Industry in the Economy
Chapter 6 Critical Summary of the Findings of the Survey

Annexes to the General Report

1 - National reports: Belgium

2 - National reports: France

3 - National reports: Italy

4 - National reports: Netherlands

5 - National reports: West Germany

6 - National reports: United Kingdom

7 - Survey of the United States aerospace industry

8 - Case history of aerospace firms in the United States

9 - American contracting practice: Department of Defense and NASA

10 - International collaboration in aircraft production.

The layout of the six national reports is substantially the same as that of the General Report.

The set method used for the EEC countries and the United Kingdom was not applied to the material collected for the United States. It was decided that it would be better to study in detail certain selected aspects of the situation in the United States, and to process and study any data explicitly required by the survey for purposes of comparison.

The present and prospective importance of international collaboration is so great that it is dealt with in a separate volume, which uses case histories to present the problems involved.

The following points should be noted concerning the national reports:

- they simply "describe", as analytically as possible, the position and development of the aerospace industry and its branches in each country;
- by virtue of their layout and the similarity of their data, they qualify as basic documents for the General Report;
- because of these features they do not include forecasts of future development, which is dealt with at EEC level as the General Report progresses.

On the other hand, the General Report uses the national reports and the information provided by the study of the most significant aspects of American aerospace activities to make tentative international forecasts on the basis of the present position and growth prospects of the Community industry. The General Report is thus a document which might provide a basis for action policies.

Chapter 6 (Critical Summary of the Findings of the Survey) is simply intended to draw attention to a number of aspects, which we regard as fundamental, of the wider and more complex problems revealed by our studies.

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Belgium

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- Belgospace
- Bell Telephone
- F N.
- Institut Von Karman
- M B L E
- S A B C A
- SABENA

France

- Air France
- Avions Marcel Dassault
- Breguet
- CNES
- D G R S T
- ELDO
- Electronique Marcel Dassault
- Engins Matra
- ESRO
- EUROSPACE
- Nord-Aviation
- O N E R A
- S E P R
- S E R E B
- S E T I S
- U S I A S

Italy

- AERFER
- Aeronautica Macchi
- Alfa Romeo
- Alitalia
- Associazione Industrie Aèrospaziali
- Centro Ricerche Aerospaziali
- FIAR
- FIAT
- Laben
- Piaggio
- Selenia

The Netherlands

- FOEGIN (Federation of Dutch Engineering & Electronics Industries)
- Fokker
- KLM

West Germany

- AEG Telefunken
- AVA
- BDLI
- Bölkow
- Bundesminister für Wissenschaftliche Forschung
- Daimler Benz
- DGF
- DVL
- Lorenz SEL
- MAN Turbo

United Kingdom

- B A C
- B E A
- B O A C
- Hawker Siddeley
- Ministry of Technology
- Plessey
- Rolls Royce
- S B A C

United States

- Aerospace Industries Association of America
- Beech
- Bendix International
- Boeing
- Cessna
- Department of Commerce
- Department of Defense
- Eastern Air Lines
- Federal Aviation Administration
- Garrett
- General Dynamics
- Grumman International
- Hughes
- IBM
- Litton Industries
- Lockheed
- LTV
- Martin Marietta
- Mc Donnell Douglas

- NASA
- National Science Foundation
- North American Aviation
- Northrop
- Pan American Airways
- Sperry Rand
- United Aircraft
- United Air Lines

CHAPTER I

The aeronautical and space research and development

1. DEFINITION OF BASIC RESEARCH, APPLIED RESEARCH AND DEVELOPMENT

As in other fields, aerospace R&D, which forms the subject of our study, comprises the three types or stages of research as defined by the OECD[1] for R&D in general and accepted by the member countries:

- basic research

  any activity undertaken to add to scientific knowledge, without any specific predetermined practical application;

- applied research

  any activity undertaken to add to scientific knowledge, with a specific practical aim;

- development

  use of the findings of basic and applied research to introduce new materials, machines, products and processes or to improve existing types.

It is recalled that, in the aerospace sector, the development stage (building of prototypes), which is much more important than basic and applied research, also includes testing and evaluation[2].

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[1] Organization for Economic Cooperation and Development, Proposed standard method for research and development enquiries, Paris 1963.

[2] In the United States, research promoted or carried out by the DoD (Department of Defence) is covered by the general title RDT&E (Research Development Test and Evaluation).

2. RELATIONSHIP BETWEEN RESEARCH AND DEVELOPMENT AND BETWEEN THE INDUSTRY AND THE MARKET

The predominant role of R&D in the aeronautical and space industry is closely linked with a feature common to all the markets which form the total demand for aerospace products. This feature is the rapid obsolescence of products, with the resultant continuous need for new equipment, even if the reasons differ. Thus:

- the military market needs equipment offering the maximum operational performance, in accordance with strategic and tactical concepts and thus military material requirements at the time;
- the civil market needs aircraft offering maximum reliability and efficiency from the operational standpoint, in accordance with growing traffic requirements;
- the space market, particularly in this first phase of expansion, requires the development of launchers and vehicles with constantly improving characteristics.

For the aerospace industry, therefore, R&D is the determining factor in development.

In no other branch of industry is the percentage of "new" products (i.e., the direct consequence of R&D) as high as in the aerospace industry, as can be seen from the table on the next page:

R&D's Payoff: the Return from new Products

as percent of estimated 1970 sales

Industry	%
Iron and steel	8
Non-ferrous metals	16
Machinery	25
Electrical machinery and communications	26
Aerospace	49
Autos and other transporting equipment	22
Fabricated metals and ordnance	18
Professional and scientific instruments	
Chemicals and allied products	20
Paper and allied products	10
Rubber products	7
Stone, clay and glass	20
Petroleum products	7
Food and kindred products	12
Textile mill products and apparel	21
Other industries	8
Total average	17

Data: McGraw-Hill Economics Dept.

Consideration of the nature of the markets which form overall aerospace demand shows that the main centres of decisions to initiate R&D are basically the government, on the one hand, and firms making up the industry on the other.

The extent and direction of R&D in the industry are decisively determined by government policy, particularly on military and space questions.

The size and spacing of the government R&D contracts awarded to industry stimulate the firms to organize their research departments and have a more or less immediate influence on the production structure, in proportion to the demands entailed by productive exploitation of the research results.

For the firms concerned in this process, which enables them to acquire experience and also a higher financial capacity linked to the levels of activity attained, there may be an opportunity for substantial R&D activity in the civil field, which they can plan independently.

This is the position in the American aerospace industry, and a few examples can also be found among European firms.

As regards the civil market, the principal features of the process whereby a firm succeeds in holding its own and increasing its size are speed in detecting user trends and the ability to supply, punctually, the right goods to meet customers' requirements. Competition between a country's various firms naturally enhances the importance of awareness and know-how and of getting the product onto the market in good time.

Clearly then, for a national aerospace industry and more specifically for the various firms comprised in the industry, strategic manoeuvring to hold its position and extend its share of the market, is governed by their ability to devote finance, organization and staff to R&D on the required scale and at the right time.

The machinery so described presupposes an integrated industry, i.e., one which engages directly in R&D as a prerequisite for programmed production for the market.

A review of national aerospace industries reveals the existence of individual firms, or a whole industry, which operate without their own R&D facilities and rely on the findings of the R&D departments of other firms (licences, patents).

Such firms and industries are as a result the least active, show the least dynamism and have the lowest rates of growth.

In addition to the advantages of an integrated process (from R&D to final production), firms can derive substantial further benefits from continuous R&D activity; for example, they can maintain an efficient research apparatus, earn the maximum return on investment in research and gain indirect benefits from research on specific subjects in such matters as data, organization, management, etc.

3. STRUCTURE AND ORGANIZATION OF R&D

3.1 R&D Operators

In the Community countries, the United Kingdom and the United States, civil and military R&D activity in the aerospace sector is in the hands of government departments and private operators, in a number of forms:

- government laboratories and establishments
- university institutes
- aeronautical and space companies.

The operators chiefly concerned with the various types of research are as follows:

- Basic research: government laboratories and establishments
universities
- Applied research: government laboratories and establishments aerospace companies
- Development, test and evaluation: aerospace companies
government laboratories and establishments

Government laboratories and establishments are principally concerned with basic and applied research and with testing and evaluation.

Within the industry, on the other hand, the main emphasis is on development and, in the absence of specialized government establishments and laboratories, on applied research.

3.1.1 Government bodies

The government is prominently represented in aerospace R&D both in the Community countries and in the United Kingdom and the United States.

The main reason for this presence, which differs widely as regards actual organization, unquestionably lies in the fact that research in the government sector is predominantly military.

Secondly, government laboratories and establishments have been, and in some cases still are, pilot establishments with a coordinating function when the structure and organization of the aerospace industry have been inadequate.

Thirdly, the government (as, for example, in France) has invested a great deal of money and has equipped its centres with extensive facilities for testing and evaluation, which are available to the industry.

Lastly, the government is in a better position, through its own laboratories and establishments, to follow and evaluate the research work of individual firms.

In the various countries, therefore, government laboratories and establishments work side by side with university institutes which are mainly concerned with basic research and are linked in varying degree with the industry. These laboratories and establishments concentrate mainly on applied research and/or testing and evaluation, including work for civil programmes.

Because of the nature of the research which they undertake, most government laboratories and establishments either come directly under the Ministry of Defense or are responsible to it, even if they are administratively independent.

In France, the first category includes the laboratories and centres of the two technical directorates of the Ministry of the Armed Forces:

- Direction technique des constructions aéronautiques (DTCA) for aircraft R&D[1]
- Direction technique des engins (DTE) for R&D concerned with missiles and space activities[2]

while the second category, under the control of the Ministry, comprises:

- the Office national d'études et de recherches aérospatiales (ONERA)
- the Insitut franco-allemand de recherches de Saint-Louis (ISL)

In the space sector, the Centre national d'études spatiales (CNES), which has financial autonomy under the Minister in charge of scientific research and atomic and space questions, itself undertakes some research but acts principally as coordinator of research commissioned from the industry.

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[1] Centre d'essais aéronautique de Toulouse (CEAT). Centre d'essais des propulseurs (CEP), Centre d'essais de vol (CEV).

[2] Laboratoire de recherches balistiques et aérodynamiques (LRBA), Centre d'achèvement et d'essais des propulseurs d'engins (CAEPE), Centre d'essais des Landes (CEL).

In the United Kingdom, government centres for aerospace R&D, of which the Royal Aircraft Establishment (RAE) is the most important, now come under the Ministry of Technology (Mintech). Since almost all these establishments are concerned with military research, their work is programmed and organized by Mintech, in close collaboration with the Ministry of Defense.

In the United States, in addition to the laboratories and centres of the Department of Defence (DoD), there is the National Aeronautics and Space Administration (NASA), which is autonomous as regards management and research programming, but is subject to public control through Congress.

It should be noted, however, that NASA is only concerned to a limited extent with actual research and mainly commissions R&D work from the industry.

3.1.2 Private bodies

The major part of aerospace R&D is handled by firms, with virtually the same percentage (about 70% of total activity) throughout the Community and in the United Kingdom and the United States.

Firms are predominantly concerned with the development stage, and to a lesser extent with applied research, with only a very small amount of basic research.

This breakdown of research work applies both to R&D which firms initiate themselves and to work under government contract.

In the first case, firms generally limit their basic research to the amount and directions which they consider absolutely necessary as a pre-condition for applied research;

in the second case, the government naturally tends to allocate basic research, whether pure or specific, to its own laboratories and establishments and to university institutes, particularly because of the objective difficulty of commissioning basic research from firms on a clearly-defined contractual basis.

At the level of individual firms, the factors governing decisions to invest in R&D naturally include the risk involved and the length of time before a return can be expected; in general terms, investment is long-term for basic research, medium-term for applied research and short-term for development; only big firms can afford substantial funds for basic research.

3.2 Organization of R&D

R&D work in the aerospace industry is planned and coordinated by the government, as part of its general policy for scientific and technological research.

As work is mainly military, the authorities principally concerned in the EEC countries are the defense departments.

Space activities are sometimes directed by a Ministry for Scientific Research (as in France and West Germany); elsewhere they are handled by the government under its general powers.

Civil aeronautical research generally comes under the Ministries of Economics and Transport.

In the United Kingdom, the Ministry of Technology is responsible for R&D concerning military and civil aircraft; in the case of space activities, it is only recently that there has been a move to concentrate the powers previously shared between several departments into the hands of the Ministry of Technology.

In the United States, the Department of Defence is responsible for military research.

There are two Federal agencies which operate under the control of Congress: they are NASA (National Aeronautics and Space Administration), which is responsible for space research, and the FAA (Federal Aviation Agency), which deals with civil aviation.

3.3 Funding of Aerospace R&D

3.3.1 General

A comparative analysis of funding of aerospace R&D shows the following increase from 1960 to 1967 (see Table 1/1):

EEC	+382.6%
United Kingdom	+59.6%
United States	+189.0%

For the EEC countries as a whole, the main contribution to the increase has come from France and West Germany, which are the two biggest spenders on aerospace R&D.

FIG. 1 Total Funds for Aerospace R&D (1960 and 1967)

Country	1960		1967		Increase 1967 as compared with 1960	
	$ millions	%	$ millions	%	$ millions	%
France	167	85.6	694	73.8	+527	+315.5
West Germany	24	12.3	194	20.6	+170	+708.3
Other EEC countries	4	2.1	53	5.6	+49	+1,225.0
Total EEC	195	100.0	941	100.0	+746	+382.6

FIG. 2

Total Funds for Aerospace R&D and for All R&D (1959, 1962 and 1965)

Country	1959			1962			1965		
	All R&D	Aero-space R&D	Aerospace R&D as a % of all R&D	All R&D	Aero-space R&D	Aerospace R&D as a % of all R&D	All R&D	Aero-space R&D	Aerospace R&D as a % of all R&D
	M$ *	M$	%	M$	M$	%	M$	M$	%
	..	..	..	2,825	342	12.1	4,562	630	13.8
	1,338	410	30.6	1,842	582	31.6	2,160	582	26.9
	12,520	2,174	17.4	15,610	5,830	37.3	20,470	9,354	45.7

FIG. 3 <u>Total Funds for Aerospace R&D as a Percentage of Gross National Product (1960-67)</u>

(Millions of dollars)

Year	EEC			UK			USA		
	Funds for aerospace R&D (A)	GNP (B)	(A)/(B)	Funds for aerospace R&D (A)	GNP (B)	(A)/(B)	Funds for aerospace R&D (A)	GNP (B)	(A)/(B)
1960	195	191,166	0,10	431	72,193	0.60	3.619	511,400	0,71
1961	270	208,319	0,13	543	77,143	0.70	5.244	528,600	0,99
1962	342	229,284	0,15	582	80,992	0.72	5.830	569,100	1,02
1963	408	251,430	0,16	588	85,952	0,68	6.762	599,700	1,13
1964	557	277,278	0,20	573	93,059	0,62	9.223	642,800	1,43
1965	630	299,702	0,21	582	99,765	0,58	9.354	695,500	1,34
1966	802	321,272	0,25	680	105,356	0,65	10.326	756,500	1,36
1967	941	341,838	0,28	688	110,141	0,62	10.462	803,914	1,30

Funds for aerospace R&D in the EEC rose simultaneously with total spending on R&D, but at a slightly higher rate (12% of the total in 1962 and 13.8% in 1965); the proportion of the gross national product going to aerospace R&D thus rose from 0.10% in 1960 to 0.28% in 1967.

By 1965, this progress had enabled the EEC to catch up and overtake the absolute figures for the United Kingdom, which over the period under review (1960-67) continued to spend a roughly constant proportion of its GNP on aerospace research and development.

In terms of the GNP, however, EEC spending on R&D is still lower than that of the United Kingdom. In relation to the United States, the EEC's position has also improved slightly, but the gap in absolute terms is still very wide; in 1960, the United States was spending 18.6 times as much on aerospace R&D as the EEC; by 1967 this figure was down to 11.1 : 1.

Over the whole period 1960-67 the majority of aerospace R&D funds in the EEC (which were over $500 million less than the British total) went to military programmes (65%).

While the absolute figure under this head rose, its proportion of total spending fell from 83.6% in 1960 to 58.9 in 1967, owing to the growing importance of space programmes (rising from 1.9% in 1961 to 21.8% in 1967) and also to a slight increase in spending on civil programmes.

The proportion allocated to military programmes was higher (75%) in the United Kingdom, but the figure dropped from 87.7% in 1960 to 65.1% in 1967, as expenditure on civil programmes rose from 12.3 to 26.6% and space programmes got under way.

FIG. 4 Breakdown of Total Funds for Aerospace R&D by Programmes

(Total for period 1960-67)

Programmes	EEC		United Kingdom		United States	
	$ millions	%	$ millions	%	$ millions	%
Aircraft programmes	3,517	84.9	4,437	95.1	30,759	50.6
- military	2,697	65.0	3.499	75.0	26,130	43.0
- civil	820	19.9	938	20.1	4,629	7.6
Space programmes	628	15.1	230	4.9	30,061	49.4
TOTAL	4,145	100.0	4,667	100.0	60,820	100.0

Spending on military programmes was proportionately lower in the United States than either in the EEC or the United Kingdom; the figure dropped from 67% in 1960 to 34.9% in 1967, as the proportion of funds allocated to space programmes rose from 23 to 56.1%.

3.3.2 Public funds

The dominant role of the government in the marshalling of funds for aerospace R&D is revealed by the very high proportion of public funds in total expenditure (ranging from 83 to 95%) in the EEC, the United Kingdom and the United States over the whole period under review.

This consistently high percentage of total expenditure on aerosapce R&D in all three groupings is due to the very special manner in which the government intervenes in this branch of scientific and technical research. In other branches, the government usually provides backing in order to advance scientific knowledge, whether or not as part of a deliberate scientific policy; in the aerospace branch, the government is mainly concerned as a user.

The government therefore looks upon the provision of funds as an instrument and a means of stimulating the necessary process of research and production within the existing or developing structure of the industry and within the administration. The results of such research are used mainly for military purposes and to help to keep the government in the forefront of technological progress.

These points explain the concentration of public funds on military and space programmes and the relatively smaller contribution to the financing of civil aircraft programmes.

Consideration of the figures for expenditure on civil aircraft programmes in the EEC, the United Kingdom and the United States show that, both as a percentage and in absolute figures, the amount of public money spent on such programmes is inversely proportionate to the size and capacity of the aerospace industry and to the number and extent of the projects carried out.

FIG. 5 Public and Private R&D Funds for Civil Aircraft Programmes
(Total 1960-1967)

	Public funds		Private funds		Total
	$ millions	%	$ millions	%	$ millions
EEC	477	58.2	343	41.8	820
United Kingdom	428	45.6	510	54.4	938
United States	335	0.7	4,294	92.8	4,629

In the three cases, taken in order, the percentage of total public funds allocated to civil aircraft programmes was 12.7, 10.3 and 0.6% respectively.

These figures show that in the EEC countries and the United Kingdom, the government had to provide substantial support, chiefly because European firms are generally not big enough to finance even modest civil aircraft programmes out of their own resources.

In the United States, however, government intervention has been limited to the last few years and concerned solely with the supersonic aircraft programme.

FIG. 6

Breakdown of Public Funds for Aerospace R&D by Programmes
(Total 1960-67)

Programmes	EEC		United Kingdom		United States	
	$ millions	%	$ millions	%	$ millions	%
Aircraft programmes	3,149	83.4	3,927	94.5	26,465	46.8
- military	2,672	70.7	3,499	84.2	26,130	46.2
- civil	477	12.7	428	10.3	335	0.6
Space programmes	628	16.6	230	5.4	30,061	53.2
TOTAL	3,777	100.0	4,157	100.0	56,526	100.0

The government contribution to R&D assumes special significance and different forms according to the programme concerned, e.g.:

- for military programmes, it takes the form of R&D contracts between the government and aerospace undertakings;

- in the case of space programmes, funds are provided either directly through government contracts with aerospace firms (national programmes) or directly through contracts placed with aerospace firms by international organizations (international programmes);
- in the case of civil programmes, the government provides all or part of the funds required by aerospace firms, in the form of either a loan or an outright grant.

3.3.3 Private funds

The funds allocated to R&D by aerospace firms are a very small proportion (7-11%) of the overall figure. They are devoted almost exclusively to civil aircraft programmes, with or without government backing.

FIG. 7 Private Funds for Aerospace R&D (total 1960-67)

Country	$ millions	% of total funds for aerospace R&D
EEC	368	8,9
United Kingdom	510	10.9
United States	4,294	7.1

Referring back to our earlier comments on public funds for civil aircraft programmes, it will be seen that, in the United States, the great majority of R&D work on such programmes is financed by private firms. Between 1960 and 1967, aerospace companies in the EEC and in the United Kingdom spent respectively 8.6% and 11.8% of the sums spent by American firms on civil programmes.

These figures show that the American aerospace industry now has a very high capacity to initiate advanced R&D programmes and to finance them out of its own resources; the sole exception is the SST programme, for which all the R&D is government financed.

The amount of money required to carry out this programme is not perhaps sufficient to explain such substantial government support for civil R&D.

The aim of this programme is to help in launching the new generation of supersonic civil aircraft which, from the seventies onward, will be carrying a large part of international traffic at higher operating capacity.
The European (France and the United Kingdom) and Soviet aerospace industries had already started work on a supersonic civil aircraft at a time when the United States industry did not perhaps feel that all the conditions for building such an aircraft on its own initiative were fulfilled, particularly as regards guaranteed outlets for production on an economic scale. Hence the reason for the seeking and granting of government support for this programme.

One special feature of the civil R&D work of American aerospace firms, which is rarely found in Europe but is unquestionably an essential factor in their success, is the fact that they allocate substantial R&D funds to marketing in order to guarantee economic production flows and thus a corresponding return on R&D investment.

3.4 Specialist Trends in the R&D Industry; Progress and Results; Collaboration between Branches

Over the last ten years particular trends have developed in the R&D work of government agencies and private firms, in line with the varying scale and features of the aerospace sector.

To clarify the situation in the EEC, it may be helpful to summarize the main lines taken in the member countries and then to make a comparison with the position in the United Kingdom.

West Germany

The main features of research and development activity are:

- concentration of resources by firms and research establishments on vertical flight and short take-off techniques (V/STOL), which appear to be one of the major lines of development in aeronautics over the next few years;
- the definition of military research programmes undertaken by firms to meet the requirements of the German Air Force after 1975.

The latter policy, initiated in 1960, is still continuing; in 1967, a working group[1] was formed, under a controlling authority[2], to work on the "Mack plan". This plan, which

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[1] Comprising the five main firms making airframes: Bölkow, Dornier, EWR, HFB and VFW.

[2] Including representatives of the Ministry of Defence.

was included in the military budget for 1967 under the heading "Development and testing of defence techniques", provides for the following:

- preliminary study of the V/STOL technique, including the problem of propulsion;
- study of structures for future aircraft;
- control, guidance and flying systems for future aircraft;
- basic studies for the preparation of aircraft projects.

In addition to these military aircraft programmes, firms have designed and built short/medium range passenger and cargo aircraft, such as the HFB 320 and the VFW 614, with financial aid from the Ministry of Economics[1] and technical support from research centres.

In the space sector, participation in the work of international organizations has been accompanied by the launching of bilateral programmes (Symphonie) and a national programme.

In some cases, international collaboration has been decisive for the initiation of research programmes, at first military (1959-60) but dealing also with the civil and space aspects in later years.

All programmes have involved cooperation either between national firms or between the latter and research centres. The latter's contribution mainly takes the form of providing information and scientific material and of carrying out tests.

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[1] Up to 60% of total R&D costs.

France

After a period marked by intense R&D activity, not always leading on to industrial production, and by the acquisition of licences, aerospace R&D has been characterized over the last ten years by the concentration of resources on specific sectors and programmes.

In the field of advanced techniques, the main emphasis has been on variable-geometry and VTOL aircraft; in this respect, the results achieved and the value of the techniques used is confirmed by the cooperation and technical assistance agreement concluded by Dassault with the American firm LTV for the variable-geometry aircraft and by the licence granted to McDonnell Douglas (USA) for the Breguet 941 (VTOL).

A substantial part of aeronautical research has been directed to the production of supersonic military aircraft; despite the amount of activity, long-range subsonic passenger and cargo aircraft have not been studied and developed.

Research on long-range aircraft has been confined to the supersonic field, on the basis of international cooperation (Concorde).

Lastly, research begun during the fifties on military and civil helicopters has been stepped up.
Ultimately, the abandonment of an overall approach covering all types of aircraft, included in a large number of programmes, has led aeronautical R&D to concentrate its resources predominantly on certain basic programmes (e.g., Caravelle and Mirage) and to produce successive versions.

In the missiles field, the main resources of R&D have been directed to the study of short-range tactical missiles; no programmes have been started for medium/long-range tactical missiles, which the French government has purchased direct from the USA[1]. Other research programmes include those concerned with ballistic missiles, as part of the national policy of creating a strategic nuclear force, and space activities, on the basis of national and international programmes.

Over the last few years, international cooperation agreements have been steadily increasing in importance, both in the space sector proper and in all other aerospace activities.
The majority of R&D has been handled by private firms (except for the ballistic missile programmes); at the same time, the government's contribution to aerospace activities has in many respects been substantial and decisive.
The government has both drawn up and financed most of the programmes and has both extended and improved R&D organization.

By setting up laboratories and test centres, the state has concentrated a large proportion of major R&D equipment in the hands of the government. The costly investments involved have been financed by the government, who have thus laid the foundations for closer collaboration with private firms and for supervising their work more effectively.

Collaboration between the two sides has been further strengthened by the launching of joint international programmes and even more of ballistic missile programmes, for which the government takes almost equal responsibility with private firms for the R&D involved.

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[1] Honest John, Nike, Tartar; the Hawk missile is an exception and is made under licence as part of a NATO programme.

This cooperation between government departments and private firms in undertaking R&D programmes is based, however, on fairly clearly defined specialization; the government defines and coordinates, undertakes R&D work and operates research, test and evaluation centres; private firms, on the other hand, are mainly concerned with the implementation of programmes started by the government and to a lesser extent with projects of private origin.

Belgium

The predominantly military character of Belgian aircraft production is reflected in firms' R&D work; the only international project with which they have been concerned is the Breguet Atlantic programme.

Firms do, however, undertake a limited amount of research on specific matters, almost always in collaboration with the universities.
Both private firms and university laboratories take part in space activities.

Italy

Over the last ten years, Italian aerospace firms have been striving continuously to reach the required technological level. They have pursued this aim by producing under licence, sub-contracting for foreign firms and engaging in research on their own account.

This research has been directed towards traditional programmes in the field of light aircraft, particularly military types, because of the outlets available on the home market. The type of research programme has been influenced by the structure and financial and technical resources of firms and by the amount of money provided by the government.

However, despite the existence of a number of factors unfavourable to research work, the leading firms have carried through extremely successful programmes for airframes, including the G 91, P 148 D and MB 326, for which production licences have been granted to foreign firms.

Subsequently, more favourable conditions for research were created by the improvement of technical knowledge, through production under licence and technical cooperation agreements, by the availability of more funds and by the increase in scale of production[1]. Helicopters are a typical example; following production in quite large numbers under licence and a series of technical cooperation agreements, national R&D programmes were initiated in 1960 (A 101, A 106 and most recently A 109).

Lately, attempts have been made to launch or take part in civil aircraft programmes (AE 160, still in the project stage, and participation in the French "Mercure" programme) which had been virtually ignored previously.

Lastly, as the government has increased its participation in research programmes (e.g., G 222), joint international programmes have also been launched (VAK 191 and MRCA 75). Participation by firms in the ELDO and ESRO space programmes is a further important element in raising their standards.

Relations between government departments and private firms are concerned with the orientation and partial definition of research programmes for military aircraft.
In addition to being concerned with basic and applied research (civil at universities and centres, military at Ministry of Defence laboratories), the government is principally engaged

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[1] In conjunction with the high level of production (particularly under licence) from 1961 to 1965.

in definition and implementation of the San Marco national space programme.

Netherlands

The Netherlands aerospace industry has always tried to maintain the continuity of R&D work, through a succession of projects under civil and military programmes, including the F 27, Breguet Atlantic, F 28, VFW 614 and MRCA 75, in that order.

The size of the industry and the level of R&D costs have not, however, allowed simultaneous work on several programmes or the launching of a national programme, as happened in the fifties with the F 27 aircraft.

Since 1960, therefore, Fokker has continued to define civil aircraft programmes (F 28), but has brought in foreign firms to help; at the same time, it has increased its own collaboration by taking part in programmes defined in other countries (VFW 614).

As regards military production, Fokker has only supplied the home market with aircraft constructed under licence, with the exception of the military version of the F 27 programme; military research has, however, been undertaken through participation in joint international programmes.

The government collaborates with the industry in R&D work by the scrutiny of programmes submitted by the industry for the allocation of funds, by supplying technical and scientific advice and by performing tests at the NLR centre.

United Kingdom

Over the last ten years, a great deal of R&D work has been planned and carried out autonomously[1] under a policy of intervening in all sectors and making all types of products on the basis of national programmes and without technical or financial assistance from abroad.

Except for the purchase of Polaris missiles from the USA (1962), the British government has only purchased military items from abroad since 1965.

However, this material developed abroad was partly reproduced in the United Kingdom, with modifications and adaptations to meet national requirements (Phantom F 4, C 130 Hercules). This policy of engaging in a large number of problems called for substantial technical and financial resources, and probably also led to a dispersal of resources. This is perhaps one of the main reasons for the delay in implementing programmes, particularly as compared with similar programmes elsewhere. This applies to both the Lightning (military) and the Trident (civil) which were started before the corresponding American projects (F 100 Sabre and B 727), but were completed later.

Many civilian and military R&D projects were not completed because of government cancellations. In the specific case of missiles, no further strategic missile programmes have been started since the Blue Streak was cancelled (1960). Over the last ten years, total expenditure on cancelled projects is estimated at around $1,000 million[2].

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[1] Except for the purchase of licences for helicopters and a number of engine programmes.

[2] Amounting to 28% of all government expenditure on aerospace R&D in the industry.

Military aircraft projects have been reduced[1] through cancellations but this has been partly offset by civil and commercial aircraft programmes.
As government programmes have slowed down, private firms have taken up and expanded research and development work in both the civil and commercial branches.

These programmes have been carried through with financial and technical assistance from the authorities but without cooperation at any level between national firms.

On the other hand, international collaboration on civil and military projects has become increasingly important over the last few years.

Within this wide range of R&D activities, the government not only defines, finances and supervises the execution of programmes; it also undertakes a large amount of R&D work through aerospace research centres (establishments) under the control of the Ministry of Technology.
It has been government policy to concentrate basic and applied research more and more in its own centres.
At the same time, these establishments have major test and evaluation apparatus and equipment and provide advisory services for private firms.

Aerospace firms are mainly engaged on development (construction of prototypes), principally in implementation of government R&D projects.
Lastly, the fact that most joint international projects stem

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[1] Consequently, fewer types of military aircraft have been available for export.

from intergovernmental agreements further strengthens the links between government departments and private firms in aerospace R&D activities as a whole.

4. THE COST OF R&D

4.1 General

Having defined, in terms of public and private funds, the extent of aerospace R&D in the EEC countries as a whole, in the United Kingdom and in the United States, we shall now consider the relative importance of the public and private sectors in the execution of R&D, and hence the cost of each.

In addition to being the main and controlling source of funds for aerospace research, the government also plays an appreciable part in the actual process of R&D.
For the EEC countries as a whole, the importance of this role increased from 1960 to 1967 (with a cost percentage of 20.0 - 37.6% and a peak of 40.9% in 1964); the average for the period was 34.7%. The figures for France and Germany were 38.2 and 24.1% respectively.

FIG. 8 Expenditure on Aerospace R&D by Sectors (total 1960-67)

Country	Government sector		Private sector		TOTAL	
	$ millions	%	$ millions	%	$ millions	%
France	1,162	38.2	1,878	61.8	3,040	100.0
West Germany	210	24.1	660	75.9	870	100.0
EEC	1,437	34.7	2,708	65.3	4,145	100.0
United Kingdom	1,366	29.3	3,301	70.7	4,667	100.0
United States	18,712	30.8	42,108	69.2	60,820	100.0

The position is very much the same in the United Kingdom (where the figure varies from 23.0 to 35.7%) and in the United States (with figures declining from 36.0 to 27.4%).

4.2 Private Firms

Breakdown of R&D expenditure by programmes

Over the whole period 1960-67, 58.5% of the sums spent by the EEC aerospace industries on R&D were devoted to military projects, with a drop from 79.5% at the start of the period to 54.7% at the end (47.2% in 1966).

The position was the same in the United Kingdom; the larger part of expenditure went to military programmes (66.2%), but there was a drop from 82 to 53% over the period. The explanation of this trend lies in the launching of space programmes (to a greater extent by the EEC) and the growing weight of civil projects. The figure for the latter is about 30% for the EEC and the United Kingdom, which is much higher than the American percentage (11.7%).

It should be borne in mind, however, that more than 40% of EEC expenditure on civil projects and around 38% of British expenditure under this heading relate to the Concorde programme, while the United States figure for such projects includes the SST programme, which accounts for about 10% of the total for the period.

FIG. 9 Breakdown of R&D in the Aerospace Industry by Programmes (total 1960-67)

Country	Military $ millions	%	Space $ milliors	%	Civil $ millions	%	TOTAL $ millions	%
EEC	1,586	58.5	302	11.1	820	30.3	2,708	100.0
United Kingdom	2,186	66.2	177	5.4	938	28.4	3,301	100.0
United States	15,271	38.5	19,733	49.8	4,629	11.7	39,633	100.0

Taking total United States expenditure on each type of programme over the period to be 100, the corresponding figures for R&D spending in the EEC and the United Kingdom are as follows:

FIG. 10

(Percentages)

Country	TOTAL	Military	Space	Civil: Including expenditure on the supersonic aircraft	Civil: Excluding expenditure on the supersonic aircraft
EEC	6.9	10.3	1.5	17.7	11.2
United Kingdom	8.4	14.3	0.9	20.3	14.1

The gap between the United States, on the one hand, and the EEC and the United Kingdom on the other is therefore widest in the case of space programmes.

Breakdown of expenditure by sources of finance

Again over the whole period 1960-67, the government has been the predominant source of funds for industrial R&D in the EEC, the United Kingdom and the United States, with somewhat similar percentages in all cases.

FIG. 11 R&D Expenditure of the Aerospace Industry by Sources of Finance (total 1960-67)

Country	Public funds		Private funds		TOTAL	
	$millions	%	$millions	%	$millions	%
EEC	2,336	86.3	372	13.7	2,708	100.0
United Kingdom	2,791	84.6	510	15.4	3,301	100.0
United States	35,339	89.2	4,294	10.8	39,633	100.0

The sums spent by the industry on R&D represent almost the same percentage of total turnover during the period in the EEC, the United Kingdom and the United States. This is due to the fact that the percentages of EEC and British production, as compared with the United States, are almost the same as the corresponding percentages for R&D.

	Value of production	R&D expenditure
EEC	7.0%	6.9%
United Kingdom	8.1%	8.4%

FIG. 12 R&D Expenditure of the Aerospace Industry as a Percentage of Value of Output (total 1960-67)

Country	Value of aerospace output	Total R&D expenditure of the aerospace industry		R&D financed out of firms' own resources	
		Value	% of value of output	Value	% of value of output
EEC	9,770	2,708	27.7	372	3.8
United Kingdom	11,220	3,301	29.4	510	4.5
United States	143,887	39,633	27.4	4,294	3.0

These figures show that the percentage of R&D financed out of firms' own resources in relation to the value of output is slightly higher in the EEC and the United Kingdom than in the United States.

This can be attributed to the fact that, over the period concerned, civil programmes, to which virtually all firms' own resources are devoted, accounted for a smaller proportion of R&D expenditure than in the EEC and the United Kingdom.

FIG. 13

Percentage Breakdown of R&D Expenditure by Type of Research (1964)

<table>
<tr><th></th><th colspan="3">France</th><th colspan="3">United Kingdom</th><th colspan="3">United States</th></tr>
<tr><th></th><th>Total R&D</th><th>Manuf. ind. R&D</th><th>Aero-space ind. R&D</th><th>Total R&D</th><th>Manuf. ind. R&D</th><th>Aero-space ind. R&D</th><th>Total R&D</th><th>Manuf. ind. R&D</th><th>Aero-space ind. R&D</th></tr>
<tr><td>Basic research</td><td>17.3</td><td rowspan="2">41.6</td><td rowspan="2">27.0</td><td>12.5</td><td>4.0</td><td>1.0</td><td>12.4</td><td>4.2</td><td>1.2</td></tr>
<tr><td>Applied research</td><td>33.9</td><td>26.1</td><td>22.0</td><td>7.0</td><td>22.1</td><td>19.2</td><td>15.5</td></tr>
<tr><td>Development</td><td>48.8</td><td>58.4</td><td>73.0</td><td>61.4</td><td>74.0</td><td>92.0</td><td>65.5</td><td>76.6</td><td>83.3</td></tr>
<tr><td>TOTAL</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td></tr>
</table>

Source: OECD

Breakdown of R&D expenditure by type of research

In the EEC countries, the United Kingdom and the United States, "development", i.e., the construction of prototypes, is the main item in the R&D activities of the aerospace industry.

Figures compiled by the OECD for 1964 (see Fig. 13) show that for France, the United Kingdom and the United States, "development" is the main item both in total R&D expenditure and in such expenditure by manufacturing industry, but does not dominate as completely as in the aerospace industry.

Breakdown of current R&D expenditure

A further comparison between France and the United Kingdom and the United States shows that the biggest item in the current R&D expenditure of the aerospace industry is the cost of labour.

FIG. 14 Percentage Breakdown of Current R&D Expenditure (1965)

	Wages and salaries	Materials and other supplies	Other costs (overheads)	Total current expenditure
France	54,4	24,8	20.8	100,0
United Kingdom	40.1	29.5	30.4	100.0
United States	44.0	26.0	30.0	100.0

The higher percentage for wages and salaries in France, as compared with the United Kingdom and the United States, is no doubt partly due to the relatively smaller spending on development in that country; a higher proportion of applied research means greater expenditure on personnel and less on materials.

Average cost of R&D per research worker

The average cost per research worker arrived at by dividing firms' total R&D costs by the number of scientists and engineers is as follows[1]:

Average R&D costs per research worker (1966)

	$
France	73,000
United Kingdom	113,000
United States	55,600

Allowing for the possibility that research staff are classified differently in the three countries concerned, the lower average cost in the United States is linked with the relatively bigger number of scientists and engineers, as is also shown by this group's larger share in the total labour force of manufacturing industry, as compared with France and the United Kingdom.

R&D scientists and engineers in the total labour force of the aerospace industry (%)

France	5
United Kingdom	1.7
United States	8.5

[1] R&D staff can be considered as a research team (one researcher, scientist or engineer, and assistants). In French aerospace firms, for example, an average research team consists of one researcher (scientist or engineer), 1.7 technicians, 1.5 operatives and 0.5 administrative staff.

The figure given therefore also represents average cost per research team.

5. R&D PERSONNEL

In 1967, about 50,000 persons (scientists and engineers, technicians and operatives) were employed in aerospace R&D, both in the EEC and in the United Kingdom, with one third in the public sector and two-thirds in the private sector.

For the United States, the only figures available are those for firms' R&D scientists and engineers, supplied by the National Science Foundation and those for technicians estimated by the OECD for 1964, although these can also be taken as correct for 1967 in view of the steady number of scientists and engineers[1].

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[1] United States - R&D scientists and engineers for industry as a whole and for the aerospace industry

FIG. 15

Year	Industry as a whole (A)	Aerospace industry (B)	(B) / (A)
1957	229,400	58,700	25.6
1958	243,800	58,600	24.0
1959	268,400	65,900	24.6
1960	292,400	72,400	24.8
1961	312,100	78,500	25.2
1962	312,000	79,400	25.4
1963	327,300	90,700	27.7
1964	340,200	99,400	29.2
1965	343,600	97,400	28.3
1966	353,200	97,200	27.5
1967	371,900	98,700	26.5

Source : NATIONAL SCIENCE FOUNDATION

Assuming that the number of R&D operatives in the United States is equal to the number of technicians, the percentage of R&D personnel in the total labour force of the aerospace industry is as follows for the three groupings.

R&D personnel as a percentage of the total labour force of the aerospace industry (1967)

EEC	22.8%
United Kingdom	12.5%
United States	13.7%

A brief survey of the situation in France, West Germany and the United Kingdom may help to give an idea of the trend and make-up of R&D personnel.

FIG. 16

Aerospace R&D Personnel by Sector and Grade (1967)

Country	Public sector				Private sector				Total			
	Scientists and engineers	Technicians	Operatives	Total	Scientists and engineers	Technicians	Operatives	Total	Scientists and engineers	Technicians	Operatives	Total
France	1,540	2,160	6,490	10,190	5,060	8,530	7,540	21,130	6,600	10,690	14,030	31,320
West Germany	868	850	757	2,475	2,950	5,000	4,550	12,500	3,818	5,850	5,307	14,975
EEC	-	-	-	13,945	-	-	-	37,450	-	-	-	51,225
United Kingdom	2,800	4,100	10,180	17,080	4,200	13,500	14,000	31,700	7,000	17,600	24,180	48,780
United States	-	-	-		98,700	31,300			-	-	-	-

France

General

In 1966, R&D personnel in the aerospace industry totalled 31,320[1], representing over 18% of all R&D staff (about 170,000 in all).

The figures for government research establishments and aircraft and space firms were 10,190 (32.5%) and 32,130 (67.5%) respectively (see Fig. 17).

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[1] Estimate arrived at by adding numbers employed on R&D in the public and private sectors, excluding university research staff, whose numbers are not known but are not thought to be very high.

As no figures for government R&D staff were available before 1966, we were unable to compile a historical series for total R&D staff in the aerospace industry.

France

FIG. 17

R&D Personnel in the Aerospace Industry by Sector and Grades - Numbers and Percentages

(1966)

Grade	Government (laboratories and research establishments) Number	Private firms (nationalized and private) Number	TOTAL Number	Government (laboratories and research establishments) %	Private firms (nationalized and private) %	TOTAL %
Scientists and engineers	1,540	5,060	6,600	23.3	76.7	100.0
Technicians	2,160	8,530	10,690	20.2	79.8	100.0
Operatives	6,490	7,540	14,030	46.3	53.7	100.0
TOTAL[1]	10,190	21,130	31,320	32.5	67.5	100.0

[1] Not including administrative staff (about 3,190 for the government sector and 2,510 for the private sector)

Source: Compiled by SORIS from:

- USIAS, L'industrie aéronautique et spatiale, 1967
- DGRST, Les moyens consacrés à la recherche et au développement dans l'industrie française en 1966, Paris, 1968
- Ministry of Industry, La recherche industrielle en France, 1966-67, Paris, 1968

Government

Government staff concerned with aerospace R&D include the personnel of research and test laboratories and establishments, as listed in Fig. 18.

Out of the total of 10,870, more than 90% are employed at the research and test laboratories and establishments of the Ministry of the Armed Forces, where some work is also done on civil aircraft projects.
Some 50% of the total may be estimated as engaged on missiles and space work.

Excluding administrative staff, the R&D potential of government departments, expressed in terms of labour force is 48% of the total numbers employed by private operators (10,190 against 21,130).

As regards grades of staff, government laboratories and establishments as a whole employ a lower percentage of scientists and engineers (15.1%) than do private firms (23.9%).

This lower percentage is due to the fact that at test centres, which employ about 70% of the total, scientists and engineers account for only 7.8% of the payroll.

Taking only laboratories and establishments exclusively or mainly engaged in research (ONERA, LRBA, ISL, CNET, CNES), the percentage of scientists and engineers rises to 27.7%.

FIG. 18

Government - Aerospace R&D Staff at Laboratories and Establishments

(1966)

Research and test laboratories and establishments	TOTAL staff[1]	Of which: scientists and engineers
*CENTRE D'ESSAIS AÉRONAUTIQUES DE TOULOUSE (C E A T)	881	58
*CENTRE D'ESSAIS DES PROPULSEURS (C E P)	1,010	50
*CENTRE D'ESSAIS EN VOL (C E V)	2,750	280
*LABORATOIRE DE RECHERCHES BALISTIQUES ET AÉRODYNAMIQUES (L R B A)	1,000	140
*CENTRE D'ACHÈVEMENT ET D'ESSAIS DES PROPULSEURS ET ENGINS (C A E P E)	400	40[2]
*CENTRE D'ESSAIS DES LANDES (C E L)	2,000	120[2]
*OFFICE NATIONAL D'ETUDES ET DES RECHERCHES AÉROSPATIALES (O N E R A.)	1,800	450
*INSTITUT FRANCO-ALLEMAND DE RECHERCHES DE SAINT-LOUIS (I S L)	225[3]	58[3]
*CENTRE NATIONAL D'ETUDES DES TELECOMMUNICATIONS (C N E T)	294[4]	61[4]
*CENTRE NATIONAL D'ETUDES SPATIALES (C N E S)	510	283
TOTAL	10,670	1,540

1 Including administrative staff.

2 Estimate.

3 French staff are estimated at half the total (450); the same applies to scientists and engineers.

4 Estimate, taking aerospace R&D staff to be 10% of the total.

For government research and test establishments as a whole, there are 1.4 technicians and 4.2 operatives to each scientist or engineer.

In aerospace firms, however, the average research team consists of:

1 scientist or engineer
1.7 technicians
1.5 operatives

Private firms

Staff with private firms are defined as R&D personnel employed by firms actually working in the aircraft and space sectors (airframes, engines, missiles and space) and therefore exclude firms engaged in making items of equipment.

From 1957 to 1967, R&D staff increased by about 850 (2.1% overall), from 20,657 to 25,513.

This period was, however, divided into two distinct phases:

- first, from 1957 to 1960 staff numbers fell (from 20,657 to 13,685), with an average annual drop of 12.8%;
- secondly, from 1960 to 1967, numbers increased each year to reach 25,513 by 1967 (rise of 10.3% a year).

This trend is the result of various factors affecting the two categories of R&D staff, namely, those employed on research and those engaged on the construction of prototypes.

Taking the same two phases of the period under review, numbers working on research remained virtually unchanged up to 1960 (drop of 160), and then rose at an average rate of 10.9% a year so that the 1967 figure was almost double that of 1957 (13,200 as against 7,080), as the missile and space programme got under way and expanded.

On the other hand, numbers working on the construction of prototypes first fell by half from 1957 to 1960 (from 13,577 to 6,765, with an average drop of 20.7% a year); they then rose each year, without, however, regaining the 1957 level (12,313 as compared with 13,577).

After attaining a peak in 1957 (mainly the Caravelle, Mirage, Alouette programmes), work on prototypes declined sharply up to 1960 in absence of new aircraft programmes, other than first version of earlier projects.

A recovery began the same year with the launching of two joint aircraft programmes, Atlantic and Transall, and gained momentum from 1962 to 1964, with the initiation of the Concorde, Jaguar and Martel projects and their associated engine programmes (Olympus and Adour).
It may be estimated that over two-thirds of all personnel are engaged on airframes and missiles.

Moreover, 50-60% of all aerospace R&D staff are concentrated in the three nationalized undertakings (Sud-Aviation, Nord-Aviation and SNECMA).
As for R&D staff, total numbers employed in the aerospace industry fell from 1957 to 1959 and then rose again.

The drop in R&D staff up to 1960 was much steeper, however, and the subsequent recovery much slower than for total numbers employed; the percentage of R&D staff to total numbers employed in fact fell (see Fig. 19)[1] from 30.5% in 1957 to 21.0% in 1960

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[1] Figures for R&D personnel in the equipment branch were not available for the period in question (1957-67); total numbers were therefore considered to be net of staff employed in that branch.
From 1957 to 1960, R&D staff in the equipment branch numbered about 1,700 and accounted for 9% of the total payroll of that branch.

FIG. 19 R&D Staff and Total Numbers Employed in the Aerospace Industry (1957-67)

(excluding equipment branch)[1]

Year	R&D staff[2]			Total numbers employed (B)	(A) as percentage of (B)
	Research	Proto-types	TOTAL (A)		
1957	7,080	13,577	20,657	67,700	30.5
1958	6,720	11,307	18,027	63,300	28.5
1959	6,500	9,037	15,537	61,346	25.3
1960	6,920	6,765	13,685	65,071	21.0
1961	7,100	7,043	14,143	65,650	21.5
1962	8,100	7,321	15,421	67,600	22,8
1963	11,328	7,600	18,928	69,629	27,1
1964	12,378	8,333	20,711	72,600	28.5
1965	12,800	10,254	23,054	74,626	30.8
1966	12,800	10,839	23,639	77,327	30.5
1967	13,200	12,313	25,513	78,098	32.6

1 i.e., engaged on aircraft and space work proper: airframes, engines, missiles and space.

2 including administrative staff.

Sources: USIAS, L'Industrie aéronautique et spatiale, 1960-68
Desseigne, L'Evolution de l'emploi dans l'industrie aero-spatiale, Paris, 1966

and then recovered slowly to the original figure and increased to 32.6% by 1967. This is a high percentage, which reflects the notable strength of R&D resources in the French aerospace industry.

Indeed, the percentage of R&D staff to total payroll was highest in the aerospace industry; in 1965 the figure was 23.8%[1] and this was followed by the electronics industry with 18%, as against a mere 1.6%[2] for manufacturing industry.

This explains why the aerospace industries which employ 1.7% of the total labour force of manufacturing industry had over 25% of the latter's R&D personnel.

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1 Total numbers employed include R&D staff in the equipment branch.

2 R&D personnel as percentage of total numbers employed in the aerospace industry (1965):

$$\frac{23,054}{96,626} = 23.8\%$$

R&D personnel (estimated) as percentage of total numbers employed in manufacturing industry (1965):

$$\frac{90,000}{5,580,000} = 1.6\%$$

West Germany

General

In 1967, R&D staff in the aerospace industry numbered 14,975[1], made up of 2,475 (16.5%) at government research establishments and 12,500 (83.5%) with aerospace firms (see Fig. 20).

In 1964, total R&D staff in aerospace sector (including administrative staff) represented 5.3% of all R&D personnel (about 10,000 out of 187,010).

Government

Government staff engaged on R&D in the aerospace sector comprise the personnel of R&D research establishments (AVA, DFL, DVL) and the German staff of the Franco-German Insitute at Saint-Louis.

Not counting administrative staff, the R&D strength of government agencies is one-fifth of the total number employed by private firms (2,475 as against 12,500).

As regards grade structure, government research establishments employ a higher percentage of scientists and engineers (35%) than do private firms (23.5%).

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1 Estimate, not including administrative staff, arrived at by adding numbers employed at DGF research establishments and the Franco-German Insitute at Saint-Louis to R&D staff at aerospace firms. The estimate does not include research staff at universities or Max Planck Institutes, whose numbers are not known; the figure was 587 in 1959.

West Germany

FIG. 20

R&D Personnel in the Aerospace Industry by Sector and Grade - Numbers and Percentages

(1967)

Grade	Government (research establishments DGF + ISL[2]) Number	Private (aerospace firms) Number	TOTAL Number	Government (research establishments DGF + ISL[2]) %	Private (aerospace firms) %	TOTAL %
Scientists and engineers	868	2,950	3,818	22.7	77.3	100.0
Technicians	850	5,000	5,850	14.5	85.5	100.0
Operatives	757	4,550	5,307	14.2	85.8	100.0
TOTAL[1]	2,475	12,500	14,975	16.5	83.5	100.0

1 Excluding administrative staff (2,907 made up of 427 in the government sector and 1,800 in the private sector).

2 Staff of German nationality are estimated at half the total (450); the same assumption is made for scientists and engineers.

Sources: Compiled by SORIS from: - DGF documents
- BOLI

In government establishments as a whole there is one technician and 0.9 operative to each scientist or engineer.

The average research team at aerospace firms is made up of:

1 scientist or engineer
1.7 technicians
1.5 operatives

Government sector - Aerospace R&D staff by establishments (1967)

Research establishment	Staff[1]
AVA	235
DFL	921
DVL	1,438
DGF[2]	2,677
ISL	225
Total (DGF + ISL)	2,902

Private firms

In 1967, aerospace firms[3] employed a total of 14,300 R&D staff, accounting for 41% of their total payroll. This appears to be a high figure in comparison with other countries; e.g., 32.6% for France and 12.5% for the United Kingdom.

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1 Including administrative staff.

2 Including staff of ZLDI and DGF head offices.

3 Airframes, engines and missiles including space vehicles.

The great strength of R&D in the German aerospace industry is even more apparent when the figure of 41% is compared with the ratio of R&D staff to total numbers employed in manufacturing industry, which works out at 1.6%.

Consequently, aerospace firms, which account for only 0.40% of the total labour force of manufacturing industry, employ a much higher proportion of the total number engaged on research (9% in 1964).

However, several other branches of manufacturing industry employ a higher proportion of R&D staff; in 1964, the list was headed by chemicals and petrochemicals with 33% and electrical engineering, precision engineering and optical engineering with 31%.

The total of 14,300 for aerospace firms has been reached by a steady increase at the rate of 10% a year. The rise was sharper after 1961-62, when work started on civil aircraft projects (BO 105, HFB 320, VFW 614) and on space programmes. Nevertheless, as the following figures show, the majority of research personnel are still employed on military R&D.

Programmes	% employed
Military	71.0
Space	17.0
Civilian	12.0
Total	100.0

Two research firms (EWR and ERNO), with about 2,000 and 1,000 respectively, employ 21% of the research staff, while 38% were concentrated in 1968 in the two biggest manufacturing companies (Messerschmitt-Bölkow and VFW).

United Kingdom

General

Numbers employed in aerospace R&D in 1967 are estimated at 48,780, representing 25% of R&D staffs as a whole (around 200,000).

The breakdown for aerospace R&D staffs - subject to certain reservations[1] - was 17,080 (35%) at government research establishments and 31,700 (65%) with aircraft and space firms (see Fig. 21).

Government

R&D strength of government agencies is defined as the staffs of Mintech aerospace research establishments, excluding university research staff, whose numbers are not known but are not thought to be very great.

Mintech aerospace research establishments have a total strength of 17,000, representing 80% of total numbers employed at Mintech establishments (21,350), excluding administrative staff in both cases.

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[1] With the available material it was not possible to produce figures for aerospace R&D staffs for a period of years. We were only able to work out a figure for 1967 by adding the numbers employed in the government and private sectors. This figure can be taken as reasonably accurate but may be slightly too low because:

- it does not include R&D personnel working on missiles at Ministry of Defence research establishments such as the Royal Armament Research and Development Establishment and the Admiralty Surface Weapons Establishment.
- it does not include researchers working on aerospace problems at universities.

United Kingdom

FIG. 21

R&D Personnel in the Aerospace Industry by Sector and Grade - Numbers and Percentages

(1967)

Grade	Government (research establishments) Number	Private (firms) Number	TOTAL Number	Government (research establishments) %	Private (firms) %	TOTAL %
Scientists and engineers	2,800	4,200	7,000	40.0	60.0	100.0
Technicians	4,100	13,500	17,600	23.3	76.7	100.0
Skilled and unskilled operatives	10,180	14,000	24,180	42.1	57.9	100.0
TOTAL[1]	17,080 (1)	31,700	48,780	35.0	65.0	100.0

[1] Administrative staff (1,600) are excluded from the total to correspond with the figures for private firms.

Source: Compiled by SORIS from Ministry of Technology documents, July/August 1968.

The predominance of military R&D at these establishments is clearly demonstrated by the high percentage (69%) engaged on such work, as can be seen from the table below:

Numbers and percentages of staff engaged on military R&D at Mintech aerospace research establishments, by branches (1967)

Branch	Staff	
	Number	%
Airframes and engines	7,100	60.2
Missiles	3,300	28.0
Space work	1,400	11.8
Total	11,800	100.0

Total R&D staff at aerospace research establishments (as %): 69.1

The R&D potential of government research establishments, as compared with private firms, in terms of numbers employed is just over half (0.54), with a payroll of 17,080 as against 31,700.

However, as regards grade structure, the percentage of scientists and engineers is slightly higher (16.4%) at government establishments than at private firms (13.2%).

Private firms

The aerospace R&D strength of private firms is defined as the numbers employed by firms directly concerned with work on aircraft and space projects (airframes, missiles, engines and space work) to the exclusion of the equipment branch.

In 1967, the engines branch - and one single firm - employed over half (18,500 representing 58%) of all R&D personnel at aerospace firms.

Overall, aerospace firms employ a high percentage of their total labour force on R&D (12.5%), as compared with barely 1.8%[1] over manufacturing industry as a whole.

Between 1959 and 1967 aerospace firms almost doubled their R&D potential in terms of numbers employed, which rose from 17,900 to 31,700, increasing their proportion of the total labour force from 8 to 12.5%.

On the other hand, the percentage of R&D staff in the total labour force of all manufacturing industry was the same in 1967 as in 1959 (1.8%).

This explains why the aerospace industry, which employs only 2.9% of the total labour force of manufacturing industry, accounted, in 1967, for 20.4% of all R&D personnel, as can be seen from the table below.

As regards grade structure, aerospace firms employ the highest number of technicians in relation to qualified researchers on R&D. The ratio of technicians to scientists and engineers is 3:1 in the aerospace industry as against 2:1 for manufacturing industry as a whole and for Mintech research establishments.

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[1] R&D staff as a percentage of the total labour force of the aerospace industry (1967):

$$\frac{31,700}{254,000} \cdot 100 = 12.5\%$$

R&D staff as a percentage of the total labour force of manufacturing industry:

$$\frac{155,520}{8,701,000} \cdot 100 = 1.8\%$$

FIG. 22

R&D Personnel Employed in the Aerospace Industry and all Manufacturing Industry, by Grade
(1967)

Grade	Aerospace industry (A)	Manufacturing industry (B)	(A) as a percentage of (B)
Scientists and engineers	4,200	37,124	12.3
Technicians	13,500	71,631	18.8
Skilled and unskilled operatives	14,000	46,765	29.9
TOTAL	31,700	155,520	20.4

Source: Compiled by SORIS

Lastly, while the percentage cost of staff is lower in the aerospace industry than for manufacturing industry as a whole (respectively 39 and 47% of current costs), the average cost per R&D staff-member is much the same as for the latter, i.e., around \$3,800 per annum against \$4,100.

6. THE RESULTS OF R&D

In the tables on subsequent pages the principal research and development programmes completed since 1955 and now in progress[1] are classified by branches of activity and separately for the EEC countries and the United Kingdom.

These tables clearly show the lines of R&D activity which we have already described for the EEC countries and the United Kingdom.

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[1] In the case of the United Kingdom, cancelled projects are listed in a separate table which shows the corresponding costs.

Briefly, the chief of these are:

- a large part of aircraft research is directed to the development of supersonic military aircraft
- long-range subsonic aircraft have not been designed and developed for civil and commercial transport
- research on long-range passenger aircraft has been confined to supersonic types, on the basis of international collaboration (Concorde)
- work on military and civil helicopter programmes has been stepped up
- in the field of advanced techniques, special attention has been given to swing-wing and V/STOL aircraft
- over the last few years there has been an increase in the importance of programmes undertaken jointly both by EEC countries, and by the latter and the United Kingdom.

A few remarks concerning the main features of each sector and of R&D work in general, in France and the United Kingdom, may also help in understanding the tables which follow.

France

- Airframes

The full-scale production stage has been reached almost completed for many projects.
The main programmes at the research and development stage (1968) for both aircraft and helicopters are all joint international projects[1]; on the other hand, national programmes,

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[1] Concorde, Airbus, SA 340, WG 13, Jaguar.

except for the Mirage (F and G), all relate to smaller civil and commercial aircraft such as business and short-haul types (Mercure, Hirondelle).

- Missiles

  The new generation of tactical missiles were mainly developed under international cooperation agreements and most projects went into full-scale production in 1968.

- Engines

  It will be noted that there are no national projects for medium and high-power turbojet engines.
  On the other hand, a great deal of work has been done on turbines, helicopters and low-power turbojets.
  With a few exceptions, current research programmes are part of international cooperative projects.

To sum up, the main features of French aerospace research over the last ten years, as already described, are as follows:

- the launching of more civil and commercial aircraft projects;
- the concentration of R&D resources on basic projects, through successive developments and versions, which extend production runs and increase chances of recovering the cost of R&D.

United Kingdom

- Airframes

  National projects were still the most numerous over the ten-year period; most of them, with the exception of the BAC 311 and new developments of projects already at the production stage in 1968[1], are now in full-scale production.

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[1] E.G., Trident and BAC 111.

Except for the Nimrod and Harrier projects, the full production run has in many cases been completed.

In 1968, the projects of greatest importance from the standpoint of technical characteristics and R&D costs, which were at the research and development stage, were all joint international projects[1].

- Missiles

A series of tactical missiles developed since 1958 are now mostly in production.
With the exception of the Martel project, which was developed jointly with France, all missile research and development was carried through with national financial and technical resources.

- Engines

There have been a larger number of national projects in this sector, mainly concerned with turbojet engines. Some are now at the development stage while others have reached production.

The main feature has been the subsequent development or new and more powerful versions of each type.
Projects undertaken with foreign firms, started by international cooperation on airframes, have also been developed separately.

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[1] Concorde, Airbus, SA 340, WG 13, Jaguar.

To summarize, the main features of aerospace research in the United Kingdom over the past ten years, as already described elsewhere in this report, are as follows:

- the launching of numerous national projects designed to gain entry to all sectors with all types of aerospace products, other than ballistic missiles (since the relevant project was cancelled in 1960);
- the completion of programmes to a large extent, but conditioned by government intervention, with cancellations having a very substantial effect;
- the concentration of R&D on engines and wider dispersal of resources in the airframe branch;
- the initiation of a growing number of civil and commercial projects;
- the launching of major joint international projects.

EEC Countries

R&D Projects Completed and Under Way
(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft							
AE 160 (short-range, passenger, twin jet)				x	I		Planning
AFVG (swing-wing aircraft)	1965		x			F, UK	Cancelled 1967
Airbus (medium-range, twin jet)	1967			x		F, G	Definition of project
AL 60 (single piston engine, aerial work and light transport)		1961		x	I (development under licence)		In production
AM 3 (short-range tactical support aircraft)		1967	x		I		2nd prototype
Atlantic (sea reconnaissance twin turbo-prop)	1959	1961	x			F, G, NL, B	In production
AVS (V/STOL fighter)	1966		x			G, USA	Project abandoned (1968)
BR 941 (4-turbine STOL transport)	1960	1961	x	x	F		Pre-production
Caravelle (version : I, IA, VIN, VINR, 10R, 11R) Super Caravelle (medium-range twin jet)	1952	1955 '58 IA '59 III '60 VI N '61 VI NR '65 10R '67 11R		x	F		In production
Concorde (four jet, supersonic)	1962			x		F, UK	Construction of prototypes

EEC Countries

R&D Projects Completed and Under Way
(airframes)

Contd.

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft contd.							
DO 28 (twin piston engine, light transport and communications)		1957	x	x	G		In production
DO 28 D Skyservant (twin piston engine, light transport STOL)		1966	x		G		In production
DO 31 (multi-jet, V/STOL, military transport)		1965	x		G		Trials
F 28 (short/medium range, twin-jet transport)	1964	1967		x		NL,G,UK	Production starting
Fan Jet Falcon (executive twin-jet)	1962	1963		x	F		In production
Falcon 70 (10-seater executive aircraft, version of Fan Jet Falcon)	1967			x	F		R&D
G 91 (R/T) (single-jet, single-seater, fighter, ground attack, photo reconnaissance (R), two-seater military trainer (T))			x		I		Programme completed
G 91 Y (twin-jet, tactical support and trainer)		1966	x		I		Pre-production
G 222 (multi-purpose, twin turbo-prop)	1963		x	x	I		Construction of prototype
HFB 320 (twin-jet executive & feeder)		1964	x	x			In production
Hirondelle (twin turbo-prop, short-range communications and transport)				x	F		Construction of prototypes

Contd.

R&D Projects Completed and Under Way
(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft contd.							
Jaguar (supersonic trainer and tactical support aircraft	1965	1968	x			F, UK	Full-scale production started
Larzac SN 600 Diplomate (twin-jet executive and communications)	1967			x	F		Development
MB 326 (7 versions) (jet trainer)	1955	1957	x		I		In production
Mercure (twin-jet, short-range passenger aircraft)	1968			x		F, I	R&D
Mirage III (versions: B, R, E, 5) (single-jet single/two-seater interceptor, assault, photo-reconnaissance, fighter, trainer)		1956 1959 (B) 1961 (E) 1967 (5)	x		F		In production
Mirage IV (twin-jet, two-seater, bomber)		1959	x		F		Production completed
Mirage F1 (single-jet interceptor and ground attack)		1966	x		F		Development
Mirage F2 (single jet, two-seater assault aircraft)		1966	x		F		Development
Mirage G (experimental swing-wing fighter)			x		F		Development
MRCA 75 (multi-purpose fighter)	1968		x			G, I, UK	Definition of project

EEC Countries

contd.

R&D Projects Completed and Under Way
(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft contd.							
NKF (V/STOL fighter)	1968		x		G		R&D
Nord 262 (twin turbo-prop light transport)	1961	1962		x	F		In production
Nord 500 (experimental vertical take-off, single-seated, twin turbine)	1965			x	F		Development
P 166 (B/C) twin piston engine light transport, executive, trainer	1957	1957 1962 1964	x	x	I		In production (versions B and C)
PD 808 (twin-jet light transport, trainer and communications)		1964	x	x	I (under technical agreement with USA)		In production
Rallye-Club, Super Rallye, Rallye Commodore (single piston engine, three/four seater trainer, private, air work)(several versions)	1959			x	F		In production (Rallye Six 260 derived from the Commodore in development)
S 205 (single piston engine, four-seater flying school, private, glider towing, etc.)		1965		x	I		Three versions in production
D 208 (single piston engine, four/five seater, private)		1967		x	I		In production
S 210 (twin piston engine, private and light transport)				x	I		Prototype under construction
SA 202 Bravo (single piston engine trainer)		1967		x		I, Switzerland	Production started

contd.

R&D Projects Completed and Under Way
(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft contd.							
SF 260 (single piston engine, for flying schools, trainer, aerobatics, private)		1964		x	I		In production
Transall C-160 (twin turbo-prop transport)	1959	1963	x			F, G	In production
VAK 191 B (V/STOL tactical fighter and reconnaissance aircraft)	1965		x			I, G	Prototypes under construction
VC 400 (V/STOL transport)	1965		x	x	G		Definition of project
VFW 614 (short-range twin-jet transport)	1963			x		G, NL	Prototype under construction
VJ 101 (supersonic V/STOL aircraft)	1960	1963	x		G		Project abandoned
Helicopters							
A 101 G (single rotor, three engine heavy transport)		1964	x		I		Prototype trials
A 106 (single rotor, single turbine, single-seater, anti-submarine)		1966	x		I		Prototype trials
A 109 C (twin engine, single rotor, transport and multi-purpose)			x	x	I		Planning
Alouette II Artouste and Alouette II Astazou (single rotor, single turbine, five-seater, multi-purpose helicopter)		1955 1961 (Astazou)	x	x	F		In production: Alouette II Astazou

contd.

R&D Projects Completed and Under Way
(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Helicopters continued							
Alouette III (single rotor, single turbine, seven-seater, multi-purpose)		1959	x	x	F		In production
BÖ 105 (light helicopter, turbine engine, fixed rotor)	1962	1967	x	x	G		Full-scale production starting in 1969
DO 132					G		Development
SA 321 Super Frelon (single-rotor three-turbine, transport and other purposes)		1962	x	x	F		In production
SA 330 (single-rotor, twin-turbine, tactical transport)		1965	x		F		In production (since 1967)
SA 340 (single-rotor, single-turbine, multi-purpose)	1967		x			F, UK	Prototype under construction
SH-4 (single-rotor, piston-engine, multi-purpose)	1963	1965	x		I		In production
WG 13 (twin turbine, multi-purpose)	1967		x			F, UK	R&D

United Kingdom

R&D Projects Completed and Under Way

(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Aircraft							
A. 109 Airedale (single piston engine, private)		1961		x	x		Production completed
Airbus (medium-range, twin-jet transport)	1967			x		with F,G	Definition of project
Argosy 650 [series 100, 200] (four turbo-prop engines, long-range transport)		1959-1964	Argosy 660	x	x		Production completed
B 121 PuP [series 100, 150, 180] (single piston engine, flying school and private)	1966	1967- 1968		x	x		In production
B 206 Basset (twin-engine, light transport)		1961-1962 1964	 x	x	x x		In production Production completed
BAC 111 [series 200, 300, 400, 500] (twin-jet, medium/short range transport)		1963		x	x		In production; series 500 at development stage
BAC 311 (twin-jet, medium/short range transport)	1968			x	x		Definition of project
BN. 2 Islander (twin piston engine, light transport)		1965		x	x		In production

United Kingdom

contd. R&D Project Completed and Under Way

(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
Buccaner [series MK 1, MK 2] (twin-yet assault aircraft)		1958-1963	x		x		In production
Concorde (four-jet supersonic transport)	1962			x		with F	Prototype under construction
F 28 (short/medium twin-jet transport)	1963-1964	1967		x		with NL, G	Production started
Gnat Trainer (single-jet, two-seater, fighter trainer)		1959	x		x		Production completed
Herald [series 100, 200, 700] (twin turbo-prop, short-range transport)		1958	400	x	x		In production
HP 137 Jetstream (twin turbo-prop, light transport)		1967	x	x	x		In production; other versions at development stage
H S 125 [series 1, 1A, 1B, 3, 3A]		1962-1967 (3A)		x	x		In production
[Dominie T MK 1] (twin-jet light transport, communications and trainer)		1964	x		x		Production completed
HS 748 [series 1, 2, 2A] (twin turbo-jet, short-range transport)		1961	Andover CC. MK 1 & CC. MK 2	x	x		In production

United Kingdom

contd. **R&D Project Completed and Under Way**

(airframes)

Project	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
HS 801 Nimrod (four-engine, air-sea reconnaissance)		1967	x		x		Production started
Husky [D. 5/160, D. 5/180] (single-piston engine, flying school, air work, private)		1960-1962		x	x		In production
Jaguar (trainer and tactical support)	1965	1968	x			with F	Prototype under construction
Jet Provost [BAC 145, 164, 166, 167] (single jet, trainer and ground attack)		1958- 1965-	x		x		BAC 167 still in production
Lightning [P. 1B, MK 1, MK 2, MK, 3, MK 4, MK 5, MK 6] (twin-jet, supersonic all-weather interceptor)		1957-1959- 1961-1962- 1959-1962 1965	x		x		MK 6 and export versions still in production
P 1127 Harrier (single jet, V/STOL tactical fighter)		1960	x		x		In production
SC.1 (experimental vertical take-off jet aircraft)	1955	1958	x		x		Prototype trials
SC.5/10 Belfast (four-engine turbo-prop, heavy transport)		1964	x		x		Production completed

United Kingdom

contd.

R&D Projects Completed and Unde Way

(airframes)

Projects	Year started	Year first flight	Military	Civil	National R&D	Joint R&D	Present status (1968)
SC 7/10 **Skyvan** (twin turbo-prop light transport)	1959	1963		x	x		In production
Trident [series 1, 1E, 2E, 3, 3B] (three-jet, medium-range transport)		1962-1964 1967		x	x		In production; version 3B at development stage
Vanguard 950 ((four turbo-prop medium-range transport)		1959		x	x		Production completed
VC 10 E Super VC 10 (four-jet, long-range transport)		1962-1964		x	x		Production to be completed during 1969
Helicopters							
SA 340 (single-rotor, single-turbine multi-purpose)	1967		x			with F	Prototype under construction
Scout [Wasp] (single-rotor, single-turbine, multi-purpose)	1957	1958-1960	x	x	x		In production
Wessex [MK 1, MK 2, MK 3, MK 5, MK 31, MK 52, MK 53, MK 60] (single-rotor, single or twin turbine, anti-submarine chaser, ambulance, transport, etc.)	1957 (acq.licenza)	1958-1962- ....-1963- 1958-1962- 1962	x	MK 60	x (developed by Sikorsky)		In production
WG 13 (twin-turbine, multi-purpose)	1967		x			with F	R&D

EEC Countries

R&D Projects Completed and Under Way

(Engines)

Project	Year started	Year first run	Military	Civil	National R&D	Joint R&D	Present status (1968)
Turbo-jet							
Adour	1966	1967	X			F, UK	Development
Atar 9			X		F		Production completed, version 9K
Aubisque		1964		X	F		In production
Marbore VI	1962	1962	X		F		In production
M 45	1964/65		X	X		F, UK	Military: cancelled Civil: at development stage
M 49 Larzac	1967			X	F		Development
Olympus 593	1962	1965		X		F, UK	Pre-production
RB 153	1960	1963	X			G, UK	Programme abandoned
RB 193	1964	1967	X			G, UK	Development
RB 207	1967			X		F, UK	Definition of project
TF 306			X		F		Development
Turbo-prop							
Astazou II C	1961	1962		X	F		In production
Astazou XII		1965		X	F		In production

EEC Countries

contd.

R&D Projects Completed and Under Way

(Engines)

Project	Year started	Year first run	Military	Civil	National R&D	Joint R&D	Present status (1968)
Astazou XIV		1968	X		F		In production
Bastan VIC, VID, VIIA	1957		X	X	F		In production
Turbine engines							
Artouste III	1961	1961	X	X	F		In production
Astazou IIA	1961	1962	X	X	F		In production
Astazou IIN		1967	X		F		Development
MAN 6012		1961	X	X	G		In production
MAN 6022			X	X	G		Production started
Turmo III (several versions; versions D3, M3 and F3 are turbo-props)	1951		X	X	F		In production
T112	1964	1967	X			G,UK	Development

United Kingdom

R&D Projects Completed and Under Way

(Engines)

Project	Year started	Year first run	Military	CIVIL	National R&D	Joint R&D	Present status (1968)
Turbo-jets							
Adour		1967	x			with F	Development
BS 53 Pegasus [& versions]		1959	x		x		In production
Conway [& versions]			x	x	x		In production
Gamma [& versions]				x	x		In production
M 45	1964	1967	x	x		with F	Military: cancelled Civil: development stage
Nimbus		1958	x		x		In production
Coin			x		x		In production
Olympus 593	1962	1965		x		with F	Pre-production
Olympus [MK 201]		1958	x		x		Production completed
[MK 301]		1962	x		x		Production completed
RB 145	1960	1961	x		x		
RB 153	1960	1963	x			with G	Abandoned
RB 162 [& versions]		1962	x		x		60 trial engines built and fitted
RB 168/62	1966	1967	x			with USA	Development
RB 193	1964	1967	x			with USA	Development
RB 207	1967			x		with F, G	Definition of project

United Kingdom

contd.

R&D Projects Completed and Under Way

(Engine)

Project	Year started	Year first run	Military	CIVIL	National R&D	Joint R&D	Present status (1968)
RB 211	1967			x	x		Development
Spey [& versions]	1959	1960		x	x		In production
Spey [& versions]	1960	1961	x		x		In production
Spey Junior	1962			x	x		In production
Thor [& versions]		1957	x		x		In production
Trent	1966			x	x		Development
Viper [& versions]	1966 (Viper 600)		x	x	x		In production
Turbo-props							
Oredon III	1966		x			with F	Cancelled in 1957
Tyne [& versions]	1955	1956	x		x		In production
Turbine engines							
Gazelle [& versions]	1954	1955	x	x	x		In production
Gnome [& versions]			x	x	x (from T58-USA originally produced under licence)		In production; M 1800 version at development stage
T 112			x			with G	Development

EEC Countries — R&D Projects Completed and Under Way

(Missiles)

Project	Year started	National R&D	Joint R&D	Present status (1968)
Tactical missiles				
AS 12 - AS 20 - AS 30 (air-to-surface)		F		In production
BÖ 810 Cobra (anti-tank)		G		In production
Crotale (surface-to-air)	1965	F		Production started
CT 10 - CT 20 (target drone)	1957	F		In production
Entac (wire-guided anti-tank)		F		In production
Harpon (anti-tank)		F		In production
HOT (anti-tank)	1965		F, G	R&D
Kormoran (air-to-surface)			F, G	R&D
Martel (air-to-surface)	1964		F, UK	Production starting end 1968
Masurca II (surface-to-air)	1965	F	F, G	In production
Milan (anti-tank)	1965			Production started
MM - 38 (ship-to-ship)	1968	F		R&D
Pluton (surface-to-surface)	1966	F		R&D

EEC Countries

contd. R&D Projects Completed and Under Way

(Missiles)

Project	Year started	National R&D	Joint R&D	Present status (1968)
R 530 (air-to-air)		F		In production
R 540 - R 550 (air-to-air)		F		R&D
R 20 (reconnaissance)		F		Production starting
Roland (surface-to-air)	1965		F, G	R&D
SS 11 (anti-tank)	1956	F		In production
SS 12 (surface-to-surface)		F		In production
Experimental missiles				
Aigle	1960	F		
Agate	1961	F		
Emeraude	1964	F		
Topaze	1962	F		
Saphir	1965	F		

EEC Countries

R&D Projects Completed and Under Way

Project	Year started	National R&D	Joint R&D	Present status (1968)
Balistic missiles				
SSBS (surface-to-surface)		F		In production
MSBS (ship-to-surface)		F		Development

United Kingdom

R&D Project Completed and Under Way

(Missiles)

Project	Started	National R&D	Joint R&D	Present status (1968)
Tactical missiles				
Bloodhound (surface-to-air)	1958	x		In production
Blowpipe (surface-to-air)		x		Development
Firestreak (air-to-air)		x		In production
Martel (air-to-surface)	1963		with F	In production
Rapier (surface-to-air)	1964	x		In production (since 1967)
Red Top (air-to-air)		x		In production
Seacat (ship-to-air)	1958	x		In production
Sea Dart (ship-to-air)	1962	x		Development
Seaslug (naval)	1962 (in service)	x		In production
Swingfire (anti-tank)	1962	x		In production
Thunderbird (surface-to-air)	1959	x		In production
Tigercat (surface-to-air)		x		In production
Vigilant (anti-tank)	1957-58	x		In production

United Kingdom

Cancelled Aircraft, Missile and Space Projects

(1951-68)

Project	Cancelled	Cost (millions of dollars)
Transport aircraft		
Brabazon (civil)	February 1952	18.1
Princess (civil flying boat)	May 1954	25.5
Vickers VC 1000 (civil and military)	December 1955	11.2
Rotodyne (civil helicopter)	February 1962	38.2
H S 681	February 1965	11.2
TOTAL		104.2
Military aircraft		
Sturgeon (anti-submarine version)	March 1951	1.4
DH 110 (fighter)	May 1952	7.0
Hawker Hunter (new version)	July 1953	0.4
High-speed fighter	February 1955	61.6
High-speed photo-reconnaissance fighter	June 1955	0.8
Swift crescent-winged fighter	December 1955	4.5
Avro 720 (rocket-firing missile interceptor)	September 1955	2.8
Javelin G 50 (thin-winged, all-weather fighter)	June 1956	6.4
Fairey (supersonic fighter)	March 1957	0.4
Avro 730 (supersonic bomber, including engine)	March 1957)	5.7
SR 177 (naval interceptor)	December 1957	9.0
P 1154	February 1965	58.8
T S R 2	February 1965	546.0
A F V G	July 1967	7.0
F 111 K	January 1968	130.0
TOTAL		841.8

United Kingdom

contd.

Cancelled Aircraft, Missile and Space Projects (1951-68)

Project	Cancelled	Cost (Millions of dollars)
Engine		
Nomad	April 1955	14,3
Screamer	March 1956	1.8
Soar	March 1956	3,4
Turmo (civil)	March 1956	0,3
Gyron turbojet	March 1957	9,5
R.B 106	March 1957	0.3
Orion (civil turboprop)	January 1958	13,3
Scorpion (rocket engine)	February 1959	3,5
Spectre (rocket engine)	October 1960	16.1
Super Sprite	October 1960	2,4
TOTAL		64,9
Missiles		
Blue Boar TV guided bomb	June 1954	8,7
Vickers Red Rayner (flying bomb)	September 1954	2.0
Air-sea guided bomb	March 1956	2,5
Red Dean (air-to-air with radar guide)	June 1956	21,0
Long-range surface-to-air guided missile	May 1957	4,2
Heavy Orange William (heavy anti-tank missile)	September 1959	6,7
Blue Steel Mark 2	December 1959	2,3
Bloodhound Mark 3	March 1960	1,7
Blue Streak (ballistic)	April 1960	235,2
Low-flying surface-to-air guide missile	December 1961	2,2
Blue Water medium-range surface-to-surface missile	August 1962	89,9
Skybolt air-to-surface ballistic missile	December 1962	75,6
TOTAL		452,0
Other projects		
Balloon-carried sighting radar	November 1960	3.6
High-definition reconnaissance radar	February 1962	2,0
Lightning III, automatic attack system	March 1965	3,9
P 35 vehicle	October 1966	0,7
TOTAL		10,2
Total cost of cancelled projects (1951-68)		1473,1

Source : MINISTRY OF TECHNOLOGY (Mr Benn), EXTRACTS FROM HANSARD VOL. 751, N 242, 28 July 1967

7. CONCLUSIONS

- Over the period 1960-67, R&D expenditure on aerospace projects in the EEC countries as a whole increased both in absolute value and as a percentage of the gross national product (from 0.10 to 0.28%).

  This growth has put the Community ahead of the United Kingdom as regards the total amount spent on aerospace R&D, but the percentage of the GNP is still lower than the British figure (0.62% in 1967).

  There is still a big gap as compared with the United States but it was narrowed somewhat over the period under review (from and expenditure ratio of 18.6:1 in 1960 to 11.1:1 in 1967). If the comparison is confined to expenditure on civil and miliary aircraft projects, progress has been even greater, with a drop in the ratio from 14.3:1 in 1960 to 6.2:1 in 1967. Within the EEC, the biggest contributor to the growth of aerospace R&D has been in France, which in 1967 devoted 0.64% of the GNP to this activity. Assuming, therefore, that the other EEC countries can devote more money to aerospace R&D and will increase the percentage of the GNP spent on it, there is likely to be a substantial increase in aerospace expenditure.

- In France and Germany, the increase in expenditure has been accompanied by corresponding improvements to the organization of research in both the government and the private sector.
  In France, as in the United Kingdom and the United States, the aeropsace industry has the biggest R&D resources.
  In France, the Ministry of Defence has provided the necessary adminsitrative and executive facilities for military

R&D, in particular, government establishments have been equipped with major test facilities at substantial cost.

Space research, which comes under the Minister for Scientific Research and Atomic and Space Questions, has been coordinated through the Centre National d'Etudes Spatiales (CNES).

In Germany, government research establishments have been reorganized by the merger of the three centres (DVL, DFL, AVA) run by the DGF, whose functions were taken over, in June 1968, by the Deutsche Versuchsanstalt für Luft- und Raumfahrt EV (German aeronautical and space experimental establishment).

The reorganization and concentration of aerospace firms now being carried through in both France and Germany is designed to provide a better structural basis for industrial research.

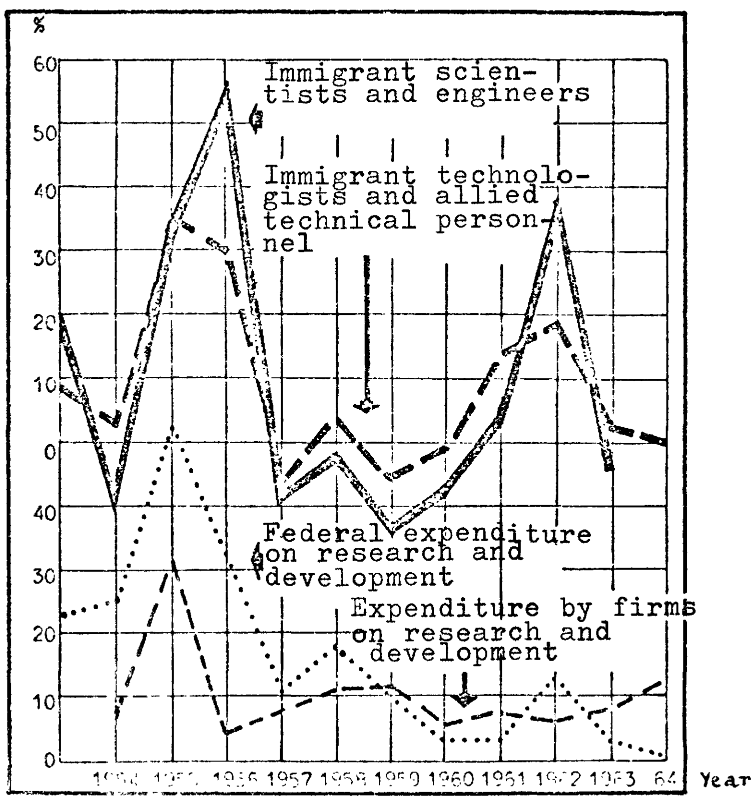
In the United Kingdom, where expenditure on aerospace R&D is a fairly constant proportion (around 0.6%) of the GNP, the government has reorganized the direction of aerospace R&D, which is now concentrated in the Mininstry of Technology. This ministry is also responsible, as a government department, for carrying out military and civil R&D at its own establishments and for supervising and checking industrial R&D projects.

- As regards numbers employed in R&D, the figures for highly qualified personnel show that in 1967 the American aerospace industry had 98,700 scientists and engineers as against 4,200 in the United Kingdom and 5,060 in France.

  Like other branches of the economy, the United States aerospace industry has drawn qualified personnel from other parts of the world.

FIG. 23

United States Annual Percentage Variation of R&D Expenditure and Immigration of Trained Personnel (1954-64)



Source Financial Times, 22 June 1968

In this connection, it is interesting to observe from Fig. 23 that in the United States the percentage annual variation in the number of trained personnel arriving from abroad over the period 1954-64 followed the same trend as the variation of R&D expenditure in general.

The brain drain in the aerospace industry from the EEC countries to the United States cannot be estimated, because no relevant figures are available. For the United Kingdom, which among European countries has certainly been most affected by this movement, on account of the advanced character of its own aerospace industry, there are figures for the years 1962-66. They show that between 1964 and 1966 emigration rose sharply and consisted almost entirely of engineers and technologists. Most of the people concerned went to the United States.

FIG. 24 Emigration of Engineers, Technologists and Scientists from the British Aerospace Industry, 1962-66

	1962	1963	1964	1965	1966
Engineers and technologists	78	66	98	156	294
Scientists	9	14	8	26	16
TOTAL	87	80	106	182	310

Source: Ministry of Technology (from "The Brain Drain", Report of the Working Group on Migration, London 1968)

An inquiry carried out by the SBAC and reported by the source used for Fig. 24 showed that, in 1966, a total of 1,345 trained personnel left the British aerospace industry to take jobs with foreign firms (either abroad or established on British territory).

The total was made up as follows:

By profession		By destination	
Designer/draughtsmen	463	Foreign-owned firms in the UK	397
Engineers	595	North America	727
Scientists	39	Australia	132
Technologists	225	South Africa and Europe	66
Others	23	Other areas	23
Total	1,345	Total	1,345

- Examination of the trend from 1960 to 1967 (in values at constant 1967 prices), both for total expenditure on aerospace R&D and for expenditure by the industry, shows an increase at the following average rate per annum.

Fig. 25. Average Annual Rates of Increase from 1960 to 1967, Calculated at Constant 1967 Prices

	Total expenditure on aerospace R&D	R&D expenditure of the aerospace industry
EEC	20.6%	16.5%
United Kingdom	3.7%	3.4%
United States	14.3%	15.6%

Subject to a number of partial corrections, a forecast of the 1980 levels of total aerospace R&D funds and expenditure by the industry can reasonably be based on the observed trend.

The previous rates of increase are assumed to remain unchanged for the United Kingdom, but it would appear safer to assume a slight drop in both overall expenditure and expenditure by the industry in the EEC countries; the figure is put at 15% (which is the rate observed over the last few years) to allow for the fact that the rates recorded are affected by their having started from a very low figure at the beginning of the period.

A bigger adjustment will be necessary in the case of the United States, to allow for the effect on growth rates of the concentration of massive resources on the space programme and for the growth forecasts made by qualified American sources[1].

An average annual rate of 6% can therefore be assumed, this being in fact the rate observed over the past few years. The 1980 figures for total funds and for R&D expenditure in the industry would then be:

Fig. 26. Forecasts of Total Funds and R&D Expenditure in the Aerospace Industry in 1980

($ millions - Values at constant 1967 prices)

	Total funds for aerospace R&D	R&D expenditure in the aerospace industry
EEC	5,790	3,612
United Kingdom	1,103	737
United States	22,314	14,843

On this assumption, the gap between the EEC countries and the United States would be appreciably narrowed (ratio of expenditure 1:4).

For the EEC countries this forecast target for R&D resources is absolutely vital because of the qualitative implications,

1 See: Stanford Research Institute, Industrial R&D 1980, Report No. 338, December 1967, in which the annual rate of growth of R&D in the American aerospace industry is estimated at 7%, based on values at constant prices.

i.e., projects are likely to be bigger and more demanding, thus adding to the importance of the necessary research findings.

It should therefore be possible to achieve this minimum target for investment in R&D, which is necessary to ensure continuing research and production at a satisfactory level of efficiency as is shown by the aerospace experience of the United States.

TABLES ANNEXED TO CHAPTER 1

The aeronautical and space research and development

List of Tables

Sources of material

As already mentioned in the Introduction (Section 3), the available data concerning R&D finance and expenditure were critically examined and processed, with due allowance for discrepancies arising mainly from differences in methods of compilation both from year to year and from country to country. These data were combined with estimates whenever the latter were considered to be sufficiently reliable.

a. France

1. Statistical studies on research and development by the Délégation Générale à la Recherche Scientifique et Technique (DGRST), as follows:

   a. Recherche et développement dans l'industrie française (for the years 1962 to 1965);

   b. Les moyens consacrés à la recherche et au développement dans l'industrie française en 1966;

   c. La recherche scientifique et technique dans le budget de l'Etat, 1958-67.

2. Annexes to reports on the Finance Bills for the years up to 1967.

3. Annual reports of the USIAS.

For types of programme and source of funds, the sources were used as follows:

- Military aerospace programmes

  Figures shown as "programme authorizations" are taken from source 2 because source 1c gives only the total sum allocated for all military R&D programmes.

  Source 3, which gives details of sales of R&D to the government, is used for public funds allocated to R&D in the aerospace industry.

- Space programmes

  The figures are taken from 1c: "Operating and equipment credits", where the latter are shown as "Payment credits".

- Civil programmes

  Figures for government finance (subsidies) are taken from source 1c.

  The figures for private finance (deduced from 1a and 1b) must be regarded as rather on the low side[1] and cannot be compared from year to year because, as the DGRST warns, they are obtained by direct enquiry using questionnaires.

  It is considered, however, that these figures define, with a sufficient degree of accuracy, the finance available to firms engaged in aerospace R&D.

b. West Germany

In the absence of official statistics[2] concerning the financing and cost of aircraft R&D, a series of figures were estimated for the period 1960-67, on the basis of information relating to military aircraft research programmes, finance provided by aerospace firms and the funds of the DGF and ISL for aircraft. The figures for allocations for space programmes and government contributions to civil aircraft projects are, however, taken from official sources.

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[1] Particularly for the first few years (1960-63).

[2] Furthermore, there are no figures under the heading "Aircraft and missiles" in the OECD survey for 1964.

c. Italy

The figures for finance allocated to aerospace R&D and for expenditure by the various branches are derived from data covering the years 1964-67 and combined with very approximate estimates for the preceding years.

For the period 1964-67, we had access to the first enquiries on R&D conducted by CNR, ISTAT and Confindustria, which are to become a regular and systematic feature. The results of these surveys and the data and information supplied by firms were combined with the figure arrived at for programmes completed or in hand, or adjusted by reference to that figure, in order to estimate the sums allocated to, and spent on, aerospace R&D.

d. Belgium

The estimates of allocations and expenditure must be regarded as too low because we were unable to estimate either government contributions to R&D at university institutes[1] or sums spent on research out of firms' own resources, except in the case of the Breguet Atlantic programme.

e. Netherlands

Sums allocated for space work can be derived from official sources. In the absence of data on aircraft programmes, we estimated the Netherlands contribution to financing:

- the Breguet Atlantic programme
- the F 28 and VFW 614 civil programmes.

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[1] Partly included under "Space programmes".

The figures are slightly too low because they do not include funds allocated to the NLR government research establishment or for aircraft research not related to a specific project.

f. United Kingdom

1. Reports of the Institute of Applied Economic Science, No. 110, February 1961, for the government survey of R&D, 1958/59.

2. Department of Education and Science, Ministry of Technology - Statistics of Science and Technology, London, 1967, for the survey of 1961/62 and 1964/65.

3. Ministry of Aviation - Plowden Report, London, December 1965 and Ministry of Technology - Revised Plowden Report, London, July 1968, for public investment in aerospace R&D in the industry.

4. Various documents supplied by the Ministry of Technology and data on the costs of private programmes.

g. United States

The figures for finance and expenditure are either calculated or estimated on the basis of data from the following sources:

- Aerospace Industries Association of America, Aerospace Facts and Figures, 1968;
- Policy Planning for Aeronautical Research and Development, staff report prepared for the use of the Committee on Aeronautical and Space Sciences, United States Senate, by the Legislative Reference Service, Library of Congress, 1966;
- Report to Congress from the President of the United States, United States Aeronautics and Space Activities, 1967;
- National Science Foundation, Research and Development in Industry, 1966.

Table 1/1

EEC, United Kingdom, United States - Total Expenditure on Aerospace R&D (1960-67)

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Military programmes	163	219	260	283	360	389	469	554
Space programmes	-	5	24	47	88	119	140	205
Civil programmes	32	46	58	78	109	122	193	182
TOTAL	195	270	342	408	557	630	802	941
United Kingdom								
Military programmes	378	422	454	455	445	430	467	448
Space programmes	..	-	-	33	35	38	67	57
Civil programmes	53	121	128	100	93	114	146	183
TOTAL	431	543	582	588	573	582	680	688
United States								
Military programmes	2,424	3,724	3,478	3,080	3,518	3,139	3,114	3,653
Space programmes	831	1,128	1,887	3,211	5,190	5,593	6,357	5,864
Civil programmes	364	392	465	471	515	622	855	945
TOTAL	3,619	5,244	5,830	6,762	9,223	9,354	10,326	10,462

Table 1/2

EEC, United Kingdom, United States - Government Funds for Aeronautical and Space Research (1960-67)

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Military programmes	163	219	260	283	355	383	462	547
Space programmes	-	5	24	47	88	119	140	205
Civil programmes	15	16	21	35	60	79	126	125
TOTAL	178	240	305	365	503	581	728	877
% of total funds for aerospace R&D	91.2	88.9	89.1	89.4	90.3	92.2	90.7	93.1
United Kingdom								
Military programmes	378	422	454	455	445	430	467	448
Space programmes	..	-	-	33	35	38	67	57
Civil programmes	8	31	33	34	34	56	92	140
TOTAL	386	453	487	522	514	524	626	645
% of total funds for aerospace R&D	89.6	83.4	83.7	88.8	89.7	90.0	92.1	93.8
United States								
Military programmes	2,424	3,724	3,478	3,080	3,518	3,139	3,114	3,653
Space programmes	831	1,128	1,887	3,211	5,190	5,593	6,357	5,864
Civil programmes	-	-	11	20	60	-	99	145
TOTAL	3,255	4,852	5,376	6,311	8,768	8,732	9,570	9,662
% of total funds for aerospace R&D	89.9	92.5	92.2	93.3	95.0	93.3	92.7	92.4

Table 1/3

EEC, United Kingdom, United States - Sources of Finance for R&D in the Aerospace Industry (1960-67)

(Percentages)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Government funds	88,5	83,9	84,6	83,8	83,6	88,3	85,4	89,1
Military and space	78,9	75,5	76,0	70,9	65,4	69,5	60,5	67,8
Subsidies	9,6	8,4	8,6	12,9	18,2	18,8	24,9	21,3
Private funds	11,5	16,1	15,4	16,2	16,4	11,7	14,6	10,9
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
United Kingdom								
Government funds	85,2	78,5	77,8	83,6	85,1	86,8	87,6	91,0
Military and space	82,6	71,1	70,1	75,1	76,5	74,0	66,6	61,6
Subsidies	2,6	7,4	7,7	8,5	8,6	12,8	21,0	29,4
Private funds	14,8	21,5	22,2	16,4	14,9	13,2	12,4	9,0
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
United States								
Government funds	84,3	88,3	88,2	90,2	92,8	90,6	89,9	89,5
Military and space	84,3	88,3	87,9	89,7	91,9	90,6	88,6	87,6
Subsidies	-	-	0,3	0,5	0,9	-	1,3	1,9
Private funds	15,7	11,7	11,8	9,8	7,2	9,4	10,1	10,5
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Table 1/4

EEC, United Kingdom, United States - Expenditure on Aerospace R&D by Sectors (1960-67)

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Public sector	39	78	96	136	228	210	296	354
Private sector	156	192	246	272	329	420	506	587
TOTAL	195	270	342	408	557	630	802	941
United Kingdom								
Public sector	126	125	154	186	178	143	243	211
Private sector	305	418	428	402	395	439	437	477
TOTAL	431	543	582	588	573	582	680	688
United States								
Public sector	1,304	1,890	1,984	2,175	2,882	2,758	2,855	2,864
Private sector	2,315	3,354	3,846	4,587	6,341	6,596	7,471	7,598
TOTAL	3,619	5,244	5,830	6,762	9,223	9,354	10,326	10,462

Table 1/5

EEC, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Sources of Finance (1960-67)

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Public funds	138	161	208	228	275	371	432	523
Firms' own resources	18	31	38	44	54	49	74	64
TOTAL	156	192	246	272	329	420	506	587
United Kingdom								
Public funds	260	328	333	336	336	381	383	434
Firms' own resources	45	90	95	66	59	58	54	43
TOTAL	305	418	428	402	395	439	437	477
United States								
Public funds	1,850	2,873	3,212	3,937	5,674	5,550	6,084	6,159
Firms' own resources	364	392	454	451	455	622	756	800
TOTAL	2,214	3,265	3,666	4,388	6,129	6,172	6,840	6,959

Table 1/6

EEC, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Programmes (1960-67)
(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Military programmes	124	144	184	170	171	233	239	321
Space programmes	-	2	4		49	65	74	84
Civil programmes	32	46	58	78	109	122	193	182
TOTAL	156	192	246	272	329	420	506	587
United Kingdom								
Military programmes	252	297	300	275	275	295	239	253
Space programmes	-	-	-	27	27	30	52	41
Civil programmes	53	121	128	100	93	114	146	183
TOTAL	305	418	428	402	395	439	437	477
United States								
Military programmes	1,388	2,194	2,008	1,804	2,137	1,804	1,812	2,124
Space programmes	462	679	1,193	2,113	3,477	3,746	4,173	3,890
Civil programmes	364	392	465	471	515	622	855	945
TOTAL	2,214	3,265	3,666	4,388	6,129	6,172	6,840	6,959

Table 1/7

EEC Countries, United Kingdom, United States - Total Funds for Aerospace R&D (1960-67) - Military Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	2	1	-	-	-	-
France	135	154	194	198	248	287	362	426
Italy	2	2	2	2	15	16	18	19
Netherlands	2	3	3	2	-	-	-	-
West Germany	24	59	59	80	97	86	89	109
TOTAL EEC	163	219	260	283	360	389	469	554
United Kingdom	378	422	454	455	445	430	467	448
United States	2,424	3,724	3,478	3,080	3,518	3,139	3,114	3,653

Table 1/8

EEC Countries, United Kingdom, United States - Total Funds for Aerospace R&D (1960-67) - Space Programmes
(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	1	1	3	4	5	6
France	-	3	17	29	42	59	72	103
Italy	-	2	2	3	10	12	14	19
Netherlands	-	-	1	1	3	4	5	7
West Germany	-	-	3	13	30	40	44	70
TOTAL EEC	-	5	24	47	88	119	140	205
United Kingdom	-	-	-	33	35	38	67	57
United States	831	1,128	1,887	3,211	5,190	5,593	6,357	5,864

Table 1/9

EEC Countries, United Kingdom, United States - Total Funds for Aerospace R&D (1960-67) - Civil Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	-	-	-	-	-	-
France	32	44	53	63	86	100	168	165
Italy	-	-	-	-	-	-	-	-
Netherlands	-	-	-	4	11	12	13	2
West Germany	-	2	5	11	12	10	12	15
TOTAL EEC	32	46	58	78	109	122	193	182
United Kingdom	53	121	128	100	93	114	146	183
United States	364	392	465	471	515	622	855	945

Table 1/10

EEC Countries, United Kingdom, United States - Total Funds for Aerospace R&D (1960-67) - All Programmes
(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	3	2	3	4	5	6
France	167	201	264	290	376	446	602	694
Italy	2	4	4	5	25	28	32	38
Netherlands	2	3	4	7	14	16	18	9
West Germany	24	61	67	104	139	136	145	194
TOTAL EEC	195	270	342	408	557	630	802	941
United Kingdom	431	543	582	588	573	582	680	688
United States	3,619	5,244	5,830	6,762	9,223	9,354	10,326	10,462

Table 1/11

EEC Countries, United Kingdom, United States - Government Funds for Aeronautical and Space Research (1960-67)

Military Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	2	1	-	-	-	-
France	135	154	194	198	248	287	362	426
Italy	2	2	2	2	10	10	11	12
Netherlands	2	3	3	2	-	-	-	-
West Germany	24	59	59	80	97	86	89	109
TOTAL EEC	163	219	260	283	355	383	462	547
United Kingdom	378	422	454	455	445	430	467	448
United States	2,424	3,724	3,478	3,080	3,518	3,139	3,114	3,653

Table 1/12

EEC Countries, United Kingdom, United States - Government Funds for Aeronautical and Space Research (1960-67)
Space Programmes
(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	1	1	3	4	5	6
France	-	3	17	29	42	59	72	103
Italy	-	2	2	3	10	12	14	19
Netherlands	-	-	1	1	3	4	5	7
West Germany	-	-	3	13	30	40	44	70
TOTAL EEC	-	5	24	47	88	119	140	205
United Kingdom	-	-	-	33	35	38	67	57
United States	831	1,128	1,887	3,211	5,190	5,593	6,357	5,864

Table 1/13

EEC Countries, United Kingdom, United States - Government Funds for Aeronautical and Space Research (1960-67) - Civil Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	-	-	-	-	-	-
France	15	16	21	29	50	69	114	115
Italy	-	-	-	-	-	-	-	-
Netherlands	-	-	-	2	5	6	6	1
West Germany	-	-	-	4	5	4	6	9
TOTAL EEC	15	16	21	35	60	79	126	125
United Kingdom	8	31	33	34	34	56	92	140
United States	-	-	11	20	60	-	99	145

Table 1/14

EEC Countries, United Kingdom, United States - Government Funds for Aeronautical and Space Research (1960-67) - All Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	3	2	3	4	5	6
France	150	173	232	256	340	415	548	644
Italy	2	4	4	5	20	22	25	31
Netherlands	2	3	4	5	8	10	11	8
West Germany	24	59	62	97	132	130	139	188
TOTAL EEC	178	240	305	365	503	581	728	877
United Kingdom	386	453	487	522	514	524	626	645
United States	3,255	4,852	5,376	6,311	8,768	8,732	9,570	9,662

Table 1/15

EEC Countries, United Kingdom, United States - Aerospace R&D Expenditure by Sectors (1960-67) - Government Sector

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	-	-	-	-	-	-
France	30	66	80	116	180	163	248	279
Italy	-	-	-	-	14	15	16	20
Netherlands	-	-	-	-	-	-	-	-
West Germany	9	12	16	20	34	32	32	55
TOTAL EEC	39	78	96	136	228	210	296	354
United Kingdom	126	125	154	186	178	143	243	211
United States	1,304	1,890	1,984	2,175	2,882	2,758	2,855	2,864

Table 1/16

EEC Countries, United Kingdom, United States - Aerospace R&D Expenditure by Sectors (1960-67) - Private Sector

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	3	2	3	4	5	6
France	137	135	184	174	196	283	354	415
Italy	2	4	4	5	11	13	16	18
Netherlands	2	3	4	7	14	16	18	9
West Germany	15	49	51	84	105	104	113	139
TOTAL EEC	156	192	246	272	329	420	506	587
United Kingdom	305	418	428	402	395	439	437	477
United States	2,315	3,354	3,846	4,587	6,341	6,594	7,471	7,598

Table 1/17

EEC Countries, United Kingdom, United States - Aerospace R&D Expenditure (1960-67) - All Sectors

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	3	2	3	4	5	6
France	167	201	264	290	376	446	602	694
Italy	2	4	4	5	25	28	32	38
Netherlands	2	3	4	7	14	16	18	9
West Germany	24	61	67	104	139	136	145	194
TOTAL EEC	195	270	342	408	557	630	802	941
United Kingdom	431	543	582	588	573	582	680	688
United States	3,619	5,244	5,830	6,762	9,223	9,354	10,326	10,462

Table 1/18

EEC Countries, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Sources of Finance (1960-67) - Public Funds

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	1	3	2	3	4	5	6
France	120	107	152	140	160	252	300	365
Italy	2	4	4	5	6	7	9	11
Netherlands	1	2	3	4	8	10	11	8
West Germany	15	47	46	77	98	98	107	133
TOTAL EEC	138	161	208	228	275	371	432	523
United Kingdom	260	328	333	336	336	381	383	434
United States	1,850	2,873	3,212	3,937	5,674	5,550	6,084	6,159

Table 1/19

EEC Countries, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Sources of Finance (1960-67) - Firms' Own Resources

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	-	-	-	-	-	-
France	17	28	32	34	36	31	54	50
Italy	-	-	-	-	5	6	7	7
Netherlands	1	1	1	3	6	6	7	1
West Germany	-	2	5	7	7	6	6	6
TOTAL EEC	18	31	38	44	54	49	74	64
United Kingdom	45	90	95	66	59	58	54	43
United States	354	392	454	451	455	622	756	800

Table 1/20

EEC Countries, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Programmes (1960-67) - Military Programmes
(Millions of dollars)

	1960	1951	1962	1963	1964	1965	1966	1967
Belgium	-	1	2	1	-	-	-	-
France	105	91	131	98	83	153	153	215
Italy	2	2	2	2	8	9	11	12
Netherlands	2	3	3	2	-	-	-	-
West Germany	15	47	46	67	80	71	75	94
TOTAL EEC	124	144	184	170	171	233	239	321
United Kingdom	252	297	300	275	275	295	239	253
United States	1,398	2,194	2,008	1,804	2,137	1,804	1,812	2,124

Table 1/21

EEC Countries, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Programmes (1960-67) - Space Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	1	1	3	4	5	6
France	-	-	-	13	27	30	33	35
Italy	-	2	2	3	3	4	5	6
Netherlands	-	-	1	1	3	4	5	7
West Germany	-	-	-	6	13	23	26	30
TOTAL EEC	-	2	4	24	49	65	74	84
United Kingdom	-	-	-	27	27	30	52	41
United States	462	679	1,193	2,113	3,477	3,746	4,173	3,890

Table 1/22

EEC Countries, United Kingdom, United States - R&D Expenditure of the Aerospace Industry by Programmes (1960-67) - Civil Programmes

(Millions of dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
Belgium	-	-	-	-	-	-	-	-
France	32	44	53	63	86	100	168	165
Italy	-	-	-	-	-	-	-	-
Netherlands	-	-	-	4	11	12	13	2
West Germany	-	2	5	11	12	10	12	15
TOTAL EEC	32	46	58	78	109	122	193	182
United Kingdom	53	121	128	100	93	114	146	183
United States	364	392	465	471	515	622	855	945

Table 1/23

EEC - Financing of Aerospace R&D by Source of Funds (1960-67)

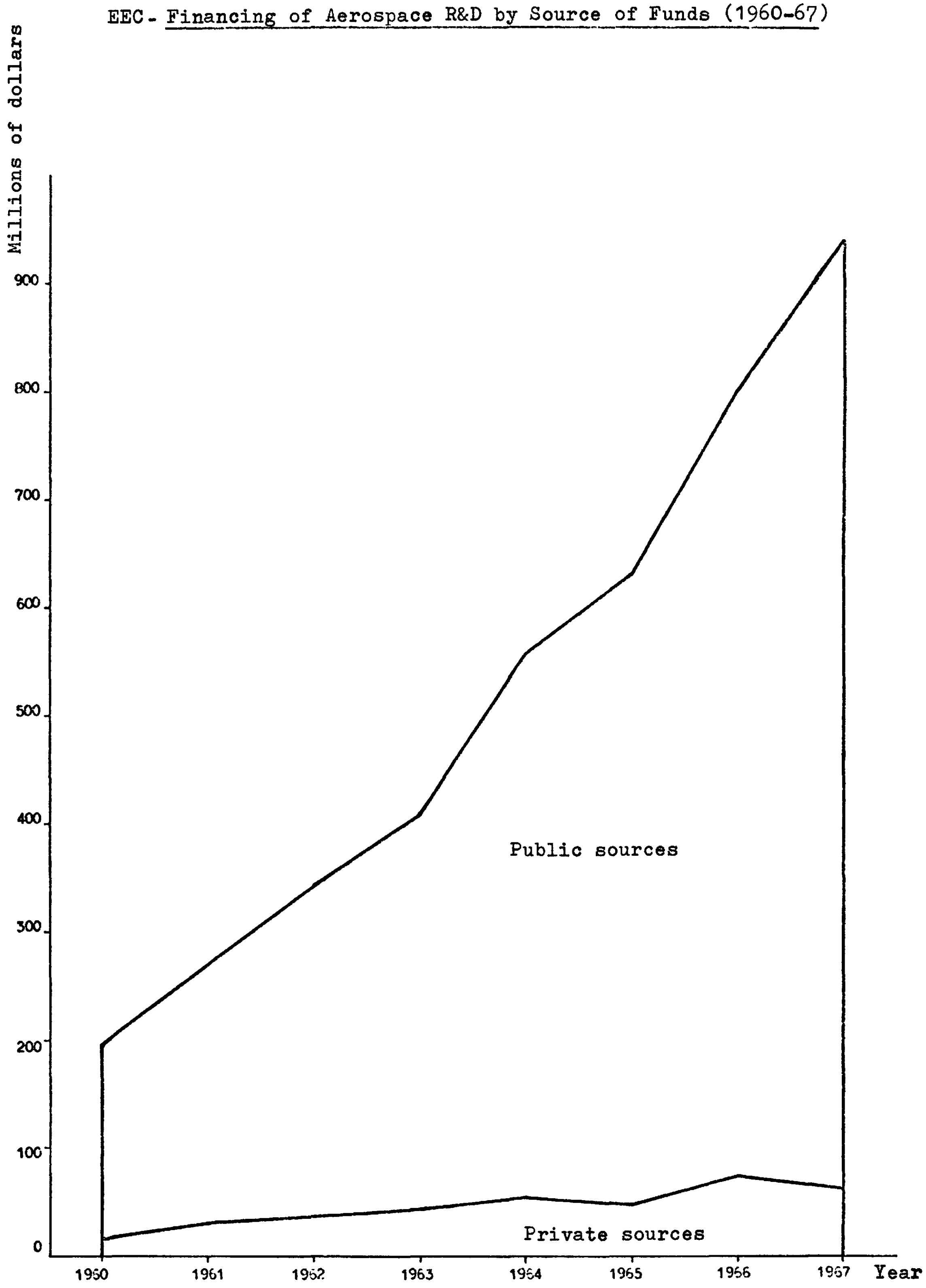


Table 1/24

United Kingdom - Financing of Aerospace R&D by Source of Funds (1960-67)

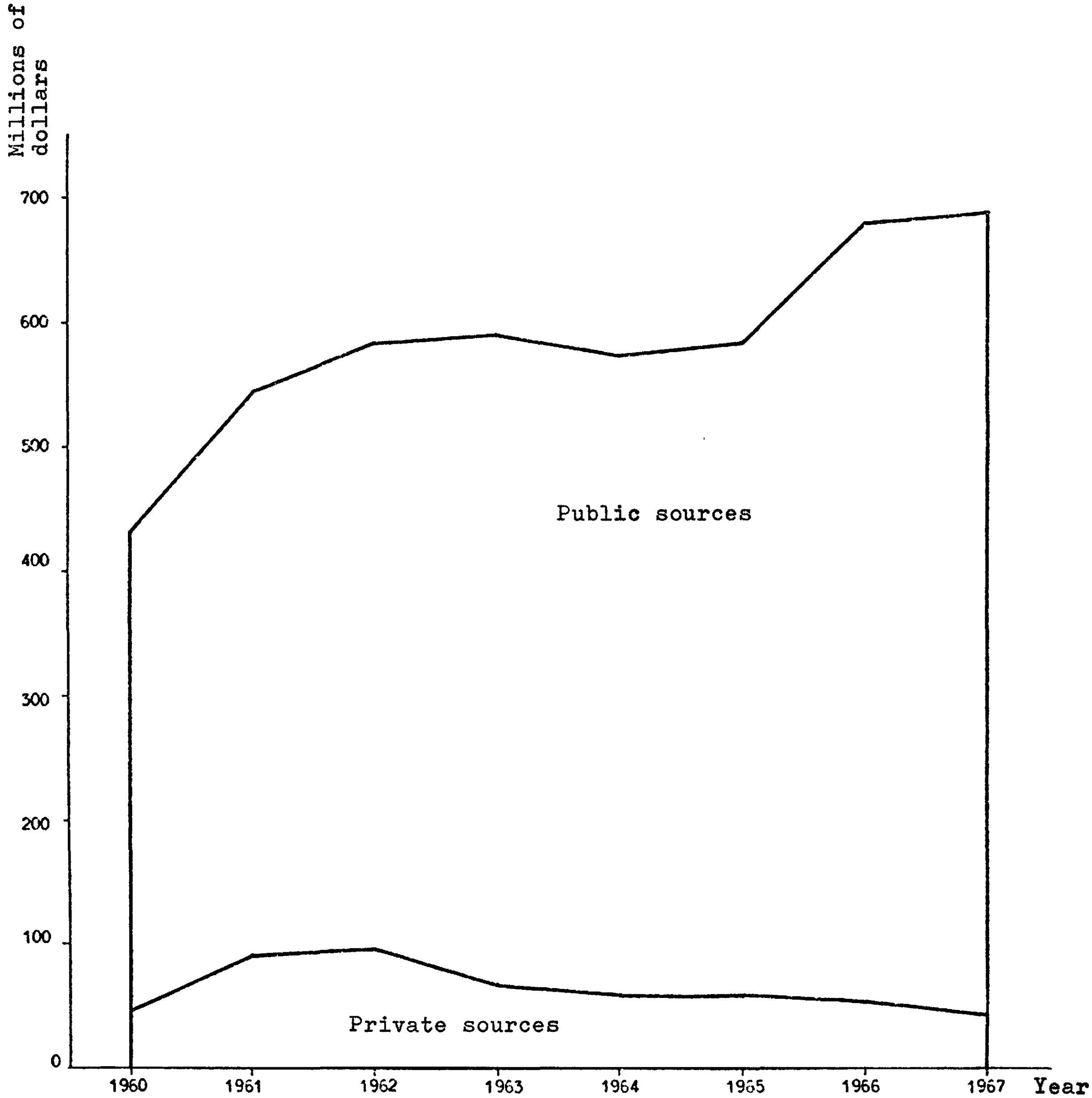


Table 1/25

United States - Financing of Aerospace R&D by Source of Funds (1960-67)

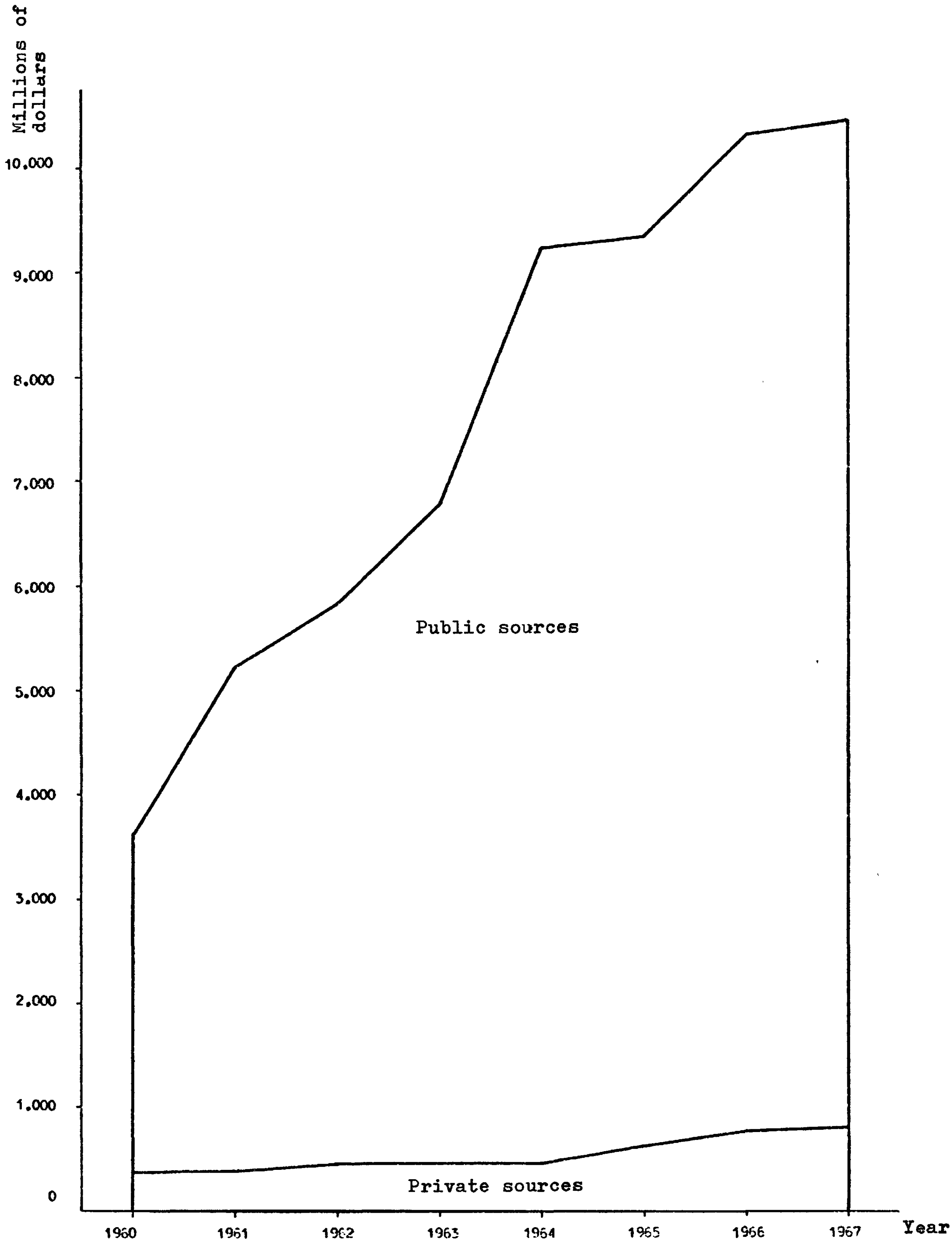


Table 1/26

EEC - Financing Aerospace R&D by Programmes (1960-67)

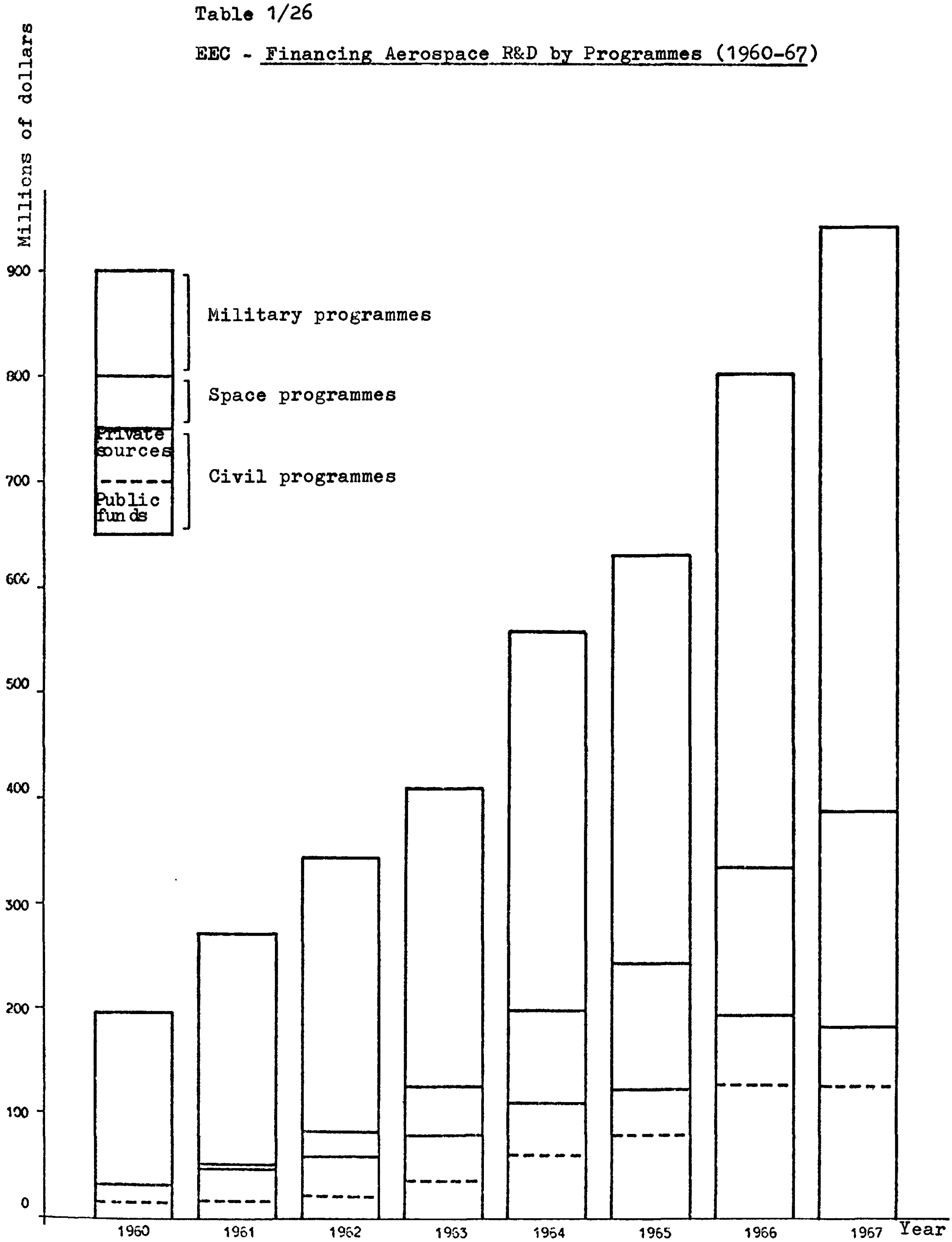


Table 1/27

United Kingdom - Financing of Aerospace R&D by Programmes (1960-67)

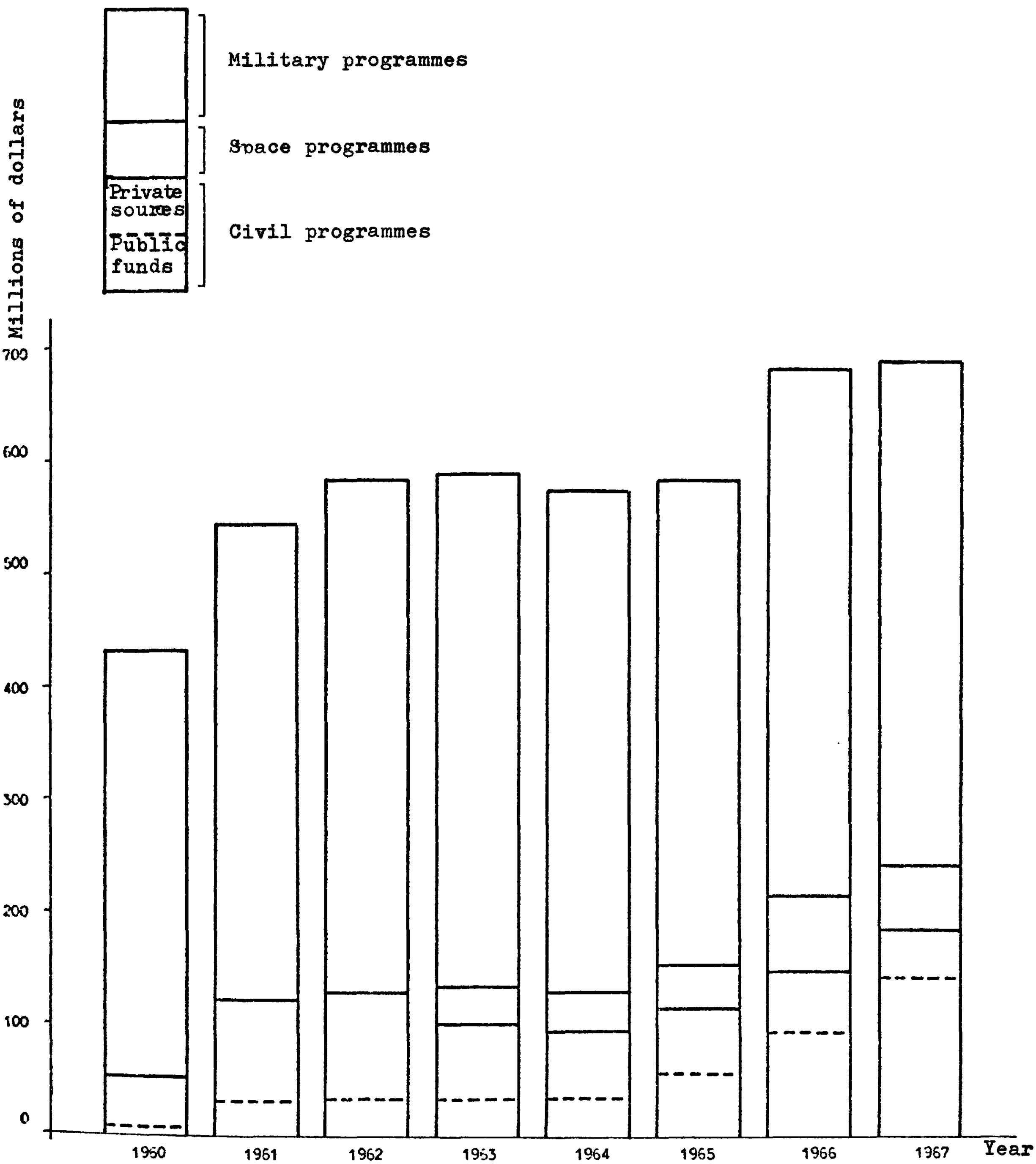


Table 1/28

United States - Financing of Aerospace R&D by Programmes (1960-67)

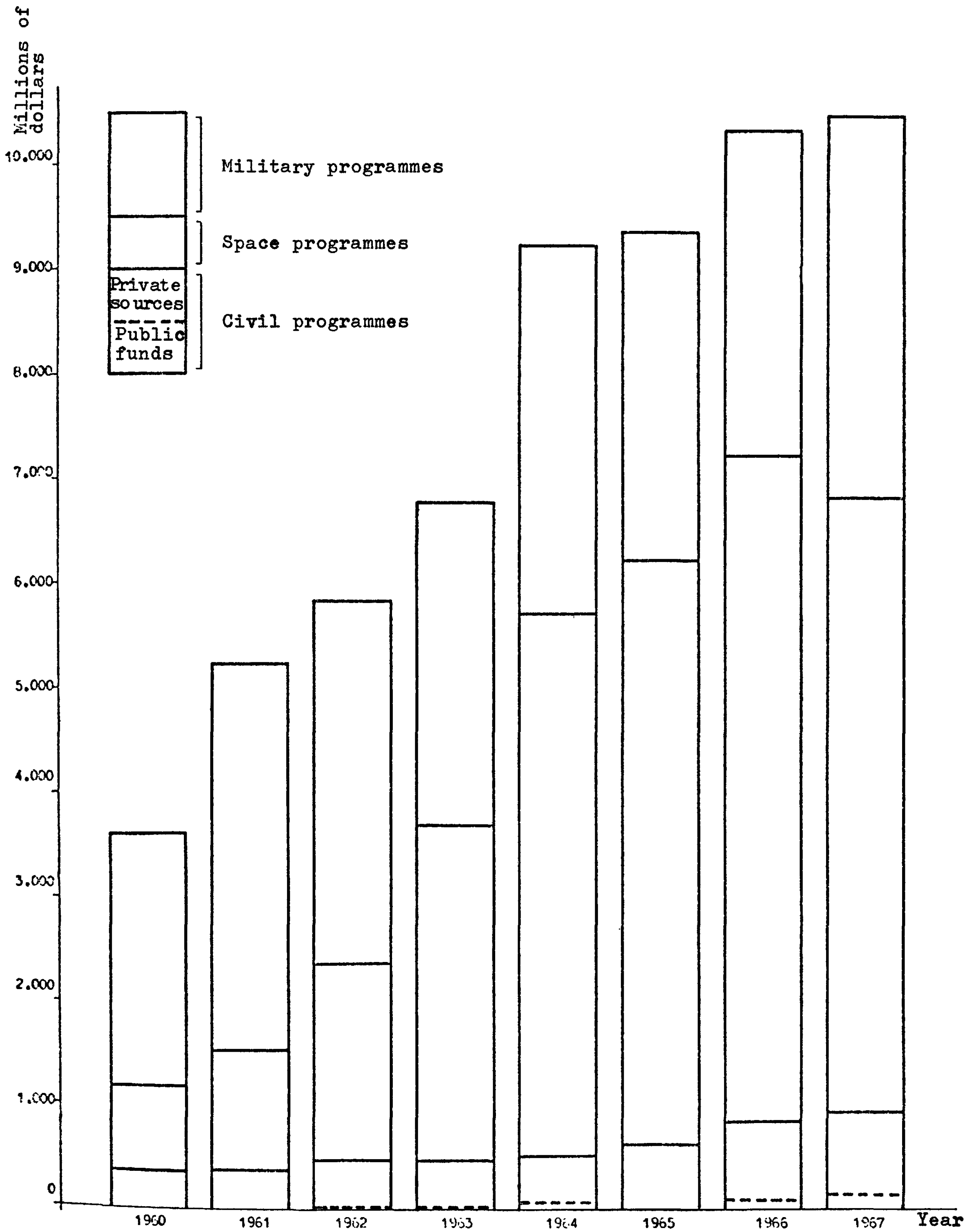


Table 1/29

EEC - R&D Expenditure of the Aerospace Industry by Source of Funds (1960-67)

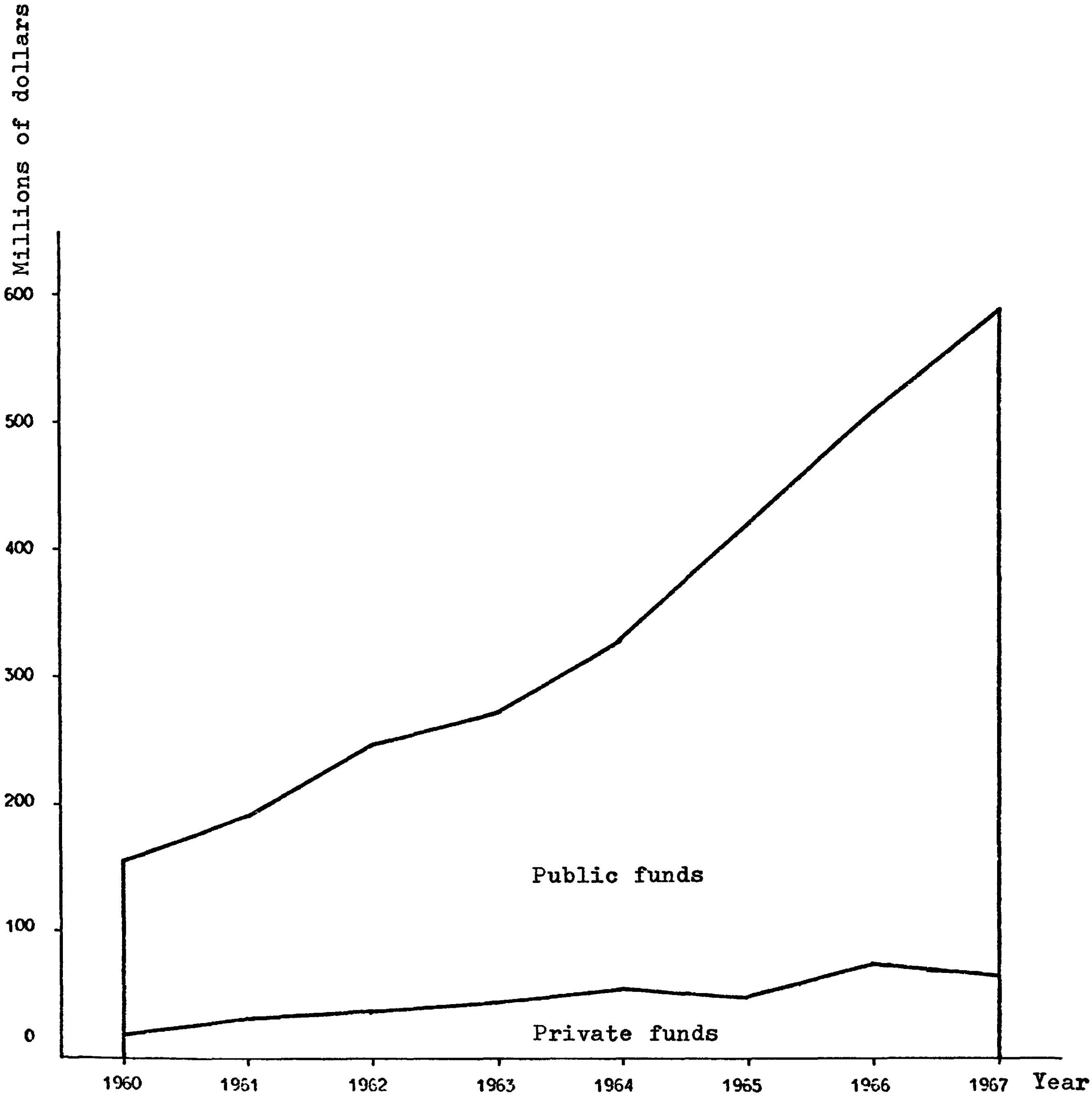


Table 1/30

United Kingdom - R&D Expenditure of the Aerospace Industry by Source of Funds (1960-67)

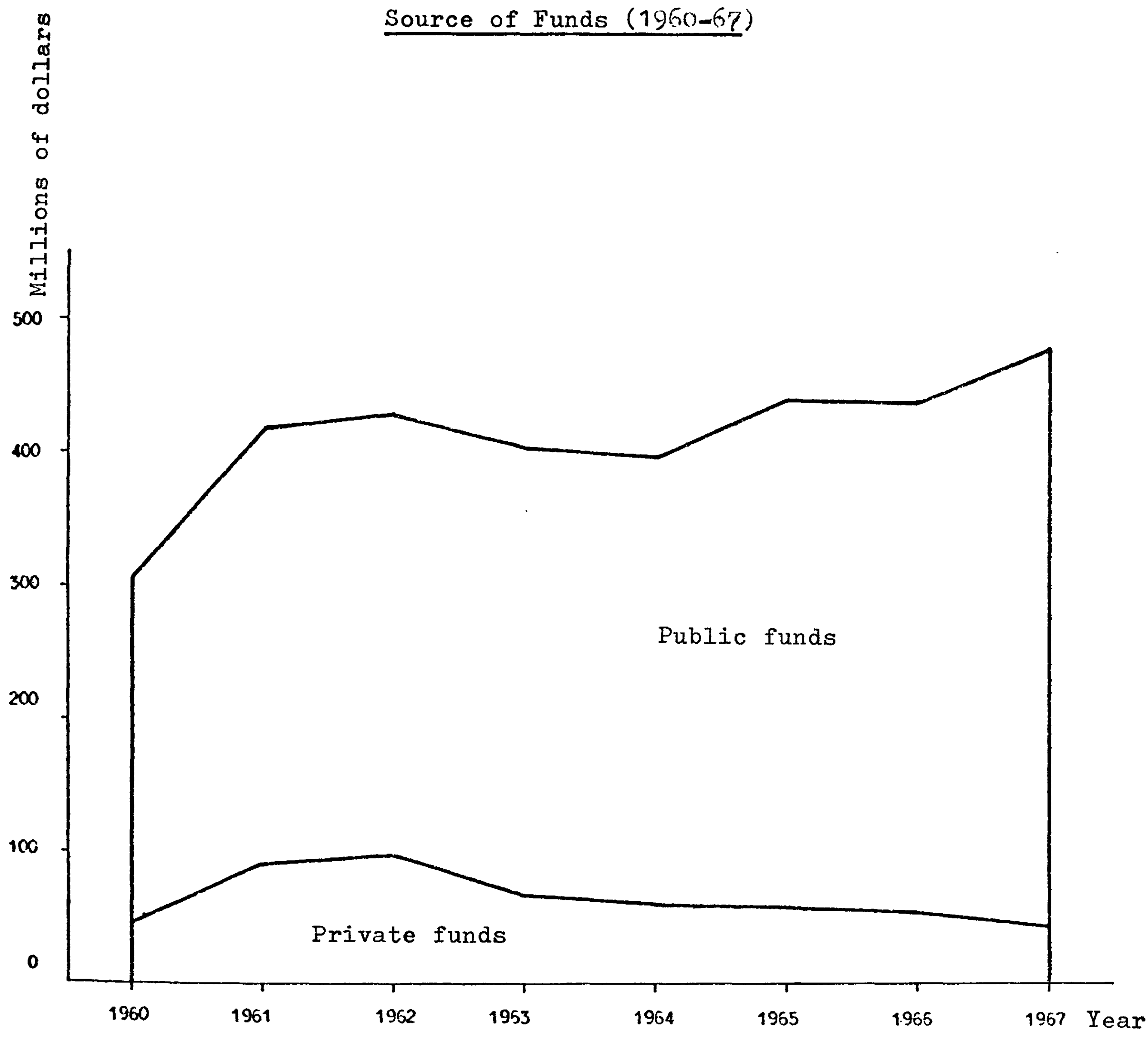
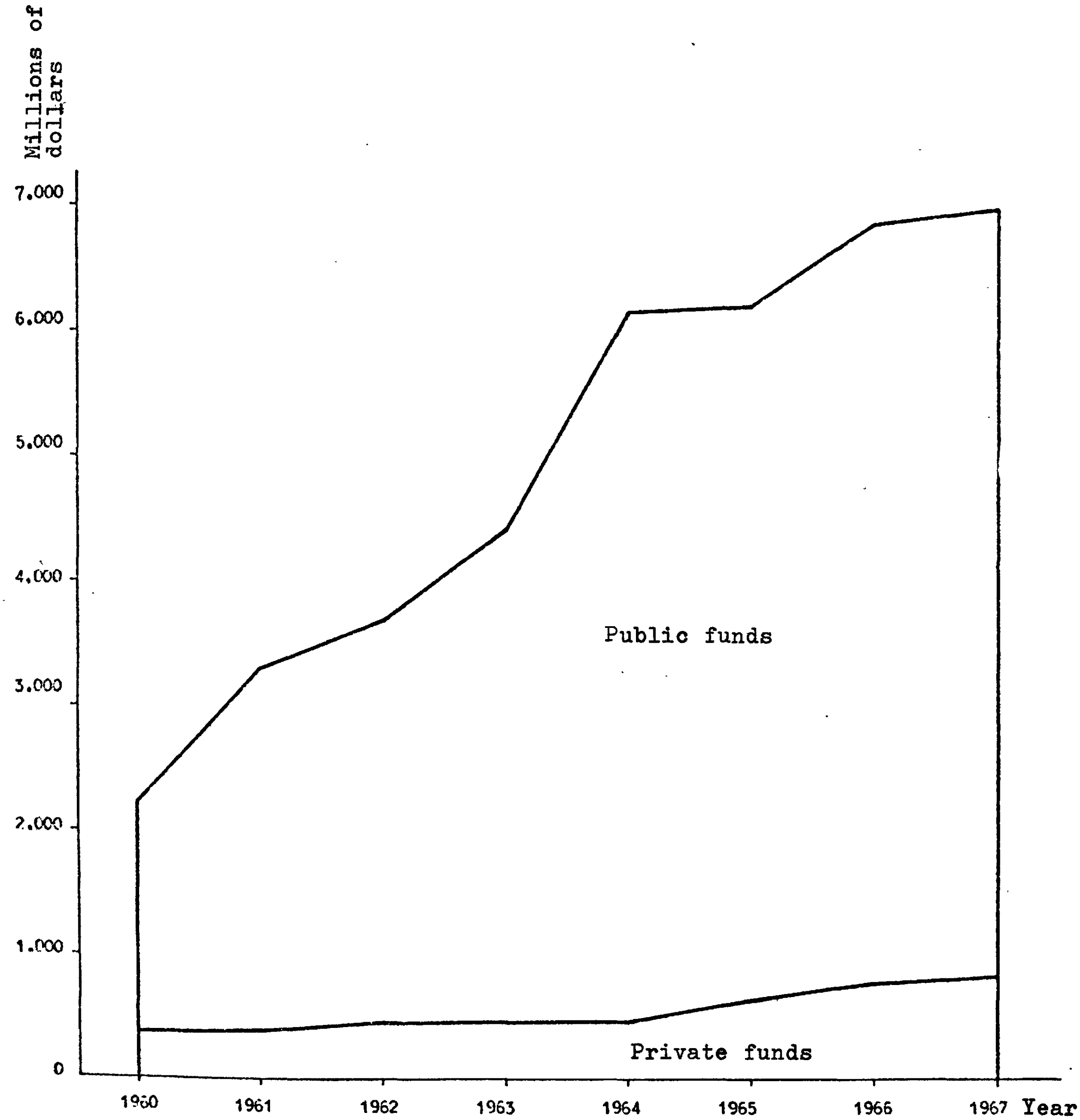


Table 1/31

United States - R&D Expenditure of the Aerospace Industry by Source of Funds (1960-67)



Annexes

A. Model questionnaires for use in interviews with ministries, organizations, vocational unions and enterprises.

B. Model questionnaires for use in interviews with airlines.

A. Model questionnaire for use in interviews with ministries, organizations, vocational unions and enterprises.

A1/ Belgium, France, Germany, Netherlands

QUESTIONNAIRE

QUESTIONNAIRE

(le contenu des parenthèses a
une valeur purement indicative)

1. Quels sont, à votre avis, les rapports entre industrie aéronautique et/ou électronique et/ou spatiale ?
   (interdépendance; échanges .....)

2. Quel est le rôle de la R&D aérospatiale dans l'économie en général ?
   (pilotage, technologique, managériel .....)

3. Quels sont les rapports entre votre activité industrielle, le Gouvernement et l'Université dans le domaine de la R&D ?
   (aspects contractuels; participation aux risques .....)

4. Quelles sont les lignes souhaitables d'évolution des politiques de R&D dans l'industrie aérospatiale ?
   (consortiums; holdings; politique des brevets .....)

5. Quel est le coût direct et indirect de votre activité de R&D ? Quelles en sont les retombées ?
   (projets réussis et manqués; amortissements; fall-out...)

6. Sur la base de quels critères choisissez-vouz entre une activité autonome de R&D et l'achat de licenses ?
(dimensions de l'entreprise; occupation de main d'oeuvre .....)

7. Quelle est l'incidence de l'éléctronique sur la production d'avions civils et militaires, de missiles, d'engins spatiaux ?
(équipements au sol et embarqués .....)

8. Quelle est la situation de l'activité spatiale,de la production d'avions militaires et de missiles dans votre pays et dans votre entreprise ?
(organisation, coopération, participation de l'état; marché .....)

9. Le coût des avions ou des moteurs ou des équipements que vous produisez est-il différent de celui des autres pays CEE, du RU, des USA ?
(différent niveau productif; coûts de démarrage .....)

10. Disposez-vous de financement d'état pour la production d'avions civils, d'hélicoptères, d'équipements ?
(à quelles conditions ; autres formes de réduction des risques .....)

11. Quels sont et quels pourraient être les rapports entre l'industrie et le marché civil ?

(volume critique du marché; rôle des compagnies aériennes .....)

12. Quels sont les rapports de votre entreprise avec celles du même secteur de votre pays, des pays de la CEE, du RU, des USA ?

(collaboration; sous-traitance; échanges de brevets, licences; know-how .....)

13. Une collaboration efficace entre les industries européennes ou bien entre industries européennes et américaines serait-elle souhaitable ?

(expériences de collaboration multinationale; secteur cellules, moteurs, avionics .....)

14. Quelles sont les perspectives de votre entreprise dans les domaines:

a. R & D
b. production aéronautique et de missiles
c. activité spatiale.

15. Quelles sont, à votre avis, les possibilités de votre pays et de l'Europe dans le domaine spatial (rapport science/application; perspectives pour CECLES, CERS, CETS, INTELSAT....) et dans les domaines aéronautique et avionics ?

16. Propositions pour d'éventuelles interventions efficaces de la CEE dans le secteur aérospatial.
(au niveau politique, économique, industriel , de R&D ...)

A2/ Italy

QUESTIONNAIRE

1. QUALI SONO A SUO AVVISO I RAPPORTI TRA L'INDUSTRIA IN GENERALE, L'INDUSTRIA AERONAUTICA E/O L'ATTIVITA' SPAZIALE ?

a. Verificare se è vero o no che per lo sviluppo di una consistente attività spaziale occorre in ordine il sostegno di una forte industria aeronautica e di una vasta attività industriale di base

b. Interscambio tra i 3 settori

c. Direttrice prevalente se esiste (caso dei progressi nella metallurgia, ad es.)

2. QUAL'E' LA POLITICA DI FONDO NELLA SCELTA TRA INTRAPRENDERE UN'ATTIVITA' DI R & D E ACQUISIRE DELLE LICENZE ?

a. Il problema va visto a breve, medio e lungo periodo per i vantaggi e gli svantaggi delle due scelte

b. Esistenza di una politica governativa nella R & D privata. (Se esiste):
La politica del Governo concorre ad indirizzare in un senso o nell'altro la politica dell'impresa, attraverso forme contrattuali particolari ?

c. Politica dell'impresa (nell'intraprendere la R & D) indipendentemente dal sostegno del Governo (distinta per campo civile, militare e spazio)

d. Percentuale di fatturato dedicata a spese di R & D

3. QUAL'E' IL COSTO DIRETTO ED INDIRETTO DI UN'ATTIVITA' DI R & D, QUALI SONO I RICAVI DIRETTI ED INDIRETTI CHE NE DERIVANO ?

a. Costo della R & D per progetti non riusciti

b. Ammortamento dei costi della R & D

c. Tempi dell'implementation della R & D e fattori che concorrono a ridurlo

d. Cessioni di brevetti, licenze e know how a industrie USA ed Europee: motivi, return diretto e indiretto

e. E' valutabile in termini quantitativi il fall-out inteso come ricavo indiretto della R & D; esiste un fall-out diretto ? Quali sono i fattori indispensabili all'utilizzazione di questo fall-out (tecnici, management, capitali, struttura industriale, mercato, legislazione contrattuale e brevettuale)

4. QUALI SONO E QUALI PREVEDE SIANO GLI INDIRIZZI DELLA R & D NELL'INDUSTRIA AEROSPAZIALE E NELL'INDUSTRIA IN GENERALE

-5. QUALI SONO I RAPPORTI TRA INDUSTRIA, GOVERNO E UNIVERSITA' PER I PROGRAMMI DI R & D ?

a. **Tra industria e Università:** finanziamenti, per che cosa; tecnici e loro preparazione a livello universitario (1), conoscenza dei risultati ottenuti dall'industria e viceversa

b. **Tra industria e Governo:** quali sono le forme di sostegno del Governo: aiuti finanziari, sostegni tecnici, partecipazioni nell'impresa; da quando; sistema di attribuzione dei contratti; indirizzi nella R & D; return allo Stato; disponibilità, per l'industria dei risultati della R & D acquisiti dal Governo; utilità o meno della R & D militare e spaziale; controllo dei profitti ed entità dei profitti permessi; sistemi di documentazione industriale e governativa

(1) Se e fino a quali limiti è necessaria un'ulteriore formazione specifica da parte dell'impresa, se indirizza l'Università in quella formazione, difficoltà attuali e future nel reperimento di tecnici.

6. QUAL'E' L'IMPORTANZA DELLA R & D AEROSPAZIALE NELL'ECONOMIA IN GENERALE ?

a. Accelerazione dello sviluppo economico

b. Polarizzazione di tecnici e di capitali (utile o no?)

c. Previsione di aumento nella ricerca e sviluppo con tassi sempre maggiori (se si, perchè ?)

7. QUALI SONO I RISCHI, I VANTAGGI E GLI SVANTAGGI DI UNA PRODUZIONE DI AEREI MILITARI E CIVILI ?

Distintamente per militari e civili:

a. Il produrre aerei militari condiziona o agevola la produzione di aerei civili ? (motivi,tra essi: tecnologie diverse ?)

b. Ciclicità della produzione militare; fino a quale punto l'intervento del Governo può modificare i piani di produzione

c. Aerei militari: che succede per i prototipi non accettati ? La proposta viene dal governo o dalle industrie ? Livelli percentuali di profitto; profitti e altri vantaggi e/o svantaggi della produzione su licenza

d. Aerei civili: che succede per i prototipi non accettati ? La proposta viene dalle aviolinee o dalle industrie ? Esiste un'interferenza governativa, livelli percentuali di profitto

e. Rapporto tra produzione civile e militare: trend

8. QUAL'E' LA SITUAZIONE ATTUALE DELLA PRODUZIONE MISSILISTICA ?

9. I LAUNCHING COSTS, I COSTI DI PRODUZIONE E IL COSTO DI OGNI SINGOLO AEREO PRODOTTO SONO IN ITALIA UGUALI, MAGGIORI O MINORI RISPETTO A QUELLI DEGLI ALTRI PAESI CEE, DELLA GRAN BRETAGNA E DEGLI USA ?

a. (se esistono differenze): Verificare se i motivi sono attribuibili a : diversi livelli di produttività, differenza nel numero medio delle serie prodotte (distintamente per civili e militari), o ad altro

b. Incidenza percentuale dei launching costs sul costo totale della produzione (idem per variable cost e per fixed costs)

c. Per aerei civili: finanziamenti statali dei lauching costs;rimborso allo Stato (forme, importi , tempi); assunzione di rischio da parte dello Stato

d. Per aerei militari: forme, importi (percentuali) e tempi dei finanziamenti pubblici. Verificare in particolare se e fino a quando l'impresa è obbligata ad autofinanziare la produzione militare

10. ESISTONO FINANZIAMENTI PUBBLICI PER LA PRODUZIONE DI AEREI CIVILI ED ELICOTTERI ?
IN ASSENZA DI FINANZIAMENTI PUBBLICI QUALI ALTRE FORME VENGONO ADOTTATE PER RIDURRE IL RISCHIO CONNESSO ALL'ELEVATO LIVELLO DEI LAUNCHING COSTS E DEI COSTI DI PRODUZIONE IN COMPLESSO ?

a. Compartecipazione di più imprese al medesimo programma e forme di tali compartecipazione (associazione, fusione, sub fornitura). Ripartizione dei rischi e dei profitti

b. Fonti di finanziamento (emissione di obbligazioni garantite o no dallo Stato ?)

11. QUALI SONO E QUALI POTREBBERO ESSERE I RAPPORTI TRA INDUSTRIA E MERCATO IN CAMPO CIVILE ?

a. E' vero che l'industria aeronautica dipende dal Governo per la sua sopravvivenza?

b. A chi spetta l'iniziativa circa le proposte di nuovi aerei ?

c. Importanza del mercato interno (quanti aerei dello stesso tipo può sopportare ?)

d. Esportazioni: per sostegno dello Stato ? Come ?
per finanziamenti agli acquirenti ?

e. Importazioni: quante sono le importazioni dai paesi Europei e quante dagli USA ? Esistono forme tacite di protezionismo ?

f. Importanza della manutenzione e costi relativi

g. Obsolescenza degli aerei

h. La produzione di aerei nell'ambito di una politica generale dei trasporti

12. E' POSSIBILE UNA COLLABORAZIONE TRA INDUSTRIE EUROPEE ? E TRA INDUSTRIE EUROPEE E INDUSTRIE AMERICANE ?

a. Quali sono le condizioni per progetti di collaborazione (giustificazione economica a corto o lungo termine ? effetti tecnologici ?)

b. In campo civile e/o militare ?

c. Specializzazione per tipi di prodotti (motori, velivoli, elettronica, ecc.)

d. Se può avvenire in termini di cooperazione di collaborazione o altro

e. Quali progetti: singoli o nell'ambito di una programmazione a vasto respiro ?

f. Quanti partner possono collaborare perchè un progetto in comune possa riuscire; quali, allo stesso scopo, dovrebbero essere le forme di collaborazione (suddivisione dei compiti, ecc.)

g. Esistono diversi livelli di produttività fra i paesi Europei (incluso U.K.); Se si, come si può superare l'ostacolo ?

h. Come si può superare l'ostacolo dei diversi livelli di produttività USA/Europa ?

i. Investimenti USA nell'industria italiana, forme e livelli quantitativi

l. Esportazioni di servizi e/o cooperazione tecnica USA

m. E' utile la creazione del Centro Tecnologico Europeo auspicato dal Ministero della tecnologia inglese; può rappresentare un primo stadio per l'attuazione di un raggruppamento di imprese europee ?

n. Quali potrebbero essere gli interventi CEE a favore della creazione di una industria aerospaziale europea competitiva ? E in quali campi: R & D e/o industria e/o mercato

13. QUAL'E' LA SITUAZIONE ATTUALE DELL'ATTIVITA' SPAZIALE IN ITALIA ?

a. Organizzazione (pregi, difetti) dei programmi nazionali e delle collaborazioni bi-e multilaterali

b. Indirizzi, fondi, forme di contratto

c. Uomini, management

d. Iniziative (industria/Governo)

e. Attività spaziale e sviluppo tecnologico

f. Utilizzazione commerciale: della tecnologia spaziale e dei suoi prodotti: esempi

g. Elettronica: è condizione essenziale ?

14. QUALI SONO LE POSSIBILITA' DELL'ITALIA E DELL'EUROPA IN CAMPO SPAZIALE E QUALI I POSSIBILI INDIRIZZI ?

a. Il gap europeo è solo tecnologico o anche di organizzazione

b. Collaborazione USA/Europa (persone, licenze, vendite, ecc.)

c. Indirizzi: meteorologia, astronomia (che ne pensano del LAS) telecomunicazioni ecc.

15. QUALI SONO LE VOSTRE OPINIONI SULLE PROSPETTIVE FUTURE DI:

15.1. R. D.

a. Investimenti (> = <)

b. Occupazione (maggiore, uguale, minore)

c. Tipo di organizzazione

d. Indirizzi

e. Migliore utilizzazione dei risultati della R.D.

15.2. INDUSTRIA AERONAUTICA

a. Mercato militare e missili (trend futuro)

- programmi
- VTOL
- che ruolo giocano nuovi propulsori nello sviluppo di nuovi aerei

b. Mercato civile (trend futuro) < passeggeri / merci

- ipersonici
- VTOL
- che ruolo giocano nuovi propulsori nello sviluppo di nuovi aerei

c. Nuovi mercati

- nuovi mezzi di trasporto correlati agli aerei in un sistema globale (in funzione del tempo complessivo di viaggio)

- altre diversificazioni (mezzi subacqui etc.)

- sistema dei trasporti aerei (aeroporti, rumori, etc.)

- Servizi di terra

d. Lavoro dell'industria per i prossimi 5-10 anni, livello dell'occupazione per i prossimi 5-10 anni

e. L'industria aeronautica in generale costituisce un settore da ingrandire, tener costante o diminuire ?

15.3. ATTIVITA' SPAZIALE

a. Investimenti

b. Indirizzi

c. Nuovi satelliti

d. Nuovi programmi

e. Telefonia, televisione diretta e indiretta, trasmissione dati

QUESTIONNAIRE

1. WHAT ARE IN YOUR OPINION THE RELATIONSHIPS BETWEEN INDUSTRY IN GENERAL, THE AIRCRAFT INDUSTRY AND SPACE FLIGHT ACTIVITY ?

* To verify whether it is true or not that we need for the development of a substantial space activity the support of a strong aircraft industry first and secondly a large basic industrial activity
* Exchanges among the three sectors
* Prevailing guiding principle if there is one (case of advances in metallurgy , e. g.)

(2.) WHAT IS THE POLICY BEHIND THE CHOICE BETWEEN ENGAGING IN R & D AND BUYING THE PATENTS AND LICENSES ?

* The problem concerning the advantages and disadvantages of each choice must be considered in the short, medium and long run
* What is the government policy in respect to the private R & D ?
* Company's policy (in undertaking R & D) independently from government support (respectively for civil, military and space activity)

3. WHAT ARE THE DIRECT AND INDIRECT COSTS OF CERTAIN R & D PROGRAMMES ? WHAT IS THE IMMEDIATE AND THE INDIRECT PAY-OFF

* Cost of unsuccessful R & D projects
* Ammortization of R & D expenditures
* Time-lag in the phase of exploitation and implementation of R & D's results and factors which may shorten it
* Granting and sale of patents, licenses and know-how to US and European firms: motives (aims), direct and indirect returns
* Can the fall-out, understood as earnings and other advantages flowing indirectly from R & D, be quantified ? Is there any kind of tangible (direct) fall-out ? What are the necessary factors for exploiting the fall-out (technological, managerial, legal, contractual, connected with problems of patent rights)

4. WHAT ARE THE PRESENT AND FUTURE TRENDS OF R & D efforts in the aerospace industry and in industry in general, in your opinion ?

5. WHAT KIND OF RELATIONSHIPS ARE THERE BETWEEN INDUSTRY, GOVERNMENT AND UNIVERSITY WITH RESPECT TO R & D PROGRAMMES ?

* Between industry and University: funds, for what purpose, scientists & engineers (tecnicians) and their university training (if and to what degree is a specific, subsequent training in the firm necessary; if universities themselves give similar courses; present and future difficulties to find enough scientists and engineers) penetration of new knowledge acquired in the industry and vice versa

* Between industry and Government: financial and technological support, Government's minority or majority interest in companies; procedures of contract awarding; control and level of profitability; trends in R & D, returns to the State; availability of R & D results obtained by the government for the industry; greater or less utility of military and space R & D. Ways and problems of scientific records and documentation

6. WHAT IS THE IMPORTANCE OF AEROSPACE R & D FOR THE WHOLE ECONOMY ?

* Stimulus of economic growth
* Attraction of scientists and engineers and capitals (useful or not) ?
* Forecast of R & D growth at ever faster rates (if yes, why ?)

7. WHAT ARE THE RISKS, THE ADVANTAGES AND DISADVANTAGES OF MANUFACTURING MILITARY AND CIVIL AIRCRAFT ?

Military and civil separately:

* manufacturing military aircraft stands in the way of (hampers) manufacturing civil aircrafts or facilitates it ? (reasons, one of them: different technologies)
* pattern of military production is cyclical; to what degree can government intervention modify production plans?
* military aircraft: what happens to the prototypes - which are not accepted ? Does the proposal come from the governement or from industry ? Percentage rates of profits
* civil aircraft what happens to the prototypes which are not accepted? The proposal comes from the airlines or from industry ? What is the role played by the government ? Percentage rates of profits
* relationship between civil and military production: trend

8. WHAT IS THE PRESENT SITUATION OF GUIDED WEAPONS PRODUCTION ?

* Relationships between missiles and military aircraft production
* Trend
* Missiles/antimissiles system

(9.) ARE THE LAUNCHING AND PRODUCTION COSTS, THE UNITARY COST (OF EACH SINGLE PRODUCED AIRCRAFT) LOWER OR HIGHER THAN THOSE OF U.S.A. AND THE E.E.C. COUNTRIES ?

Possible reasons:

* Different level of productivity (reasons); average length of production runs (for military and civil aircraft separately); others
* What is the incidence (percentage) of the launching costs on the total production cost (similarly for variable and fixed costs)
* For civil aircraft: government funds to finance launching costs, repayments to the government (modality, amount, timing); sharing of risk-taking by part of the government
* For military aircraft: modality, amount (percentages) and terms of government funding. Check particulary if and in what proportion the firm has to finance military production out of own funds

(10) IS THERE ANY STATE'S FINANCING FOR CIVIL PROJECTS (AIRCRAFT AND HELICOPTERES)
IN THE ABSENCE OF THE STATE FINANCING THE PRODUCTION OF CIVIL AIRCRAFT, WHAT OTHER WAYS ARE THERE TO REDUCE THE RISKS ARISING FROM THE HIGH LAUNCHING COSTS AND TOTAL PRODUCTION COSTS ?

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* Participation of several firms to one programme only and different forms of such participation (association, merger, subcontracting)
* Sources and different ways of raising funds (issue of debentures and bonds - backed or not by the state? Advance payments by airlines)

(11) IN THE CIVIL FIELD WHAT KIND OF RELATIONSHIP EXISTS BETWEEN THE INDUSTRY AND THE MARKET ?

* Up to which degree does the aircraft industry depend on government support ?
* Proposals for new types of aircraft
* Market studies; (up to which point can and should the government intervene) ?
* Importance of the home market (how many aircraft of the same type can the latter absorb)
* Exports: with reference to: 1. backing by the State? How?
  2. Special terms of payment granted to the buyers by companies and banks
* Imports: level of imports from U.S. and from other European countries

  does the government intervene in this field ?
* Relevance of overhaul and related costs
* Obsolescence of aircraft
* Home production of parts and equipment for American or other imported aircraft (e.g. Phantom)
* Aircraft production in the framework of a general policy for transport

12. IS A COLLABORATION BETWEEN EUROPEAN INDUSTRIES POSSIBLE ? AND BETWEEN EUROPEAN AND AMERICAN INDUSTRIES WITHIN A NORTH ATLANTIC MARKET ORGANIZATION ?

* What is the main justification for it (economic, scientific, technological etc.)
* Civil and/or military ?
* Specialization by types of products (engines, airframes, electronics etc.)
* Whether the collaboration might be successful under the present forms or whether we need other new forms
* Which projects: individual or in the framework of an all-embracing plan ?
* How many partners can collaborate so that a common project can be successful; to the same extent, what should be the form of collaboration (sharing of functions, tasks, etc.)
* Are there different levels of productivity between U.K., U.S.A. and Europe; if so: how can this difference be overcome ?
* In the case a collaboration US/Europe were impossible, we can assume that Europe will develop its own aerospace industry: what would be the main problems in such a case ?
* United States interferences in European industry
* Imports of services and/or technological cooperation from or with the U.S.
* May the creation of a European Technological Establishment as put forward by the British Minister of Technology, represent a first step towards a grouping or concentration of European firms ?
* How could the E.E.C. effectively intervene to further the creation of a competitive European Aerospace Industry ? What sector should the said interventions primarily aim at ? R & D or/and industry or/and market ?

13. WHAT IS THE PRESENT SITUATION OF THE SPACE ACTIVITY IN YOUR COUNTRY ?

* Organization (merits, drawbacks) of national and multina tinational programmes
* Guidelines, funds, procedures of contract awarding
* Management and employment
* Initiatives (government industry etc.)
* Space activity and technological development
* Commercial utilization and exploitation: of space tecnology, of its finished products
* Electronics: essential condition ?

14. WHAT ARE EUROPE'S POSSIBILITIES AND WHAT ARE YOURS IN THE SPACE SECTOR. WHAT ARE THE POSSIBLE POLICIES OF YOUR COUNTRY IN THIS CONNECTION ?

* The "gap" is a technological one only, or one of management, too
* Joint-effort UK/Europe and UK/US (scientists and engineers, licences patents, sales etc.)
* Aims: meteorology, astronomy telecomunications etc.

(15.) WHAT ARE YOUR OPINIONS ON FUTURE PROSPECTS OF:

15.1. R & D

* Investments (> = <)
* Employment
* Management
* Trends
* Better exploitation of R & D results

15.2. AIRCRAFT INDUSTRY

* Military and guided weapons market (future trend)
  - programmes
  - VTOL
  - the role played by new systems of propulsion in the development of new aircraft

* Civil market (future trend) — passengers / freight
  - what after the supersonic aircraft
  - hypersonic transport
  - VTOL
  - the role played by new sistems of propulsion in the development of new aircrafts

* New markets
  - new means of transport to form, together with the air-transport as an integral part of it, a global system of transport
  - other diversifications (underwater transports)
  - air transport (airports, noise etc.)

* Production programmes of the industry for the next 5-10 years; employment trend for the next 5-10 years

* Do you think that the aerospace industry should remain constant, grow or become smaller in the future?

15.3. SPACE

* Investments
* Trends
* New satellites
* New national and multinational programmes
* Telecomunications

A4/United States

STUDY ON R & D ACTIVITIES IN THE AEROSPACE INDUSTRY OF THE EUROPEAN ECONOMIC COMMUNITY

QUESTIONNAIRE

1. WHAT ARE IN YOUR OPINION THE RELATIONS AND CONNECTIONS BETWEEN INDUSTRY IN GENERAL, THE AIRCRAFT INDUSTRY AND SPACE FLIGHT ACTIVITY ?

* To verify whether it is true or not that we need for the development of a substantial space activity the support of a strong aircraft industry first and secondly a large basic industrial activity
* Exchanges among the three sectors
* Prevailing guiding principle if there is one (case of advances in metallurgy , e. g.)

(2.) WHAT IS THE POLICY BEHIND THE CHOICE BETWEEN ENGAGING IN R & D AND BUYING THE PATENTS

* The problem concerning the advantages and disadvantages of each choice must be considered in the short, medium and long run
* Does federal policy contribute to direct the company's policy in one sense or in the other, by means of special different forms of contracting ? (particulars about different types of contracts concluded by Dod and NASA)
* Company's policy (in undertaking R & D) independently from federal support (divided in civil, military and space)

3. WHAT ARE THE DIRECT AND INDIRECT COSTS OF CERTAIN R & D PROGRAMMES ? WHAT IS THE IMMEDIATE AND THE INDIRECT PAY-OF

* Cost of unsuccessful R & D projects
* Ammortization of R & D expenditures
* Time-lag in the phase of exploitation and implementation of R & D's results and factors which may shorten it
* Granting and sale of patents,licenses and know-how to US and European firms: motives (aims), direct and indirect re turns
* Can the fall-out, understood as earnings and other advantages flowing indirectly from R & D, be quantified ? Is there any kind of tangible (direct) fall-out ? What are the necessary factors for exploiting the fall-out (technological, managerial, legal, contractual, connected with problems of patent rights)

4. WHAT ARE THE PRESENT AND FUTURE TRENDS OF R & D efforts in the aerospace industry and in industry in general, in your opinion ?

5. WHAT KIND OF INTERCONNECTIONS ARE THERE BETWEEN INDUSTRY, GOVERNMENT AND UNIVERSITY WITH RESPECT TO R & D PROGRAMMES ?

* Between industry and University: funds, for what purpose scientists & engineers (technicians) and their university training (if and to what degree is a specific, subsequent training by part of the firm necessary; if universities themselves give similar courses; present and future difficulties to find enough scientists and engineers) penetration of new knowledge acquired in the industry

* Between industry and Governement: procedures of contract awarding; trends in R & D, returns to the State; availability of R & D results obtained by the government for the industry; greater or less utility of military and space R & D. Ways and problems of scientific records and documentation

6. WHAT IS THE IMPORTANCE OF AEROSPACE R & D FOR THE WHOLE ECONOMY ?

* Stimulus of economic growth
* Attraction of scientists and engineers and capitals (useful or not) ?
* Forecast of R & D growth at ever faster rates (if yes, why ?)

7. WHAT ARE THE RISKS, THE ADVANTAGES AND DISADVANTAGES OF MANUFACTURING MILITARY AND CIVIL AIRCRAFTS ?

Military and civil separately:

* manufacturing military aircrafts stands in the way of (hampers) manufacturing civil aircrafts or facilitates it ? (reasons, one of them: different technologies)
* pattern of military production is cyclical; to what degree can federal intervention modify production plans?
* military aircrafts: what happens to the prototypes - which are not accepted ? Does the proposal come from the governement or from industry ? Percentage rates of profits
* civil aircrafts what happens to the prototypes which are not accepted? The proposal comes from the airlines or from industry ? Percentage rates of profits
* relationship between civil and military production: trend

8. WHAT IS THE PRESENT SITUATION OF MISSILES PRODUCTION ?

* Since 1962-63 a phase of recession can be recorded (noticed)
* Missiles/antimissiles system

9. ONE CAN OFTEN READ THAT IN SPITE OF HIGHER LAUNCHING AND PRODUCTION COSTS OF THE AMERICAN AIRCRAFT INDUSTRY, THE UNITARY COST (OF EACH SINGLE PRODUCED AIRCRAFT) IS LOWER. IS THIS ASSERTION TRUE ? IF YES, WHAT ARE THE REASONS OF IT, IN YOUR OPINION ?

* Higher productivity (reasons)
* Average length of production runs (for military and civil aircraft separately)
* Analysis of costs. Total costs consist of launching costs, variable and fixed costs. What percentage of total costs does each type of costs represent ?
* For civil aircrafts: federal funds to finance launching costs repayments to the government (modality, amount, timing)
* For military aircrafts: modality, amount (percentages) and terms of federal funding. Check perticulary if and in what proportion the firm has to finance military production out of own funds

10. IN THE ABSENCE OF THE STATE FINANCING THE PRODUCTION OF CIVIL AIRCRAFTS, WHAT OTHER WAYS ARE THERE TO REDUCE THE RISKS ARISING FROM THE HIGH LAUNCHING COSTS AND TOTAL PRODUCTION COSTS ?

* Participation of several firms to one programme and different forms of such participation (association, merger, subcontracting)
* Sources and different ways of raising funds (issue of debentures and bonds - backed or not by the state? Advance payments by airlines)

11. IN THE CIVIL FIELD WHAT KIND OF CONNECTIONS AND RELATIONSHIPS EXIST BETWEEN THE INDUSTRY AND THE MARKET ?

* Proposals for new types of aircrafts
* Market studies; (up to which point can and should the government intervene ?
* Importance of the domestic market (how many aircrafts of the same type can the latter absorb)
* Exports; with reference to: 1. backing by the State? How?
  2. credit facilities for the buyers
* Imports: are imports from Europa feasible ?
  what is the limit set by the State ? Do latent protectionist measures exist and occur ?
* Relevance of servicing and related costs
* Obsolescence of aircrafts
* Compensations to overseas countries (e.g. DC 9, Phantom)
* Aircraft production in the framework of a general policy for transport

12. IS A COLLABORATION BETWEEN EUROPEAN AND AMERICAN INDUSTRIES WITHIN AN ATLANTIC MARKET ORGANIZATION POSSIBLE ?

* Civil and/or military ?
* Specialization by types of products (engines, airframes, electronics etc.)
* Whether it might be successful under the present forms of collaboration and cooperation, or whether we need other new forms
* Which projects: individual or in the framework of an all-embracing plan ?
* How many partners can collaborate so that a common project be successful; to the same end, what should be the form of collaboration (sharing of functions,tasks, etc.)
* How can the obstacle represented by different levels of productivity USA/Europe, be overcome ?
* In the case a collaboration USA/Europe were impossible, we can assume that Europe will develop its own aerospace industry: what would be the main problems in such a case ?
* United States interferences in European industry
* Exports of services (TWR) and/or tecnological cooperation

13. WHAT IS THE PRESENT SITUATION OF THE UNITED STATES SPACE ACTIVITY ?

* Organization (merits, drawbacks)
* Guidelines, funds, procedures of contract awarding
* Men, management
* Initiatives (industry / NASA)
* Space activity and technological development
* Commercial utilization and exploitation: of space technology , of its finished products
* Why have the United States abandoned the project O.A.O. (Orbital Astronomic Observatory); what has been the cost; what were its prospects ?
* Electronics: essential condition ?

(14.) WHAT ARE EUROPE'S POSSIBILITIES IN THE SPACE SECTOR AND WHAT THE POSSIBLE POLICIES ?

* The "gap" is a technological one only, or one of management, too
* Joint-effort USA/Europe (scientists and engineers, licences, sales etc)
* Aims: meteorology, astronomy (what do you think of LAS which is a project similar to the O.A.O) telecommunications etc.

15. WHAT ARE YOUR OPINIONS ON FUTURE PROSPECTS OF:

** R. D

* Investments (> = <)
* Men
* Management
* Trends
* Better exploitation of R & D results

** AIRCRAFT INDUSTRY

* Military and missiles market (future trend)
  - programmes
  - VTOL
  - the role played by new systems of propulsion in the development of new aircrafts

* Civil market (future trend) < passengers / freight
  - what after the SST
  - hypersonic transport
  - VTOL
  - the role played by new systems of propulsion in the development of new aircrafts

* New markets
  - new means of transportation to form, together with the air-transport as an integral part of it, a global system of transport
  - other diversifications (underwater transports)
  - air transport (airports, noise etc)

** SPACE

* Investments
* Trends
* New satellites
* New programmes

B. Model questionnaires for use in interviews with airlines.

B1/ Belgium, France, Germany, Netherlands

QUESTIONNAIRE

1. Quelles sont vos prévisions au sujet du trafic des passagers et des marchandises pour les 5/10 années à venir ?

   * pour votre Compagnie
   * pour l'Europe
   * pour le monde entier

2. Quelle est la politique suivie par votre Compagnie, dans le but de satisfaire aux exigences du trafic prévu pour les passagers et pour les marchandises ?
(on se réfère ici tout particulièrement aux nouveaux programmes - Jumbo, Airbus, SST, Concorde - et à l'obsolescence des avions actuels).

3. En ce qui concerne strictement le trafic européen (passagers et fret) quel est votre avis au sujet de la solution alternative qui consisterai à mettre en service des nouveaux types d'avions, tels ceux mentionnés au point 2 - ou à intensifier la fréquence de vol des avions actuellement en service ?

4. Quels sont les critères sur lesquels se fonde votre Compagnie, lorsqu'elle est appelée à effectuer un choix entre des types d'avions ayant des performances compétitives ?
(par ex.: prix, frais d'exploitation, entretien, révision, pièces de rechange, etc.).

5. L'accroissement du trafic (passagers et fret) et la mise en service de nouveaux types d'avion pourront, d'après votre avis, modifier le niveau des tarifs ?

6. Quelle serait, d'après votre avis, la politique que les Compagnies aériennes pourraient adopter, dans le but de acquérir une tranche plus importante du trafic des passagers et des marchandises (tarifs nationaux et/ou européens plus avantageux, stand-by fares, individual tour-basing fares, inclusive tour fares, air-shuttle, accélération des opérations de check-in, meilleur niveau qualitatif des services offerts etc.) ?

7. Quels sont les rapports existant entre les Compagnies aériennes et les entreprises aéronautiques ?
(par ex.: initiatives pour l'étude de nouveaux types d'avions, recherches de marché, options, commandes, préfinancements, etc.)

8. Quels sont les rapports existant entre le gouvernement et les Compagnies aériennes ?
(par ex.: tarifs, autorisations pour de nouvelles routes aériennes, achat d'avions nouveaux, etc.)

9. Quels sont d'après votre avis les critères prédominants qui doivent régir la composition de la flotte aérienne d'une Compagnie nationale dans le cas où cette Compagnie trouve dans l'industrie nationale et/ou européenne la possibilité de satisfaire ses exigences ?

10. Estimez vous que le marché civil européen futur sera suffisamment vaste pour représenter le seul ou le plus important débouché de l'industrie aéronautique européenne ?

11. Quels sont les problèmes qui se posent actuellement pour les Compagnies aériennes, au sujet des possibilités d'escale et de vol aux Etats Unis ?

B2/ Italy

QUESTIONNAIRE

1. Quali sono le vostre previsioni sul traffico passeggeri e merci per i prossimi 5/10 anni ?

* per la vostra Compagnia
* per l'Europa
* per il mondo

2. Qual'è la politica della vostra compagnia in ordine al soddisfacimento del previsto traffico passeggeri e merci ? (il riferimento è fatto in particolare ai nuovi programmi - Jumbo, Airbus, SST, Concorde - e alla obsolescenza degli aerei oggi in servizio)

3. Limitatamente al traffico europeo (passeggeri e merci) come valuta l'alternativa tra introdurre nuovi tipi di aerei come quelli sopracitati ed aumentare la frequenza degli aerei attualmente in servizio ?

4. Quali sono i criteri della vostra compagnia nello scegliere tra diversi tipi di aerei tra di loro competitivi ? (per esempio: prezzo, costi operativi, manutenzione, revisione, parti di ricambio, ecc.)

5. Il previsto aumento del traffico (passeggeri e merci) e l'introduzione di nuovi tipi di aerei possono modificare il livello delle tariffe ?

6. Quali sono a suo avviso le politiche adottabili dalle linee di navigazione aerea per assicurarsi una maggior quota del traffico passeggeri e merci (tariffe nazionali e/o europee più favorevoli, stand-by fares, individual tour-basing fares, inclusive tour fares, air-shuttle, sveltimento delle operazioni di check-in, migliore qualità dei servizi offerti, ecc.) ?

7. Quali sono i rapporti tra le compagnie di navigazione aerea e le industrie aeronautiche ?
(es. iniziative per la progettazione di nuovi tipi di aerei, ricerche di mercato, opzioni, ordini, prefinanziamenti, ecc.)

8. Quali sono i rapporti tra il governo e le compagnie di navigazione aerea ?
(es. tariffe, concessione di nuove linee, acquisti di nuovi aerei, ecc.)

9. Quali criteri ritiene debbano essere prevalenti nella politica di composizione della flotta aerea di una compagnia di bandiera, in presenza di una industria aeronautica nazionale e/o europea, potenzialmente in grado di soddisfare le esigenze della compagnia stessa ?

10. Ritiene il futuro mercato civile europeo sufficientemente ampio per essere il solo o il principale sbocco dell'industria aeronautica europea ?

11. Quali sono per le compagnie di navigazione europea gli attuali problemi concernenti le possibilità di scalo e di volo in USA ?

B3/ United Kingdom

QUESTIONNAIRE

1. What is your forecast of passenger and freight traffic for the next 5 to 10 years ?

   * for your company
   * for Europe
   * for the world

2. What is the policy of your company in order to meet the forecasted passenger and freight traffic ? (with particular reference to the new programmes - Jumbo, Airbus, SST, Concorde - and to the obsolescence of the aircraft presently in service)

3. With particular reference to European traffic (passenger and freight) do you believe that increasing the frequency of scheduled flights of aeroplanes now in service may be a possible alternative to introducing completely new types of aircraft such as the above mentioned ones ?

4. What are the criteria of your company in choosing between competitive types of aircraft ?
(for example: price, operating costs, maintenance, overhauling, spare parts, etc.)

5. Might the forecasted increase of traffic (passengers and freight) and the introduction of new types of aircraft modify the current fares level ?

6. What policies do you think national airlines should adopt in order to increase their respective shares of the world passenger and freight traffic (lower domestic or international - European - fares, stand by fares, air-shuttle, simplification and speeding up of check-in, higher quality of supplied services, etc) ?

7. Can you describe the kind of relationships existing between airlines and aircraft industries ? (e.g. proposals of projects for new types of aircraft, market studies, options, orders, etc.)

8. What is the relationship between the government and national and independent airlines ? (e.g. fares, concession of new routes, purchase of new aircraft, etc.)

9. What criteria do you think should be followed by a national airline in assessing the composition of its fleet in presence of a national aircraft industry potentially able to meet all its requirements ?

10. Do you estimate the future European civil and commercial market as whole large enough to be the only or the main outlet of a European aircraft industry ?

11. What are the present problems facing European airlines operating in or through the United States in connection with route and landing facilities ?

B4/ United States

QUESTIONNAIRE

1. What is your forecast of passenger and freight traffic for the next 5 to 10 years ?

    * for your company
    * for U.S.A.
    * for the world

2. What is the policy of your company in order to meet the forecasted passenger and freight traffic ? (with particular reference to the new programmes - Jumbo, Airbus, SST, Concorde - and to the obsolescence of the aircraft presently in service)

3. What are your company's planned expenditures for new types of aircraft in the next five years ?

4. What are the criteria of your company in choosing between competitive types of aircraft ?
(for example: price, operating costs, maintenance, overhauling, spare parts, etc.)

5. Might the forecasted increase of traffic (passengers and freight) and the introduction of new types of aircraft modify the current fares level ?

6. What policies do you think airlines should adopt in order to increase their respective shares of the world passenger and freight traffic (lower domestic or international fares, stand by fares, air-shuttle, simplification and speeding up of check-in, higher quality of supplied services, etc.) ?

7. Can you describe the kind of relationships existing between airlines and aircraft industries ? (e.g. proposals of projects for new types of aircraft, market studies, options, orders, etc.)

8. What are the relationships between government and airlines ? (e. g. fares, concession of new routes, purchase of new aircraft. etc.)

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