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STUDIES

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

GENERAL REPORT **Volume 2**

COMPETITION INDUSTRY – 1971 – **4**

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

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Competition Industry No. 4
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THE AERONAUTICAL AND SPACE INDUSTRIES OF THE COMMUNITY COMPARED WITH THOSE OF THE UNITED KINGDOM AND THE UNITED STATES

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CHAPTER 2

Section A

The aeronautical and space industry

Contents

1. FOREWORD

Over the last sixty years the aeronautical industry has unquestionably made an outstanding contribution to technical progress.

New products have been developed at an exceptionally rapid rate as part of an evolutionary process which has been continuous and still shows no sign of being exhausted.

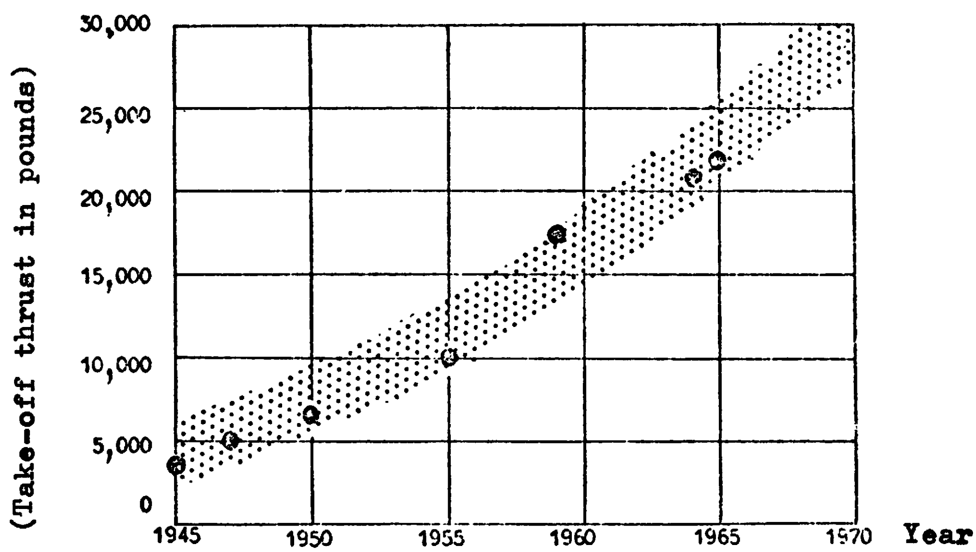
Since the first tentative steps at the beginning of this century, aeronautical construction techniques have made enormous strides. As regards means of propulsion, the invention of piston engines followed by turboprop and pure jet types has led to a succession of faster and more powerful aircraft (Fig. 1). At the same time, detailed research in a number of directions (aerodynamics, structures, solid physics, etc.) has resulted in the production of aeroplanes of a size, and capable of speeds, which would have been inconceivable only a few years ago (Fig. 2).

The development of increasingly powerful rockets, combined with extremely rapid progress in other branches, among which electronics are outstanding, has led to the construction of missiles and huge space launchers. With these, it has been possible to put first unmanned, and then manned, artificial satellites into orbit round the earth; within twelve years of the launching of the first artificial satellite, two men landed on the moon and returned to earth after spending about twenty hours on our satellite.

Widely differing branches of science and technology have contributed to this progress, with the aeronautical industry acting as a catalyst.

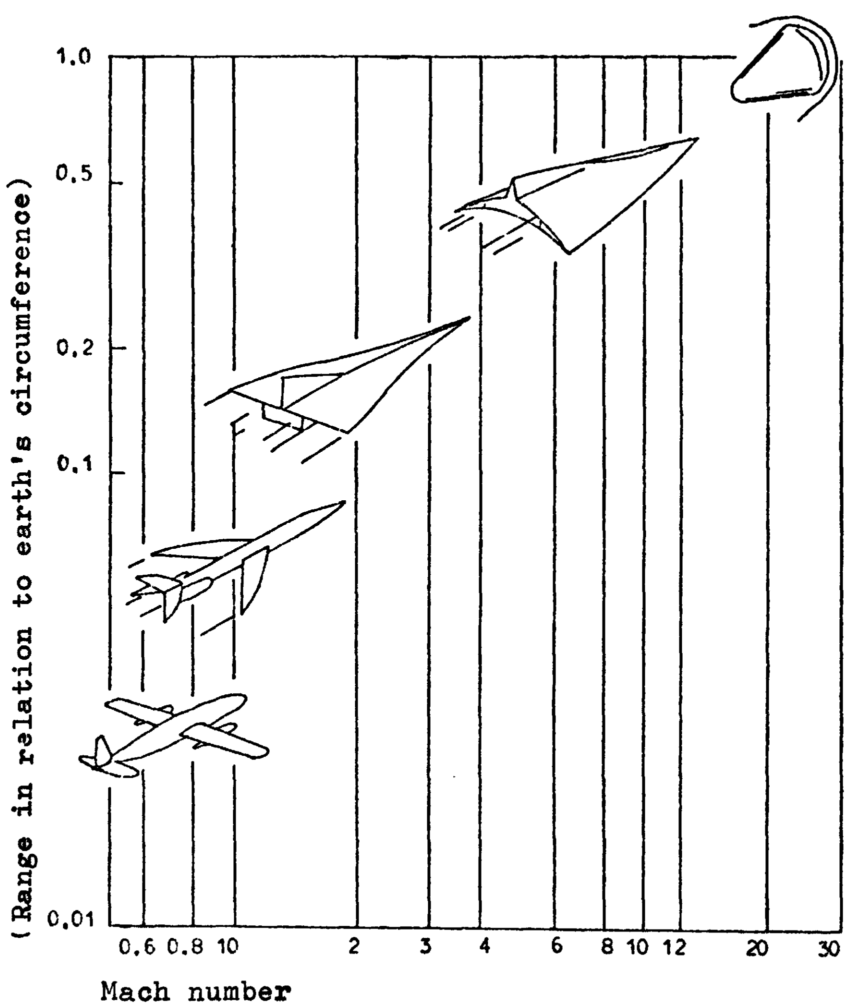
It is unlikely, however, that all this would have been possible but for at least two other factors, which characterize the aeronautical industry in varying degree: (a) government intervention and (b) the

FIG. 1 <u>Increase in the Power of Jet Engines 1945-65</u>



Source : INTERAVIA 4/1966.

FIG. 2 Changes in Aerodynamic Configuration



Source : INTERAVIA 4/1966.

development of new methods of management and of organizing production.

Obviously, the first factor cannot be regarded as peculiar to the aeronautical industry; nevertheless, in this case, it is not only of decisive importance but also has assumed highly specific forms.

In the aeronautical industry, the State plays a dual and sometimes a triple role:

- it finances and directs research and development concerned with military aircraft and space programmes, and often civil aviation as well;
- it is traditionally the main purchaser of the products of the aeronautical industry;
- it sometimes intervenes at the production stage, either by holding capital in companies or by allowing the latter to use premises, plant and machines almost or completely free of charge.

The result, with variations of emphasis and direction from country to country, is a permanent partnership between the government and the aeronautical industry.

The second factor, namely, the introduction and application of new methods of management and of organizing production, has been equally decisive for the aeronautical industry. With these methods it has been possible to carry through highly complicated and sophisticated aircraft, missile and space programmes in a very short time and at the same time to achieve absolute reliability for both components and the whole system. The coordination and specialization of the planning and production stages and the coordination of firms engaged on individual programmes have attained a remarkable pitch of efficiency, particularly in the United States, where the impetus given by the government has been of great importance in this respect.

We feel that because of these features (development of new products and introduction of completely new production and management techniques) the aerospace industry's contribution to technological progress can be regarded as decisive. Nor does this important observation cover all aspects of the question.

First and foremost, there is the problem of the interdependence of branches of the economy, regarding which it should be noted that:

- today, all the most technologically advanced branches of industry are linked, directly or indirectly, with aerospace research and production, which indeed sparked off their development, with the consequent impact of all the new technological knowledge on the productive system as a whole;
- analytical planning, or, as it is more generally known, systems management, which was first developed in the aerospace industry, is now spreading to all other branches both within and outside industry, with effects which cannot yet be assessed in material terms but will certainly be positive in the very near future.

Lastly, special reference should be made to the far-reaching influence of the aerospace industry on the economics of transport at national, international and intercontinental level and to the social and political consequences of the introduction and rapid spread of air transport.

The final conclusion is that over these first sixty years of its existence, the aeronautical industry has changed so radically and profoundly from its original form that it now has no set limits.
For example, it cannot be said that the aeronautical industry consists exclusively of constructors of airframes, engines, components and equipment: in particular, work on missiles and space programmes has now brought in many other productive branches, and electronics most of all.

It is therefore very difficult, if not completely impossible, to define the aeronautical industry, especially as the techniques used are changing very rapidly.

For the purposes of this survey, therefore, our definition of the aeronautical industry will be restricted to the traditional branches and the statistical criteria adopted by the countries investigated will be adjusted to that definition. Interconnections with other branches of research and production will, however, be described and given special mention.

Again, the aeronautical industry cannot be regarded as existing on its own; due allowance must also be made for the economic, social and political consequences of aerospace activities and this we shall also seek to do in this report.

2. THE PROCESS OF PRODUCTION

2.1 General Remarks

Up till the Second World War, aircraft were not extremely complex.

Since 1945, however, the aeronautical industry has progressively developed more and more sophisticated products for both military and civil applications[1].

This evolutionary process has involved the use of new materials[2],

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[1] Some of the main problems dealt with since the war are supersonic flight, the swing-wing aircraft, automatic all-weather landing, short and vertical take-off and landing (S/VTOL).

[2] In many cases the aeronautical industry has made a decisive contribution to the development of the techniques involved (e.g., titanium).

the introduction of the traditional branches (airframes and engines) of new technologies and advanced construction techniques, swift changes in equipment[1] and generally greater sophistication and complexity in planning and production, with consequent increases in the relevant times and costs[2].

Missile and space work was added to this process with a consequent speeding up of the rate of change in certain branches[3]. New technologies were stimulated, the reliability of components and systems was improved and new methods of management and of organizing production were introduced at both branch and industry level.

The changes which have taken place have not, however, substantially altered the basic characteristics of production in the aeronautical industry i.e., the clear distinction between the airframe, engine and equipment branches has been maintained.

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[1] Electrical, electronic, hydraulic and mechanical.

[2] According to the Plowden Report:

- a Spitfire cost £10,000; a Lightning Mk 1 now costs £500,000;
- the development of the TSR-2 would have cost £300 million and each single aircraft produced would have cost £3 million, this being respectively 20 and 10 times the cost of the Canberra, which the TSR-2 was intended to replace;
- the cost of developing a modern subsonic commercial jet aircraft may exceed £50 million, with each single aircraft costing from £1,500,000 to £3 million; these figures are two or three times as those for the previous ten years.

[3] e.g., avionics.

At the same time, the relative importance of the three branches with respect to the finished product has changed with the passage of time. In particular, while the engines branch shows no appreciable change, the airframe branch has declined in relation to the equipment branch.

This process is clearly demonstrated by the table below, which gives figures for a number of French military aircraft produced since 1949.

Type of Aircraft	Flight of First Prototype	Airframe %	Engines %	Equipment %	Total Cost %
Ouragan	1949	54.7	13.7	31.6	100.0
Nord 2501	1950	42.7	20.7	36.6	100.0
M.D. 452	1951	46.2	23.3	30.5	100.0
Mystère IV A	1952	48.4	21.9	29.7	100.0
Vautour	1952	42.4	19.1	38.5	100.0
Super Mystère B2	1955	48.6	22.4	29.0	100.0
Breguet 1050 Alizé	1956	33.0	12.8	54.2	100.0
Etendard IV	1958	36.5	19.5	44.0	100.0
Mirage IV	1959	31.2	16.8	52.0	100.0
Mirage III C	1960	29.2	24.2	46.6	100.0
Mirage III E	1961	25.7	16.7	57.6	100.0

Source: Interavia 6/1965

The same process can be observed in the case of commercial aircraft[1], but is less marked than in the case of military types.

Missile and space programmes have further increased the importance of the equipment branch, and in particular of avionics and electronics.

2.2 The Production Cycle and the Organization of Production

The production cycle of the aeronautics industry consists basically of:

a) General research

b) Specific research and development

c) Production

The stages of the first phase cannot be determined in advance; moreover, since this research is not directed to specific projects it does not affect the direct cost of programmes.

Specific R&D comprises a number of separate stages, as follows: a first stage before production starts and possibly a second stage after the start of production.

The times required for specific R&D can be fairly accurately forecast at all stages; the first stage, for example, generally ranges from six to eight years for the first turbojets and from four to six years for the latest types (Figs. 3 and 4).

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1 For example, a comparison between the Caravelle and the Mystère 20 shows that the share of the airframe fell from 68 to 43% while that of equipment rose from 18 to 32.2%

It is interesting to note that times spent on R&D for similar aircraft projects (e.g., Trident and B 727) do not vary appreciably between the USA and Europe, up to the time of the first flight.

On the other hand, the time between the first flight and the first delivery is much shorter in the case of American aircraft programmes, so that American firms are often able to catch up on the lead initially established by European firms[1].

This advantage, which, we repeat, is frequently decisive is achieved by American firms at a stage which should theoretically be longer for them. As production runs are normally much longer than in Europe, tooling[2] is a much more complicated process and takes much longer to carry out and perfect than in the case of European firms.

The ability of American firms to "catch up" at this stage must therefore be due to other factors, which this chapter seeks to identify.

Specific R&D can continue even after the aircraft has gone into production; in such cases it is concerned with studies for modified versions of the original aircraft.

The length of the production cycle depends on a number of factors which are considered later. On average, however, it varies from eight to ten years, including modified versions.

The great length of the complete cycle (14-18 years) at once suggests the need for long-term programming in terms of markets, investments

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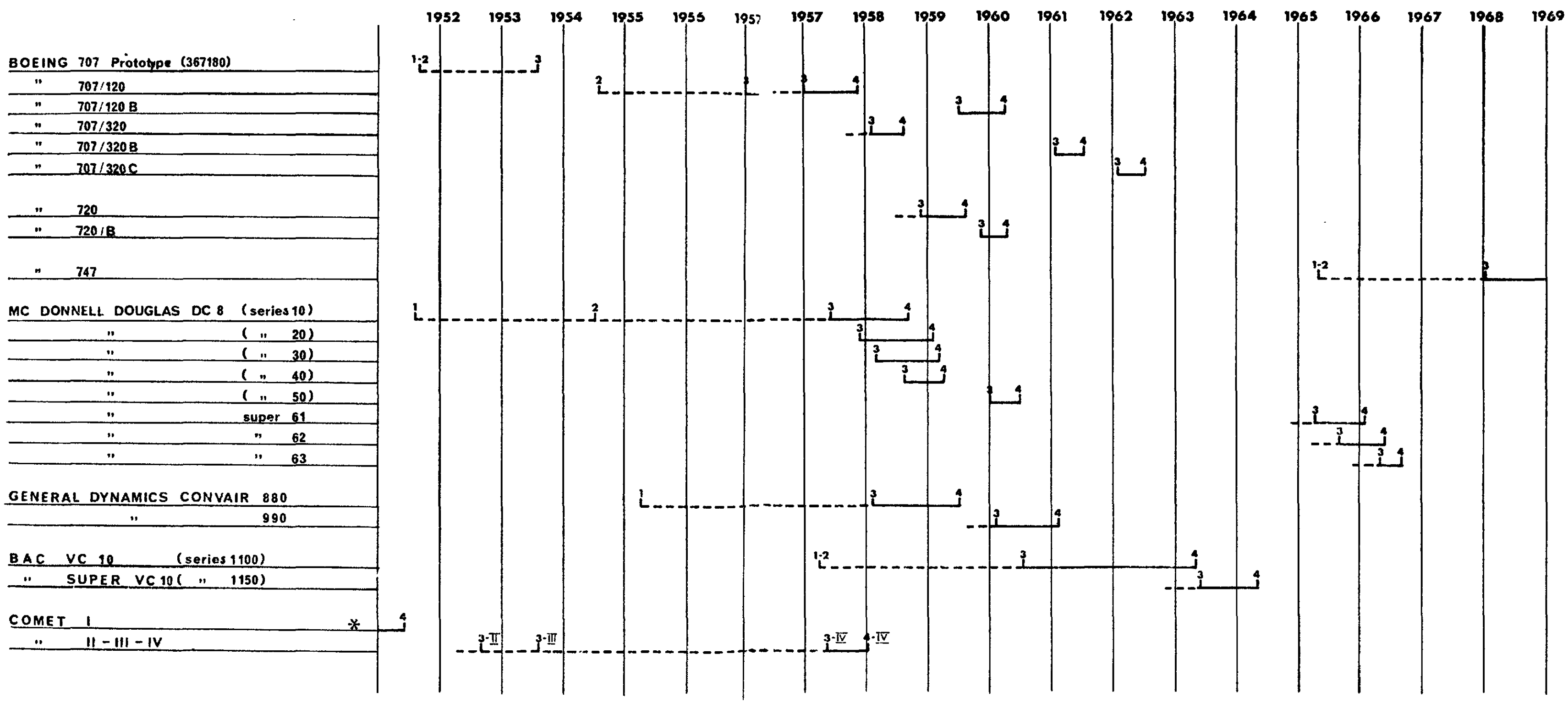
1 See, for example, the Trident and B 727 programmes.

2 See Section 2.4 below.

Fig. 3 Times Spent on R&D for Certain Long-Range Turbojets

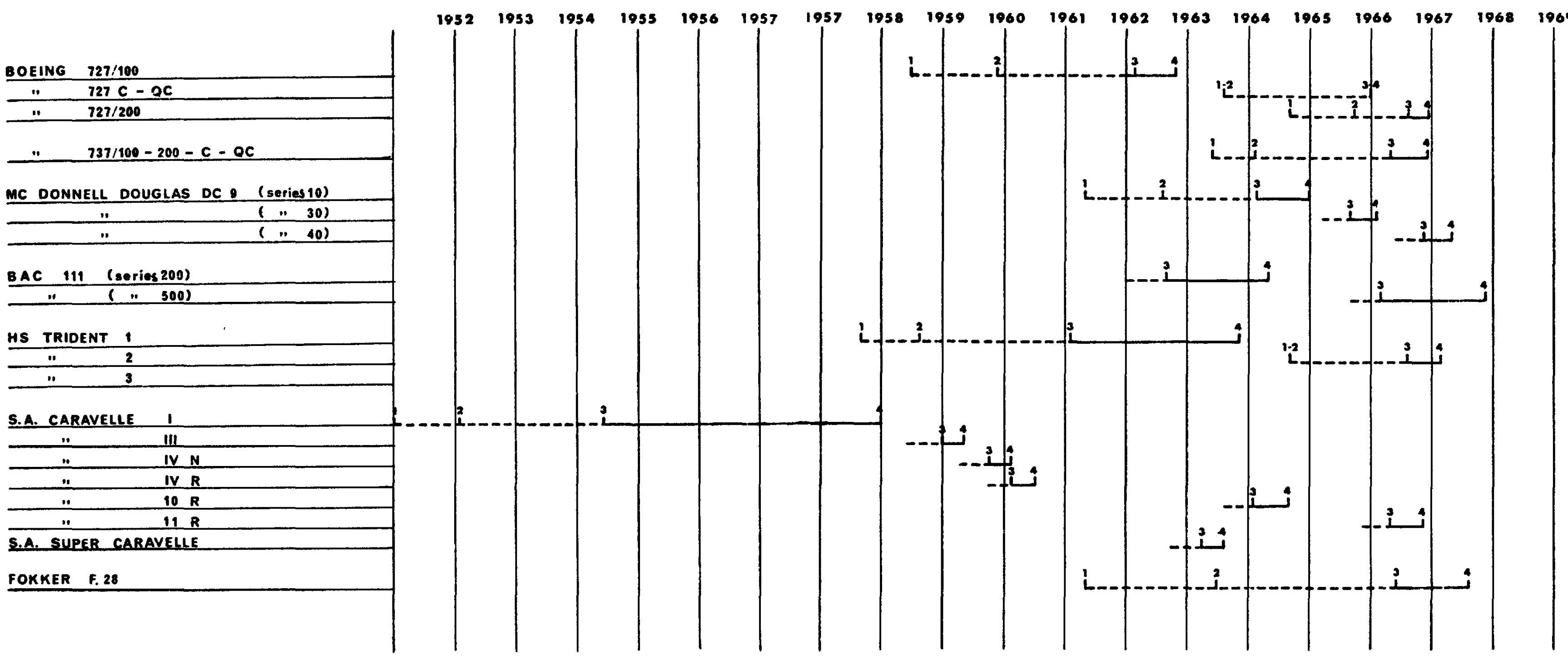


*Start R&D = 1943; GO AHEAD = 1947; 1st flight = July 1949

Source: Compiled by SORIS from statistical bulletins and Jane's "All the World Aircraft" (various years).

1 = Start R&D
2 = GO AHEAD
3 = 1st flight
4 = 1st delivery

Fig. 4 Times Spent on R&D for Certain Short/Medium Range Turbojets



1 = Start R&D
2 = GO AHEAD
3 = 1st flight
4 = 1st delivery

Source: Compiled by SORIS from statistical bulletins and Jane's "All the World Aircraft" (various years).

and personnel and underlines, particularly for commercial aircraft, the heavy risks associated with any project in this field.

Apart from special cases occurring in exceptional conditions[1], the aeronautical industry has always been characterized by the production of small numbers of each single type of aircraft. In practice, this special feature rules out the possibility of fully automating aircraft assembly lines, although previous stages of production are automated to some extent (parts of airframes and engines).

The final assembly of an aircraft does not therefore require large quantities of machinery, fixed plant and general tools[2]; on the other hand, big hangars, large numbers of expensive special tools[3]

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[1] For example, the following numbers were produced during the Second World War:

- single-engined types: Messerschmitt 109 (over 33,000 from 1936 to 1945;
  Focke-Wulf 190 (20,068 from 1940 to 1945);
  Spitfire (more than 22,000 from 1936 to 1945);
- twin-engined types: Douglas DC 3 (10,926 from 1934 to 1945);
- four-engined types: Convair Liberator (18,188 from 1939 to 1945).

[2] This statement must be taken to be relative; it is valid, for example, if the aeronautical industry is compared with the motor vehicle industry. On the other hand, it does not apply in absolute terms; aircraft firms also have to invest large sums in technical equipment, particularly for long production runs.

[3] Which can be used for one type of aircraft only.

and testing equipment and a very large, skilled labour force are required. This indicates the pattern of investment for firms making airframes. Buildings and land, special machinery and plant and test equipment will be heavy items. Special tools are not generally included among investments on the assets side of the balance sheet because, as will be seen, they are written off directly against orders.

Lastly, the fact that assembly cannot be automated and the need for heavy deliveries over relatively short periods involve heavy costs before processing (storage of components), on the production line and after production (testing stage). When one considers the cost of components, semi-finished products and finished items in this industry, it is not difficult to appreciate how much capital is tied up in these items, which in some American firms together account for one-third to half of the total assets on the balance sheet.

From the form which processing takes, as already briefly mentioned, it may be concluded that productivity in the aeronautical industry can only be increased by improving the organization of production as a whole, because stages or whole processing cycles cannot be automated, as they can in other engineering industries.

This is confirmed by examination of the structure of American aerospace firms[1], among which airframe constructors are increasingly adopting a new strategy and a special form of organization.

The new strategy can be defined as the gradual abandonment of the production of individual components and subsystems and the increasing adoption of the role of integrator and manager of the system.

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[1] See Annex 7: "Survey of the American Aerospace Industry".

Provided efficient means of systems management and monitoring are available, it is possible by dividing the work between large numbers of contractors and sub-contractors:

- to spread R&D and production risks over a number of firms;
- to make substantial savings on special tools and products by specialization of the various firms, while at the same time reducing outlay on machines and fixed plant and increasing their work ratio;
- to cut down overall production times.

With this arrangement, the firm in charge of the programme also tends to specialize and to introduce an appropriate pattern of production and organization.

Factories are planned on the basis of assembly of the large sub-systems and the complete system of a single aircraft programme so that the factory becomes identified with the programme.

As regards organization, responsibility for R&D, production and sales under a given programme is given to a division or one of its branches.

2.3 Production Costs[1]

2.3.1 Classification of costs

Aircraft production costs can be classified as follows:

Variable costs:	Direct labour
	Raw materials

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[1] The material which follows is taken from: "Cost curves and pricing in aircraft production" by S.G. Sturney in the Economic Journal, December 1964, and from "The learning curve and its application to the aircraft industry" by K. Hartley in the Journal of Industrial Economics, March 1965.

	Parts and components
	Variable production charges
Fixed costs:	Fixed production charges
	Overheads
Launching costs[1]:	Research and development
	Jigs and tools
	Sales and promotion costs
	Learning costs

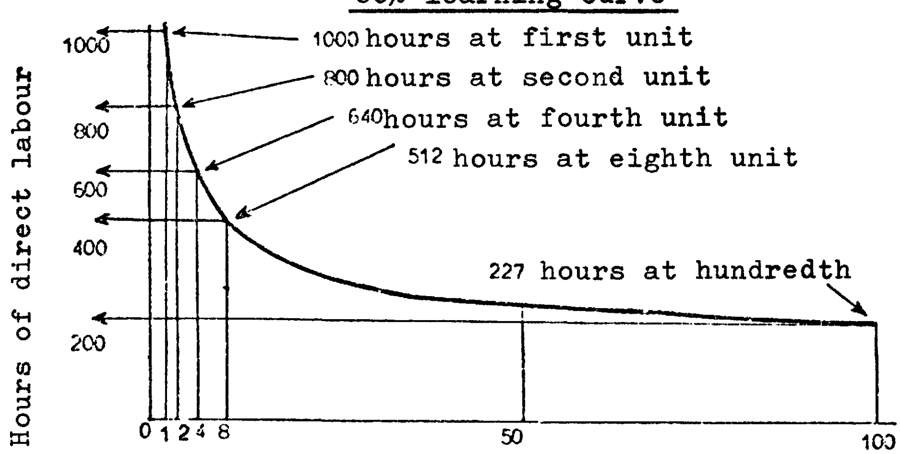
We shall now briefly review the main cost items in an attempt to highlight certain features and the main problems of aircraft production.

2.3.2 Direct labour and the learning curve

In the aircraft industry, the incidence of direct labour costs on production is defined by the so-called "learning curve".

This was devised by T.P. Wright from empirical data in 1936 and can be illustrated graphically as follows:

80% learning curve



Source: K. Hartley Op.Cit.

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[1] Launching costs as defined in English.

According to Wright, therefore, when the total number of units produced doubles, the average input of hours of direct labour drops to about 80% of the average input per unit prior to the doubling of production. This reduction applies to all units produced. Wright's curve is known as a cumulative mean learning curve.

Next, a (marginal) curve (Fig. 5) was worked out to express the reduction , in terms of a constant factor[1], of the input of direct labour per unit produced, each time that the number of units produced is doubled.

Despite the fact that learning factors may vary from case to case, 0.8 can be taken as a representative average for the trend of direct labour hours per unit produced.

The shape of the curve shows a marked drop in direct labour hours per unit produced during the first stages of production (up to the fortieth unit); the curve then tends to flatten, indicating that direct labour input per unit produced tends to become constant.

2.3.3 Raw materials, parts and components

It may be postulated that the cost of raw materials per unit produced tends to decrease at the earliest stages of production; once the cycle has been standardized, and excess losses and waste have therefore been cut out, this cost will tend to become constant for each unit produced.

Components comprise the engine, electronic and other equipment, landing gear, wheels and all other parts produced by specialist

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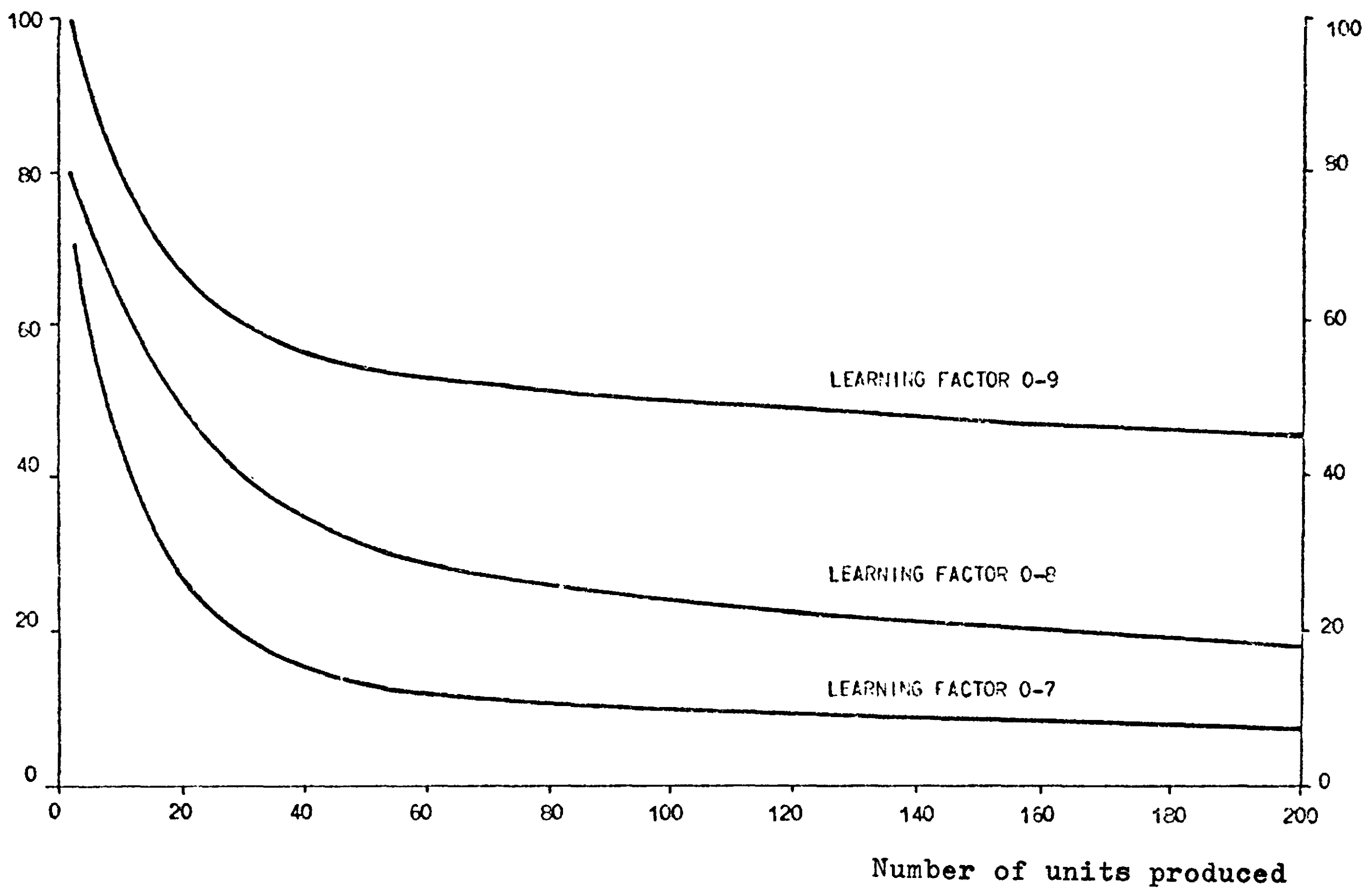
[1] Learning factor: three different learning factors (0.9, 0.8 and 0.7) are considered in Fig. 1

FIG. 5 Marginal Learning Curve



Labour input at unit n as a percentage of labour input for the first unit produced.

Source : S.G. STURMEY OP. CIT.

firms. The cost of components for an aircraft is constant for each unit produced if the number in the series to be constructed is known at the outset[1].

Allowing for the fact that the maker of components also has launching and learning costs, which have to be covered by a given number of units[2], the price is fixed by reference to the anticipated demand for aircraft equipped with the required components, plus the possible demand for spares.

Since the maker of the aircraft buys at this price, the cost of components per unit produced will remain constant if sales forecasts are fulfilled or prove too high (in which case the maker of components will lose to the extent that he fails to cover launching costs).

On the other hand, if sales exceed forecasts:

- the price of components may be reduced for units produced in excess of the number originally planned (this is normally the case in Europe);
- the price may remain constant if the contractor is associated with the R&D risk; in this case (frequent in the USA) the increased profit will go to the component manufacturer.

2.3.4 Launching costs

The biggest items in launching costs are research and development and special tooling (jigs, etc.).

Promotion, sales and learning costs are smaller items. These have already been mentioned under direct costs, with which they are included (in the learning curve).

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[1] and thus before orders are placed with contractors.

[2] the price per unit will clearly be higher for small runs.

As regards promotion and sales costs, it should be noted that when production is started before any firm orders have been placed, the manufacturing company normally charges special prices to the buyer who takes over the risk of introducing a new aircraft on the market. The difference between the "normal" price and this (lower) "special" price charged for the first units made forms an item in launching costs. Promotion and development costs account for a large part of launching costs, particularly at the moment: their special feature is that they have to be covered before production is launched and that their level is not affected in the slightest by the number of units produced.

This second aspect does not necessarily apply to specific tools, which are, however, a priority charge, in the same way as R&D.

In designing his tools, the manufacturer has a very wide range of choices, governed basically by the length of the run to be produced, the work load at factories and the cost of labour.

When the production run is short and wages are relatively low, the preference will go to simple jigs and dies, which are made by hand, are cheap and do not last long.

In such cases, the cost of drawings will also be cut because full details of all the assemblies are not required.

If the run is longer, detail drawings are needed for all (or most) items of the airframe and the corresponding tools; more use will have to be made of machine tools to produce dies, jigs and tools, involving high direct and indirect costs (tooling of machine tools). One option to some extent excludes the other and the consequences of a mistake can be very serious. If poor tools are chosen it may not be possible to meet an unexpected demand[1]. In the opposite

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[1] Tools, and more particularly assembly tools, are a real bottleneck in the production cycle, because they prevent output from exceeding the rate for which they were planned (this point is further discussed in Section 2.4 below).

case of large numbers of special tools and demand less than expected, inability to pay off capital investment will mean a substantial loss.

2.4 Trend of Costs in Relation to Volume and Rate of Production

In the study to which reference has been made, S.G. Sturmey reconstructs the cost components for a "standard" aircraft and makes a calculation for the break-even unit, i.e., the conditions in which for unit n and unit price p, np is by definition equal to total costs.

It is assumed that:

a) - launching costs = 20 p;
   - average unit launching cost for unit n = 0.2

b) - overheads = 300% of direct costs (excluding components)
   - the ratio of direct labour to materials (including components) and overheads is 1 : 4 : 5

c) Total overheads are made up as follows:

   - fixed overheads = 20% of the total; the ratio of fixed and variable production charges is 2 : 1.

On the assumption that for unit n total costs are equal to p and that average unit launching cost is 0.2, it follows that average production costs will be 0.8 p.

The breakdown of cost items at the break-even point is, therefore, as follows:

Direct labour	0.08 p		
Raw materials	0.05 p		
		Direct costs	0.13 p

Components	0.27 p		
Variable on costs	0.10 p		
		Variable costs	0.50 p
Fixed on costs	0.22 p		
Overheads	0.08 p		
		Production costs	0.80 p
Launching costs	0.20 p	Total cost	p

The number of aircraft n to be produced is also determined by the foregoing.

If:

- total costs = np
- total launching costs = 20 p
- average unit launching cost = 0.2 p

Then:

n must be 100

By applying an 80% learning curve for direct labour to this unitary relation, S.G. Sturmey was able to compile the following table, which assumes that the break-even point is reached with the hundreth unit:

Number of units produced	Direct labour cost	Materials parts and components	Variable on-costs	Estab-lish-ment costs	Over-heads	Prod-uction costs	Launching costs	Total costs
1	2.43	3.2	1.0	6.63	3.0	9.63	200.00	209.63
10	1.54	3.2	1.0	5.74	3.0	8.74	20.00	28.74
20	1.28	3.2	1.0	5.48	3.0	8.48	10.00	18.48
30	1.15	3.2	1.0	5.35	3.0	8.35	6.66	15.01
40	1.05	3.2	1.0	5.25	3.0	8.25	5.00	13.25
50	0.98	3.2	1.0	5.18	3.0	8.18	4.00	12.18
60	0.93	3.2	1.0	5.13	3.0	8.13	3.33	11.46
70	0.89	3.2	1.0	5.09	3.0	8.09	2.86	10.95
80	0.85	3.2	1.0	5.05	3.0	8.05	2.50	10.55
90	0.82	3.2	1.0	5.02	3.0	8.02	2.22	10.24
100	0.80	3.2	1.0	5.00	3.00	8.00	2.00	10.00
200	0.65	3.2	1.0	4.85	3.00	7.85	1.00	8.85

It will be seen that:

- the difference in average production cost between the thirtieth and the hundredth unit is 4.2%; the drop in total cost due to this factor is about 2%;
- total costs fall by 33% from the thirtieth to the hundredth unit produced because of the reduced incidence of launching costs.

This clearly demonstrates that the critical factor in any aircraft programme is to be found in launching costs.

The overall pattern of costs shows that action to support production has its maximum effect (by lowering the break-even point) if it brings down launching costs[1].

While the length of the production run is unquestionably the most important variable, the rate of production, which has so far been assumed to be constant, can play a very significant part in some cases.

Short runs rule out high rates of production because they do not justify costly tooling[2]: instead, the maximum savings on production are usually achieved when rates are not high.

The balance can however, be upset by two different factors:

- the market may require higher rates than planned: in this case, once the saturation point of the available equipment has been exceeded (particularly in the case of assembly jigs), it will become necessary to make new tools which cannot easily be covered by a short run;
- demand may be higher than anticipated; in these circumstances, even with a low rate of production, the situation already described may be repeated with the variant that new dies and tools will have to be made for machine tools rather than new assembly tools.

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[1] In the case quoted, a grant amounting to 50% of launching costs would lower the break-even point from 100 to 54 units.

[2] See Section 2.3.4 above.

On the other hand, a long run allows high rates of production, because of the large number of tools available which can be paid off over the number of aircraft to be produced.

Such rates can be handled economically by a large manufacturer, who can use his fixed plant at full load to make parts and sub-assemblies and can use various assembly jigs.

A small manufacturer seeking to compete for the long runs at high production rates would, however, be in difficulty: he would be unable to increase his fixed plant, unless he hoped to recoup his capital outlay over subsequent runs making other types of aircraft. If he decides against this and increases his stock of special tools, this item will cost more and his production costs will be higher than those of a firm tooled from the outset for long production runs.

The points so far discussed mark one of the basic differences between the American and European industries.

Long runs are , of course, very frequent in the United States, for both military and civil aircraft; moreover, American runs are longer than those experienced in Europe[1].

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[1] The Plowden Report estimated that:

- production runs for American military aircraft brought into service between 1955 and 1961 amounted to 530 units as against 177 for the United Kingdom (ratio 3 : 1);
- the corresponding figures for commercial aircraft were 320 for the USA and 68 for the United Kingdom (ratio 4.5 : 1).

A similar calculation for Europe, covering only the main types brought into service since 1955, gives the following results:

- military aircraft: average American run = 1,409 against 409 for Europe (ratio 3 : 1);
- commercial aircraft: average American run 492 against 138 for Europe (ratio 3.5 : 1).

On the basis of our foregoing remarks, it may be stated that the American industry is tooled and scaled for long aircraft production runs at lower cost and at higher rates than its European counterparts.

Figs. 6 and 7 illustrate this last point and show clearly how the American industry succeeds in constructing large numbers of aircraft during the first two or three years of production.

With this productive capacity, American firms are able to fulfil orders very quickly (Figs. 8 and 9) and to deliver at almost the same rate as orders are obtained.

As already stated[1], the shortest of the time between the first flight and the first delivery often enable American firms to catch up the lead initially enjoyed by European firms; their ability to produce large numbers of tools rapidly in turn enables them to fulfil orders from airlines very quickly. Clearly, this last point will weigh heavily when airline companies are making a choice[2] because their market is on such a scale and so competitive that they cannot delay bringing new aircraft into service as they have to keep up with their competitors.

Since only the main programmes are taken into consideration, the average run is naturally higher than the figure given in the Plowden report. However, for military aircraft the USA/Europe ratio is the same as the figure in the Plowden report; for commercial types, the ratio is more favourable to Europe because a number of non-British projects (Caravelle, etc.) are included.

1 See Section 2.2.

2 The same argument can be used in the case of military aircraft, but for different reasons.

FIG. 6 Deliveries of Long-Range Turbojets
(Year of first delivery = 0)

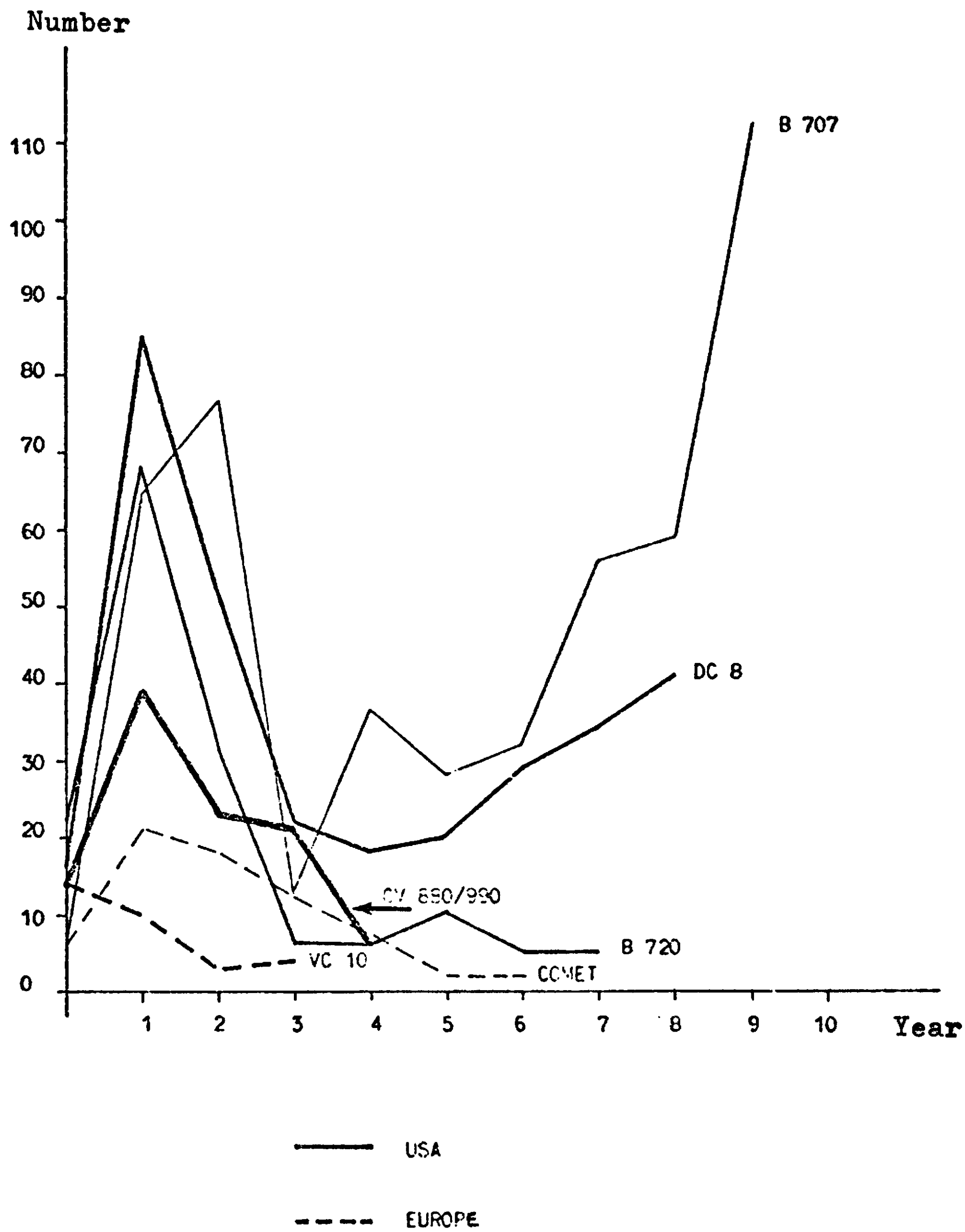


FIG. 7

Deliveries of Medium/Short Range Turbojets

(Year of first delivery = 0)

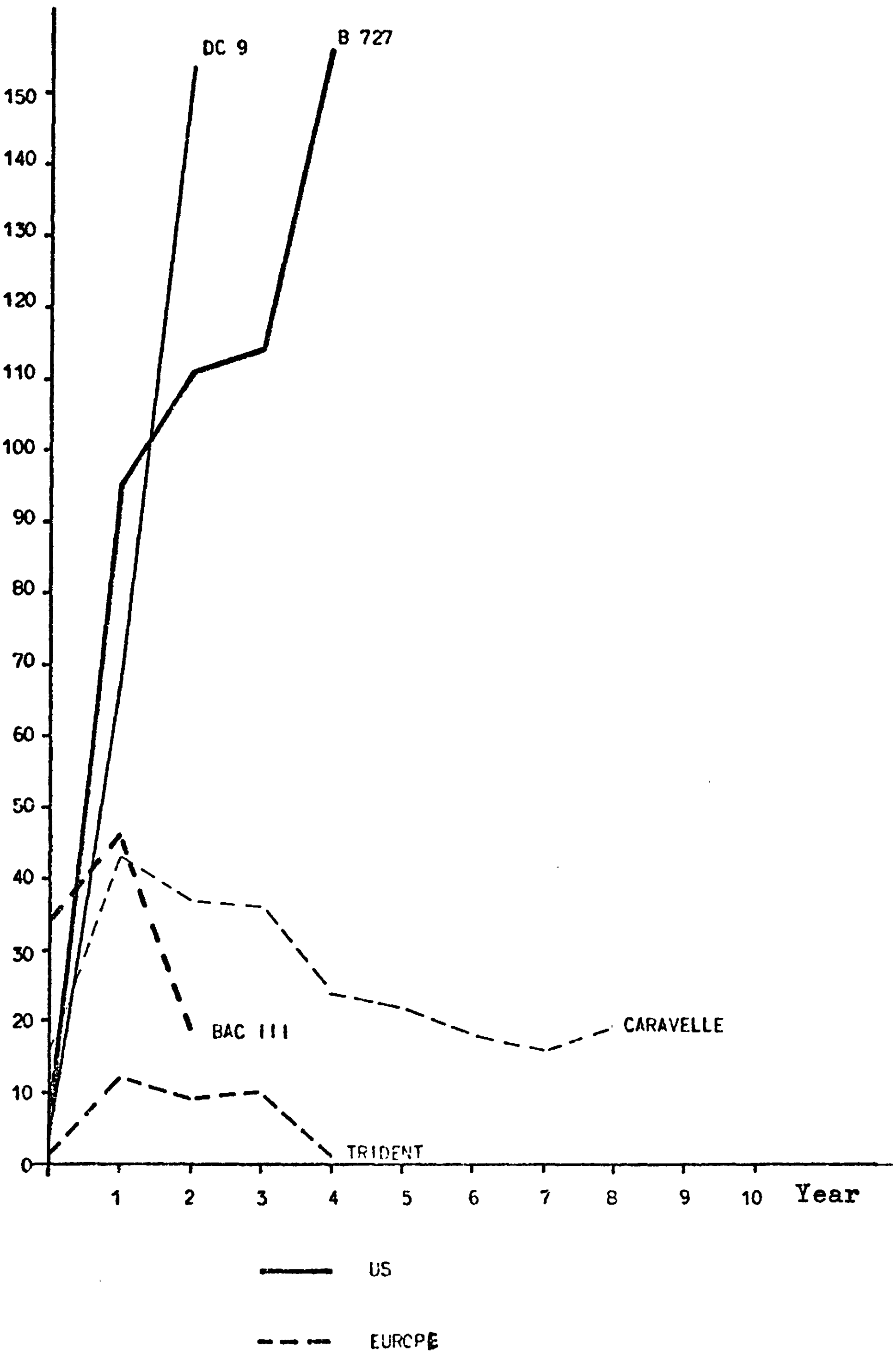


FIG. 8

Orders and Deliveries: American and European Long-Range Turbojets

(US - DC 8, B 707, B 720, B 747, CV 880/990; EUROPE - COMET, VC 10)

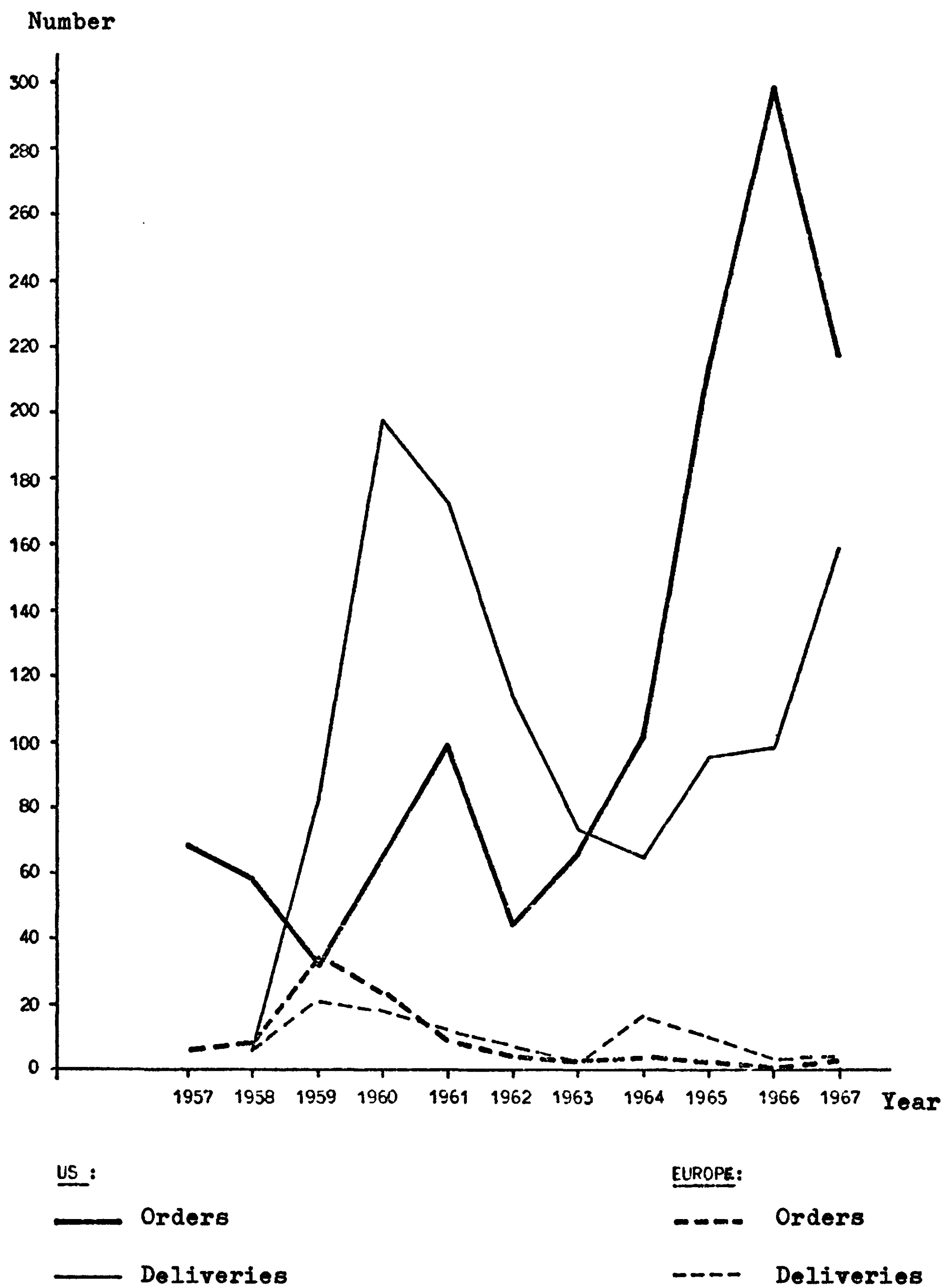
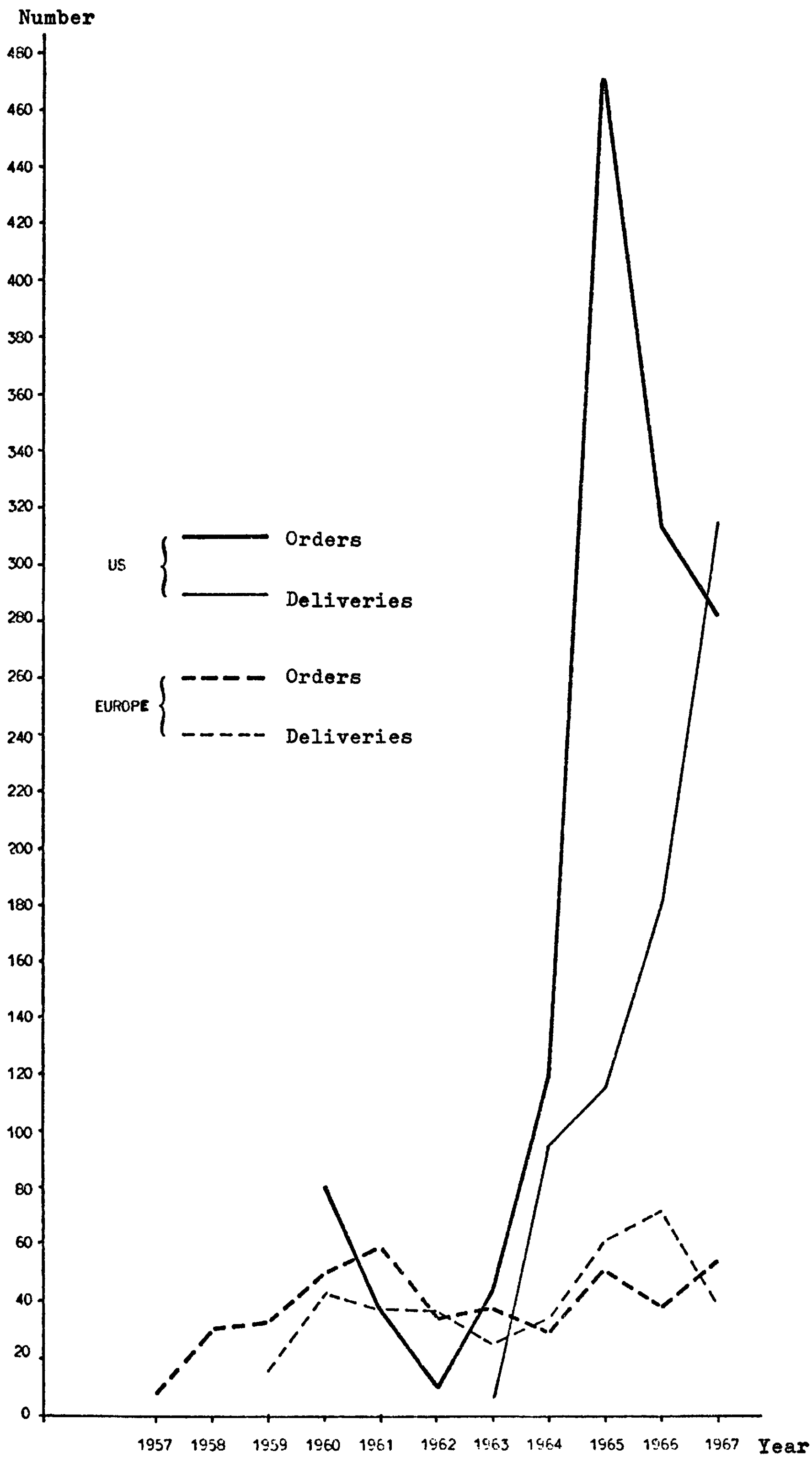


FIG. 9 **Orders and Deliveries: American and European Medium/Short Range Turbojets**

(US : B 727, B 737, DC 9; EUROPE - BAC 111, TRIDENT, CARAVELLE F 28)



3. CHANGES IN AERONAUTICAL AND SPACE FIRMS

3.1 Concentration of Firms

It has already been stated[1] that only a big undertaking is capable of producing long runs economically and at the same time of maintaining a high delivery rate.

Turning to the financial aspects, it must now be noted that, because of the length of the planning/production cycle and the actual form of the production process, aerospace firms require a large amount of capital[2] to finance:

- productive investments;
- research and development;
- production;
- leasing and customer credit.

Clearly, a big undertaking will find it easier than a small one to obtain the funds it requires from the capital market, and will also be in a stronger position to deal with government departments because of its greater contracting resources.

Another factor which favours the big firm derives indirectly from the diversification of the activities of aeronautical companies. Anticipating a fuller treatment of this point[3], it may be said that this diversification has either been stimulated by the government (missiles and space programmes) or has been undertaken deliberately

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[1] See Section 2.4.

[2] As well as a big labour force and a high input of materials.

[3] See Section 3.3 below.

by firms who have channelled investments to the commercial aircraft sector and marginally towards other minor sectors, to escape from the dangerously rigid position of having the State as their sole customer.

The fact that minimum optimum levels, to which reference has already been made, apply to the new branches of activity also, has necessarily militated in favour of bigger dimensions.

The trend towards big undertakings is a fact, and is fully justified by the foregoing remarks.

However, the existence or absence of the conditions calling for large firms may alter the pattern so far described.

Thus, for example, a public company may have no problems as regards finance (assuming that its programmes are sound or of interest to the State) or may have no interest in diversifying (the government may, on the contrary, insist on specialization).

Similar circumstances may arise in countries where the central government intervenes otherwise than by providing capital but with similar effects so far as firms are concerned.

This may well explain the size of many European undertakings, which, as will be seen, are much smaller than their American counterparts.

The only condition which can hardly be challenged is the first one set out at the beginning of this section, namely, that only a big firm is capable of producing long aircraft runs economically and rapidly. Since it is not necessarily true, at least on a priori grounds, that the market for the European aerospace industry must be confined to Europe, and assuming therefore a world market and the possibility of long production runs, European firms must, other things being equal, be big enough to meet international competition successfully.

Taking into account the varying conditions of the markets in which the main aerospace firms in the EEC countries, the United Kingdom and the United States have to operate, we shall now make a brief survey of trends over the last few years[1].

In the United States, if we exclude the merger of the McDonnell and Douglas companies[2], the present size of the main aerospace firms has been arrived at more by autonomous development than by a process of concentration.

Three main factors have contributed to the growth of American companies, which were in fact already of some considerable size by the end of the fifties.

While space programmes have not overall, i.e., so far as the industry is concerned, contributed greatly to increasing total output (owing to the falling off of demand for military aircraft), they have concentrated orders on a few firms and in particular on those which were already "big" by the end of the fifties.

The new contracting policy, first, of NASA and then of the DoD, have considerably restricted the government's previous policy of providing factories, plant and machinery to be used free of charge or virtually so, and has obliged companies to invest large sums in technical equipment and premises to meet the revived public demand.

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[1] This point is dealt with in greater detail for each country in the "National Reports" and in Annex 2: "Survey of the American Aerospace Industry".

[2] Brought about by Douglas' need for substantial amounts of capital to finance tooling, R&D and production to meet orders obtained or under negotiation, and probably by McDonnell's interest in diversifying on the demand side.

From 1964 onwards, the expansion of commercial aviation has called for heavy investment in technical equipment and large amounts of capital to finance production.

Consequently, there have been other mergers of aerospace undertakings, such as the absorption of Republic and Hiller by Fairchild, the concentration of Sikorsky and Pratt and Whitney into United Aircraft, etc., as well as others between aerospace and outside firms, such as the merger between North American Aviation and Rockwell, which is perhaps the most important of all.

Indeed, at a given size of undertaking, changes in the pattern of the aeronautical and space market would appear to have led the company concerned to merge with undertakings from other branches and/or to purchase them.

The table below may be helpful as a guide to what has been happening:

Concentration of American Aerospace Firms by Branches of Activity

(1955-63)

(percentages)

Total turnover of aerospace firm taking over ($M)	Branch of activity of firm taken over						
	Aerospace	Electronics	Production of metals and machinery	Chemicals	Instruments	Other	Total
200	10	30	10	22	13	15	100
50-200	12	21	35	6	-	26	100
50	37	1.5	34	-	-	14	100

Source: Federal Trade Commission and National Industrial Conference Board.

Between 1955 and 1963 the biggest American aerospace companies, notably those with a turnover of over $200 million, mainly took over firms working in the most advanced branches of industry, such as electronics, chemicals and instruments.

The reason for this trend may be the growth of space programmes which, over the last few years, have been increasing the demand for work on electronics, power plants, instruments and other extremely complex and sophisticated sub-systems, while activity in the aircraft branch proper (airframes) has been falling off relatively.

The steadily growing importance of aerospace firms in the field of the most advanced technologies may easily be deduced from the foregoing.

Medium-sized firms (with a turnover from $50 million to $200 million) have to a greater extent taken over undertakings engaged in the production of metals and the construction of machinery.

This is indicative of the trend towards diversification (outside the aeronautical industry), but in branches of industry which are less advanced technologically.

The smallest firms (turnover below $50 million) have, on the other hand, taken over a greater number (37%) of companies already working in the aerospace sector.

These last are generally firms engaged on the supply of components and the production of parts of aerospace systems, rather than on the planning and manufacture of finished products. With their limited scientific and technical management capacity, such firms are naturally less interested in taking over companies from advanced technological branches.

Around 1960, the example of large American firms, on the one hand, and the excessive fragmentation of British companies, on the other, led the British Government to promote the concentration of firms in the United Kingdom, through its position as a source of contracts.

The aim of this move was to reduce the excessive fragmentation of investments and research expenditure and to enable the British industry to compete at international level.

The initial result (Fig. 10) was the formation of two groups each in the airframes and engine branches and one for helicopters.

The subsequent concentration of the two engine undertakings resulted in the formation of a company bigger[1] than the engine divisions of the equivalent American companies. There are still two airframe companies, however, even though the government has come out in favour of their merger into a single undertaking. This has so far been prevented by the state of the economy.

The aerospace industry of the European Community is characterized by the fact that firms are small and, in some cases, very small.

The French and German governments have encouraged concentration and mergers at national level.

In France, the main form of government action has been the nationalization of a number of companies[2].

Up till 1966, private undertakings were not involved in the process of concentration which in any case was not on a large scale[3]. In 1967, when the government declared its policy on the reorganization of the aerospace industry, the private company Dassault took over another private company, Breguet, and the nationalized undertaking,

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[1] Employing about 80,000 men.

[2] Namely, the formation of Sud-Aviation (1957), Nord-Aviation (1946) and SNECMA (1945).

[3] Absorption of a number of subsidiaries and small firms (Morane-Saulnier, Air Fouga, Potez).

FIG. 10

United Kingdom - Concentration in the Aerospace Industry (1958-68)

1958	1960	1968
Airframes		
Hawker Siddeley [1] Blackburn Folland de Havilland	Hawker Siddeley	Hawker Siddeley
Bristol Aircraft English Electric Aviation Vickers-Armstrong Hunting Aircraft	British Aircraft Corporation	British Aircraft Corporation
Westland Bristol Helicopter Division Fairey Saunders-Roe	Westland Aircraft Ltd	Westland Aircraft Ltd
Auster Miles	Beagle	Beagle
Handley Page	Handley Page	Handley Page
Scottish Aviation	Scottish Aviation	Scottish Aviation
Short Bros	Short Bros	Short Bros
Engines		
Bristol Aero Engines Armstrong Siddeley de Havilland Engines Blackburn Engine Co	Bristol Siddeley Engines	Rolls-Royce
Rolls-Royce	Rolls-Royce	
Napier & Son (subsidiary of English Electric)	Napier Aero Engines (50% Rolls-Royce)	
Alvis	Alvis	Alvis

[1] In 1960, Hawker Siddeley had the following subsidiaries:

- Armstrong Whitworth
- Hawker
- Gloster
- A.V. Roe
- Armstrong Siddeley Engines.

SNECMA, took over the engine division of Hispano Suiza.

The two nationalized undertakings (Nord- and Sud-Aviation) and the research company SEREB are due to merge in 1970.

In Germany, the first mergers[1] date from 1963, when the conditions for starting a process which is still continuing, were created (government policy, firms brought together in consortia).

The decision to merge with Messerschmitt-Bölkow GmbH was taken by the family company of HFB in 1969.

In the Netherlands, there is only one firm working on airframes. This is Fokker, which has in turn taken over Avio Diepen and the aircraft interests of De Schelde (1954) and Aviolanda (1967).

In Belgium, three firms employ 90% of the labour force of the national aerospace industry: Sabca and Fairey in the airframes branch and the Fabrique Nationale d'Armes de Guerre SA in the engine branch. The fact that some of the capital of the two airframe firms is held by non-nationals probably accounts for the failure to merge.

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[1] The main mergers can be shown diagrammatically as follows:

Bölkow Entwicklungen KG (including Bölkow Apparatebau) Siebelwerke ATG GmbH	Bölkow GmbH	Messerschmitt Bölkow GmbH (1968)
Messerschmitt AG Junkers Flugzeug- und Motorenwerke AG Flugzeug Union Süd GmbH	Messerschmitt- Werke Flugzeug Union Süd GmbH	
Weser Flugzeugbau GmbH Focke-Wulf GmbH Ernst Heinkel Flugzeugbau GmbH	Vereinigte Flug- technische Werke GmbH (VFW)	
BMW Triebwerkbau GmbH MAN Turbomotoren GmbH	MAN Turbo GmbH	

Similarly, in Italy there have been no moves to concentrate aerospace undertakings, but for different reasons.

Overall, however, there has been a decisive move in Europe to concentrate aerospace firms at national and EEC level. In this connection, reference should be made to a number of recent steps (1968-69) aimed at setting up multinational companies[1] within the EEC.

For example, Fokker (Netherlands) and Dassault (France) have acquired equal shares in the capital of the Belgian company SABCA, while Fokker (Netherlands) and VFW (Germany)[2] have formed (in 1969) a holding company under the name of "Zentralgesellschaft VFW/Fokker GmbH".

Nevertheless, even allowing for the special conditions in which they operate, EEC firms and British companies (with the exception of Rolls Royce) do not yet appear to have achieved the necessary size to ensure sufficient financial, productive and organizational resources to enable them to compete independently on the international market.

Moreover, both governments and private operators appear to be well aware of these limits, as is confirmed by recent moves at both national and international level.

In the table on the next page (Fig. 11), the five leading American firms are compared with, respectively, the five biggest in the EEC

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[1] Which involve legal problems in the absence of adequate Community legislation.

[2] They had already been working together for some time on R&D and production.

FIG. 11 **Labour Force and Value Figures for the Main Firms Operating in 1969 in the EEC, the United Kingdom and the United States[1]**

	Labour force		Output	
	thousands	Percentage	Value millions of dollars	Percentage
EEC Countries				
Whole industry	164	100.0	1,758	100.0
of which:				
SUD-AVIATION - NORD-AVIATION - SEREB [2]	37	22.6	509	28.9
DASSAULT	13	7.9	279	15.9
SNECMA	13	7.9	213	12,1
MESSERSCHMITT - BÖLKOW - HFB	19	11.6	164	9.3
VFW - FOKKER	16	9.7	146	8.3
Total for five firms	98	59.7	1,311	74.5
United Kingdom				
Whole industry	254	100.0	1,610	100.0
ROLLS-ROYCE	73	28.7	605	37.6
B A C	37	14.6	439	27.2
HAWKER SIDDELEY	48	18.9	364	22.6
Total for three firms	158	62.2	1,408	87,4
United States				
Whole industry	1,168	100.0	23,258	100.0
MC DONNELL DOUGLAS	140	12.0	2,933	12.6
BOEING	142	12.1	2,880	12,4
NORTH AMERICAN ROCKWELL	115	9.8	2,438	10.5
LOCKHEED	92	7.9	2,335	10.0
GENERAL DYNAMICS	103	8.8	2,253	9.7
Total for five firms	592	50.6	12,839	55.2

1 The labour force and output value figures relate to 1967.

2 In 1970.

and the three biggest in the United Kingdom (classified on the basis of turnover).

It will be seen that the leading EEC undertakings account for a bigger percentage of both production and employment in the Community aerospace industry than do the main American firms within their industry.

On the other hand - and this is the crux of the problem - each of the leading American firms separately produces one and a half times as much as the whole EEC industry, with a smaller labour force.

The process of concentration which has been started and largely carried through in Europe must now be considered from other angles.

Some doubts may be felt concerning the formation, at national level, of a single undertaking with a monopoly of one branch (airframes or engines) of the aerospace industry.

Indeed, in some European countries voices of authority have expressed concern at the possible absence of healthy competition.

Far from disputing the soundness of this attitude, we shall here confine ourselves to pointing out that the geographical area within which the aeronautical industry operates and effective competition exists goes far beyond the confines of a single country.

The United States, which escape this competition in some measure, are the real proof to the contrary.

As is well known, the principal reason for the underdevelopment of the European aerospace industries is the narrowness of their national markets. Furthermore, programmes[1] calling for a great deal in the way of technology or the production of a long run have had to be undertaken jointly by the industries of several European countries.

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[1] Aircraft, missiles and space programmes.

It has already been shown, therefore, that markets of adequate size very often have to be sought beyond the national frontiers so that, in this case also, several European industries have to work together to deal with the problem. Hence, competition is not very active within the EEC or at European level.

While the European market may to some extent, and for a limited period, be sufficient for military aircraft, missiles and space work, the same cannot be said of commercial aviation. In the latter case, the market and competition are worldwide.

The contrast between the leading American firms taken separately and the EEC aerospace industry as a whole is now very clear. It thus seems to us that the characteristics of the aircraft, missile and space market do not merely prove that anxiety concerning national monopolies is ill-founded but call rather for further concentration on a supranational basis.

While this is unlikely at the moment[1], for a wide variety of reasons, there can, however, be no doubt that the concentration on aeronautical interests at national level may ultimately favour this process and, in more immediate and concrete terms, cooperation between the industries of the Community countries and more generally the countries of Europe, at either government or company level.

In Europe, the concentration of firms has led to the formation of groups of considerable size with substantial economic resources[2].

In the form it has taken, this concentration should theoretically enable the firms concerned to deal, at least partially and better

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[1] Even though the Fokker/VFW agreement is a by no means insignificant pointer.

[2] Within the limits stated earlier.

than before, with two of the problems enumerated earlier; they should be better able to obtain the necessary capital and to win contracts.

On the other hand, the problem of gearing the pattern of production to the new scale of the firm would appear to remain unresolved. In practice, mergers have not as a rule been concerned with reorganizing and replanning the existing production units. This is confirmed by looking at the large numbers of factories operated by each new undertaking[1]; these are generally widely scattered over the country concerned, are often very small and are still managed after quite some time by the companies included in the merger.

All this naturally militates against the rational and economic organization of production and, more generally, of the firm itself.

It may be concluded that the disadvantages of not having achieved the requisite size are further aggravated by the fact that expansion to the existing size has not as a rule been accompanied by reorganization of the production process and of the undertaking as a whole.

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[1] See "National Reports".

3.2 The Financial Structure of Aerospace Firms

3.2.1 Foreword

This analysis of the financial structure of aerospace firms in the EEC countries, the United Kingdom and the United States suffers from a number of limitations:

- no data are available concerning the aerospace activities of many firms either because none are published (in the case of companies not required to issue balance sheets)[1], or because they cannot be extracted from the general balance sheets of firms partly (and sometimes mainly) engaged on other activities[2];
- it is not accurate to add together, or even simply compare, figures for different firms working in the same branch and the same country: every undertaking has its own logic and history and, among other ways, this is expressed in the criteria which it applies in evaluating items in the balance sheet;
- if figures from the balance sheets of companies operating in different countries are compared or added together, further inaccuracies creep in because the companies concerned operate under different economic and political conditions.

In view of these reservations, great caution must be exercised in aggregating the figures from the balance sheets of several firms: in particular, the last reservation excludes any reasonable possibility of compiling even a tentative consolidated balance sheet for the main aerospace firms of the EEC. Since, for the reasons stated, no balance sheets are available for a number of aerospace firms, our analysis is limited to the following countries and companies:

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[1] This applies to almost all German aerospace companies.

[2] E.G., Hawker Siddeley (UK), Fiat (Italy), North American Rockwell (USA), etc.

France:	Nord-Aviation, Sud-Aviation, Breguet, Snecma, Matra and Turbomeca (economic indices were calculated for the first three only);
United Kingdom:	British Aircraft Corporation, Rolls Royce, Hawker Siddeley Group (figures for aircraft and missiles cannot be separated from the overall balance sheet);
United States:	Boeing, Douglas, McDonnell, Lockheed, General Dynamics, North American, Grumman, Northrop Aerojet General, United Aircraft.

The figures discussed below mostly refer to 1966[1]; the exceptions will be indicated as they occur.

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[1] Douglas and McDonnel are dealt with separately in the USA for this reason; the figures for North American precede the latter's merger with Rockwell.

3.2.2 Investment[1] and sources of finance

The pattern of the consolidated balance sheets of the companies named was as follows on 31 December 1966 (in percentages):

Relationship between the Consolidated Balance Sheets of Certain French, British and American Aerospace Undertakings on December 1966

	France	United Kingdom	United States
Floating capital	20.7	45.4	39.0
Net technical assets	41.5	19.5	44.0
Other assets and deferred charges	37.8	35.1	17.0
Invested capital	100.0	100.0	100.0
Made up of:			
Medium and long term debts	54.1	26.5	26.0
Own capital	45.9	73.5	74.0
	100.0	100.0	100.0

[1] The term "investments" is used here as meaning "capital used for ..." and is defined as:

a) Total net assets: total assets net of depreciation

b) Current assets: cash + short-term loans + production waste + finished products

c) Current liabilities: short-term debts

d) Floating capital: current assets - current liabilities

e) Invested capital: floating capital + net technical assets + shareholdings + deferred charges

f) Own capital: firm's capital + reserves + undistributed profits (or less accumulated losses)

The following points may be noted concerning capital invested: the proportion of floating capital is high in the United Kingdom and the USA. This is due mainly to the varying proportion of medium-term loans.

In France, the assets side of balance sheets includes a big item for credits deferred for more than one year, which do not therefore appear under "Current assets" but under "Other assets and deferred charges".

The percentage of net technical assets is very low in the United Kingdom and the figure of 19.5% cannot fail to arouse some perplexity.

The percentage of "Other assets and deferred charges" is high in France and the United Kingdom. Apart from the earlier comment regarding deferred loans, the explanation lies in the different proportion of holdings in associated companies. Moreover, in the case of the United States, it should be noted that the amount of capital tied up in leasing aircraft is higher than in Europe both absolutely and relatively.

The statistics available in the countries under review do not give details of investment in the separate branches.

This being so, we compared a number of firms, taking the airframe and engine branches separately. Our results are set out in the table on the next page:

Investment in a Number of French, British and American Aerospace Firms

(1966)
(Millions of dollars)

	France	UK	USA
	SUD-AVIATION	BRITISH AIRCRAFT CORP.	BOEING
Airframes			
Net total assets	552,8	221,7	1,444.5
Invested capital	239.3	138.1	1,076.7
Net technical assets	89.5	38.4	426.5
Net total assets per employee	22,209	6,471	11,241
Invested capital per employee	9,443	4,031	8,378
Net techn.assets per employee	3,531	1,120	3,319
Engines	SNECMA	ROLLS ROYCE	UNITED ARICRAFT[1]
Net total assets	273.6	618.7	1,046.1
Invested capital	106.1	407.9	558.3
Net technical assets	44.3	71.6	263.3
Net total assets per employee	22,352	7,332	12,826
Invested capital per employee	8,668	4,838	6,845
Net techn.assets per employee	3,619	848	3,228

[1] No separate figures available for Pratt and Whitney.

As regards sources of finance, we simply note that "Own capital" is the major source in both the United Kingdom and the United States. One result of this is a decisively more favourable degree of financial autonomy.

3.2.3 Profitability of firms and other economic indicators

Profitability was considered by reference to turnover, net total assets and own capital; the annual rate of turnover of net total assets was also taken into account.

Figures for the period 1962-66 are given in the table on the next page.

Profitability and Other Economic Indices for a Number of French[1], British[2] and American Aerospace Firms

(1966)

Year	Net profits × 100/turnover (%)			Annual turnover of net total assets (Times a year)			Net profits × 100/ turnover (%)			Profits × 100/own capital (%)		
	FRANCE	UK	U S A	FRANCE	UK	U S A[3]	FRANCE	UK	U S A[4]	FRANCE	UK	U S A
1966	0,92	2,03	2,5	0,56	1,12	2.1	0.51	2.27	5,4	3,80	5.34	15.8
1965	0,53	2,45	3.0	0,55	1.45	2,5	0.28	3.55	7.5	2,22	7,26	17,6
1964	0,55	2,33	2,4	0,59	1.38	n.a.	0,33	3.21	n.a.	2,27	6,16	15.5
1963	0,96	2,42	2,0	0,51	1,40	n.a.	0.49	3,38	n.a.	2,87	6,67	13,8
1962	1,64	1,68	1.9	0.61	1.38	n.a.	1,01	2.31	n.a.	5.27	4,99	13,6

1 It is recalled that for France only Sud-Aviation, Nord-Aviation and Breguet were considered.

2 There are no figures for BAC prior to 1966.

3 The annual rate of turnover in 1959 was 2.4

4 The return on net total assets was 2.9% in 1959.

Source: Compiled by SORIS from the annual reports of the firms concerned.

It must at once be pointed out that the figures for the United Kingdom are not as homogeneous as those for France and the United States because of the leading position occupied by the motor vehicle branch (Rolls Royce) and because of the weight of a major group such as Hawker Siddeley, which is not exclusively aeronautical. Comparison between the USA and France shows:

- the profits of French firms are rather low in relation to turnover, but the American figure, though higher, is still below that for other branches of industry (e.g., motor vehicles).

- nevertheless, the high annual rate of turnover of net total assets enables American firms to earn a good return on total investments; this is not so in the case of French firms, whose rate of turnover is well below unity.

  The problem appears to be particularly difficult both in the form stated and even more so when these figures are correlated to the higher level of investment per head already noted in American firms as compared with their French counterparts.

- profit on own capital, which is very good in the USA, appears to be inadequate in France, where the most important feature is that the relative proportion of risk capital to total sources of capital is distinctly lower.

Excluding the German firms, for which, as already noted, no balance sheets are accessible the comments for French firms can be extended to the other aerospace firms of the EEC countries.

The final picture is far from rosy:

- the low turnover of assets may indicate that capital is not being used to the full;

- the low rate of profit militates against the accumulation of capital and the recruitment of labour.

It should be borne in mind, however, that the profit rates of aerospace firms are low throughout the Western world; a fair return on total investments must therefore be sought by increasing the annual turnover of capital.

3.3 Specialization, Integration and Diversification of Production

A characteristic feature of almost all aerospace firms (airframe branch) has always been their almost exclusive concentration on that branch. The exceptions are either big financial groups (e.g., Hawker Siddeley Group Ltd, LTV, etc.) or companies formed by the relatively recent merging of aircraft firms with firms from other branches of activity (e.g., North American Rockwell).

On the other hand, for firms making engines, the aircraft side is generally one of several activities and in some cases (e.g., General Electric) not even the most important.

Demand has always been characterized by the clear dominance of government orders.

The picture is not as clear as that, however; particularly over the last twenty years, many positions have changed, as regards both supply and demand, as part of a process which is still continuing.

In the years immediately after the war, aircraft firms were engaged almost wholly on defence orders; 90% of their turnover was accounted for by military equipment. The proportion of government orders in the turnover of the aerospace industry has since gradually declined[1] and demand has become diversified almost everywhere.

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[1] In 1967, the proportion of government orders in the turnover of the aerospace industry was 65.3% in the EEC, 62.6% in the United Kingdom and 75. 3% in the United States.

The missile and space programmes have provided the new firms with subjects for research and have thus stimulated the growth of secondary branches such as those concerned with equipment (electronics in particular).

The establishment of civil space authorities in a number of countries has also introduced a new customer, who has made quite a lot of changes, especially in relations with the industry and more particularly in the United States.

On the supply side, therefore, all or almost all aircraft firms have diversified considerably and have added R&D and the production of missiles and space hardware to their traditional range of activities.

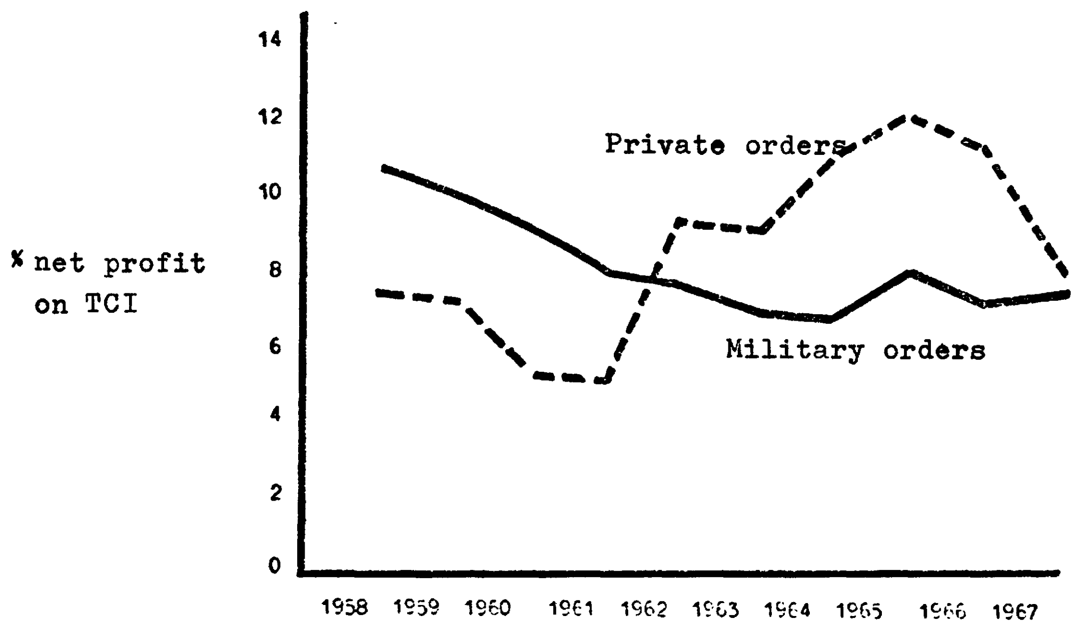
From firms' point of view, government demand, whether military or civil (space) has a number of disadvantages, which may be too great when the proportion of the firm's total activity goes beyond a certain limit. These disadvantages include:

- The limited strength of firms (taken separately) when negotiating contracts with the government exposes them to serious risks arising from factors over which they have no control, such as variations in the quality and quantity of government orders (budget fluctuations, changes in strategy and therefore in the relative importance of different types of armaments, etc.) or the introduction of new regulations for contracts (which may, for example, require firms to use a large amount of their own capital).

- The return on government orders is generally low and normally less than that on private orders, as can be seen from the graph (Fig. 12) on the next page.

On the other hand, government orders offer firms' substantial advantages, including:

FIG. 12 <u>Return on Government and Private Orders in Terms of Total Capital Invested (TCI) in the Main American Firms</u>



	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Military orders %profit on TCI	10.1	9.5	8,7	7,5	7.4	6,5	6.3	7.6	7.0	7.3
Private orders %profit on TCI	7.0	6.8	4.8	4.7	9,0	8.7	10.9	11.6	10.8	7.4

Source : DEFENSE INDUSTRY PROFIT REVIEW - LOGISTICSMANAGEMENT INSTITUTE, WASHINGTON DC, MARCH 1969.

- the possibility of undertaking R&D in the most advanced fields and of acquiring the corresponding knowhow, which can then be transferred to their own lines of production;
- the provision of plant and tools free or virtually free of charge;
- adequate finance for R&D and production;
- a relatively certain work ceiling, which will keep plant running at satisfactory capacity and ensure relatively stable employment, thus providing an adequate return on total investments.

As a result of the disadvantages of government orders, firms have concentrated a considerable part of their resources on commercial activities, particularly in recent years. In many countries, moreover, the government is not a complete stranger to this new development, for throughout the world governments are making decisive moves to support commercial aircraft firms. The reasons for such intervention, which vary from country to country, can be enumerated as follows:
- support for programmes which are too costly for firms (e.g., supersonic aircraft);
- expansion of exports;
- adequate use of plant;
- stabilization of employment.

Despite frequent government support (particularly in Europe), commercial aircraft production involves very heavy risks[1] which can have disastrous consequences[2] if they materialize.

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[1] Balanced by an adequate return, however.

[2] The American firm of Convair is a significant example.

In view of the typical advantages and disadvantages of both government orders and commercial activity, the main firms have adopted a strategy of compromise so that today the risk tends to be more or less evenly spread between the government and commercial production, particularly by the leading American firms. A modest degree of diversification, which must not be underestimated, has been started by a number of firms, mostly in the USA, which have entered branches outside the aerospace industry (e.g., shipbuilding and oceanography) and the service sector (real estate development and planning).

The changes described above have taken a number of sharp turns in the countries under review.

In the United States, the aircraft industry was faced with excess production capacity in 1951, when the government embarked, even if not avowedly, on a policy of protecting companies by awarding them contracts under a non-competitive purchasing policy[1].

That year saw the start of the missiles programmes, which were not, however, sufficient to absorb the excess production capacity.

The Korean War speeded up expenditure on both aircraft and missiles, but this flow was suddenly cut off in 1957[2]. Firms which had meanwhile been forced to resort to government protection had to find new markets, to adapt to the changed government demand and, from 1961-62 onwards, to a new contracting policy[3].

---

[1] Or competitive only at the design stage.

[2] Some months before the first Sputnik was launched.

[3] See Annex 9 - "United States Contracting Policy: DoD and NASA".

Firms' policy of diversifying production has been of particular interest as offering new solutions to the authorities.

Convair, for example, used its own resources to finance part of the ICBM missile programme; before the Mercury programme, four firms independently started major space research[1]; and the Apollo programme benefited from original contributions from a large number of firms.

Many undertakings successfully embarked on a policy of diversifying demand (commercial aircraft) and lines of products.

Efforts have also been made to apply the branch's techniques and capacity to activities outside the aircraft industry.

This type of diversification, which accounts for only a small fraction (no more than 2%) of aerospace sales, was mainly achieved by the absorption of firms from other branches of industry.

Lastly, all the main airframe companies[2] moved more or less marginally into the equipment branch by setting up their own divisions or by taking over electronics firms. Over the same period the United Kingdom has witnessed a process of vertical integration and specialization by branches, as part of government policy for the reorganization of the aircraft industry. The development of

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[1] For example, McDonnell, who won the contract, had been engaged in studies on the subject for 11 months.

[2] Predominantly those with assets exceeding $200 million (see Section 3.1).

commercial aircraft has also been encouraged[1] as a means of reducing excess production capacity.

Only one company, Hawker Siddeley, which was mainly engaged on defence orders, has extended its activities to other branches of industry, by taking over electrical, metallurgical and other companies.

Among the EEC countries, only France, beginning in 1957 and with government support, has adopted a policy of specialization by branches and by products. Attempts to diversify production in other branches of industry have been significant, while there is only one previous example (Caravelle) from the commercial aircraft sector. More recently, Dassault first set up an electronics division and later (1968) began to produce civil aircraft.

In the remaining Community countries, only the Netherlands has sought to diversify production; it should be noted, however, that in the absence of such a policy the national industry would have found it very difficult to survive with such a narrow military market in the Netherlands.

In the cases of Germany, Italy and Belgium, problems relating to reorganization of their respective industries and the narrowness of the national markets explain why there have as yet been no special diversification problems in the commercial aircraft sector.

3.4 Collaboration between Firms

Collaboration between firms is now essential because of the complexity of products and of the process of making aircraft[2],

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[1] By a government contribution to R&D.

[2] See Section 2.2 above.

missiles and space equipment.

The first and simplest forms of collaboration are usually commercial agreements (after-sales assistance and maintenance), exchanges of technical information (knowhow) and, most important of all, licence agreements[1].

Side by side with agreements of this kind, the sixties were marked by increasing cooperation between firms[2] in the matter of research and/or production, through contracting and sub-contracting[3], co-production[4] and joint participation[5].

There are marked differences between the American and European approaches to collaboration; the basic reasons would appear to lie in the differences between their political and economical systems and between the sizes of their industries, firms and markets; This may explain, without wholly justifying, European solutions which at first sight may appear inconsistent.

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1 These agreements, which are extremely important for the EEC industry, are dealt with in Chapter 4 (The Technological Balance of Payments).

2 Stemming from agreements between governments in some cases.

3 Meaning the supply of parts which the purchasing company could make (sub-contracting) or is not technically equipped to make (contracting).

4 With the main contractor responsible for R&D and production costs.

5 Meaning that several firms participate as prime contractors.

We shall now consider how the most widespread forms of collaboration have evolved differently in the United States and in Europe.[1] In the United States contracting and sub-contracting have now assumed substantial proportions[2]. American leader firms tend increasingly to regard themselves as systems designer, integrator and manager, or, in other words, they tend to coordinate, direct and supervise a productive process which to a large extent takes place away from the firm itself. In so doing, the leader firm tends to specialize not only in management (of systems and programmes) but also in the productive process for which it is best equipped, namely, the final assembly of the system.

Many contracting firms both in America and in other countries - although in fewer numbers and mostly for contingent reasons - are involved in this process.

The government is not unconnected with the growth of this trend. Indeed one of the general aims of the contracting policy of the Department of Defence is to promote sub-contracting[3] as fully as possible, particularly with small businesses[4].

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[1] This problem is discussed in detail in the "National Reports" which should be consulted for further information.

[2] Around 40-50% of the leader's turnover goes on supplies from contractors and/or sub-contractors.

[3] In order to keep employment fairly stable, particularly in relatively underdeveloped areas and to spread the relevant technical knowhow over the whole country.

[4] Firms employing less than 500 men.

In our view, this line of action has at least three basic advantages:

a) it gives the leader a degree of flexibility which would otherwise be impossible;

b) it spreads technical knowhow and widens participation in industrial development without any dispersal of resources, because it allows firms to specialize at all levels;

c) the channelling of government and commercial orders to a few leader firms avoids on the one hand excessive concentration[1] and on the other coordinates industrial development and the spread of knowhow mentioned in b) above.

   The establishment of the biggest firms as leaders in the sector, receiving the principal orders and jointly organizing the whole sub-contracting system, ensures that the sector as a whole benefits from government contracts and finance on a centralized basis.

The position in Europe as regards contracting and sub-contracting[2] is somewhat different in many respects.

First and foremost, foreign contractors are rarely employed on national programmes[3].

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[1] Which, at the extreme, would mean that the government was the sole operator.

[2] These terms are used with the same meanings as for the USA; they therefore exclude for the moment mixed forms of contracting (or sub-contracting) and co-production.

[3] Or the national parts of international programmes.

In the light of the European political situation, this certainly has some significance but, when the problem is considered at European level and from the strictly economic and productive standpoint, there is serious waste due to the duplication of effort, the impossibility of specializing properly and the smallness of sub-contracting firms.

Furthermore, with the exception (although not complete) of the duplication of effort, it would appear to us that the last two factors are also present at national level, and this considerably worsens the position of the European aerospace industry.

Indeed, for reasons which may be attributed, not merely as a first approximation, to the characteristics of the various national markets (inadequate and widely fluctuating volume of demand) situations have arisen in the European countries with a number of not dissimilar features which can be briefly described as follows:

The size of the leader firms, although increased by successive concentrations, has not gone beyond a certain point and has in no case reached European level. In this process, the firms concerned have only specialized marginally along the American lines (management of programmes and final assembly of systems) nor in fact would full specialization have been possible. The whole system has been conditioned by the inadequacy and variability of demand:

- in the case of contracting firms, it has hindered specialization, checked its growth or even militated against its emergence;
- in the case of the leader firms, it has prevented specialization because the lack of outside suppliers has had to be made good or a certain level of employment has even had to be maintained.

This has resulted in national production systems which, under the influence of an inadequate and variable internal demand, have developed sporadically and with characteristics (size and quality) ill-suited to an extension of the industrial process to the European level. At the same time, as noted previously, efforts expended at national level have resulted in duplication at European level.

The foregoing remarks do not mean that governments and firms in the EEC countries and the United Kingdom have not pursued a policy of widening the participation of national firms in the process of production, because they have in fact done so. In particular, when the government has intervened, work has as a rule been distributed at national level having regard to firms' work plans (with the main purpose of maintaining employment in the sector) and to their specialization.

Other forms of collaboration to be found in the United States are co-production and joint participation.

The first[1] finds its own justification in the complexity of current aircraft programmes and in the heavy risks associated with their implementation.

Under this form of collaboration, the co-producing firms assume part of the economic and financial risks of individual programmes. Specially, they are responsible for financing R&D, tooling and carrying through the order placed with them, for a predetermined production run[2], regardless of the fact that the theoretical break-even point may be reached and/or exceeded.

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[1] This is relatively recent (the DC 9 was the first programme) and is not proving easy to establish.

[2] Derived from research designed to evaluate the potential market, carried out by the leader and sometimes by the co-producers.

Joint participation, on the other hand, is characterized by the shared responsibility (within a single programme) of the prime contractors[1] and is found typically in the case of missile and space programmes, although the aircraft industry also offers a few examples.

In other words, the prime contractors are responsible for all R&D, design and construction work relating to the part they have to make and for the choice and coordination of subcontractors.

In Europe, co-production and joint participation[2] have been and still are found at a level which generally goes beyond national frontiers and can thus be defined as the typical forms of cooperation between European countries. In our earlier remarks on the production process in the aeronautical industry[3] and, before that, on the problems of contracting and subcontracting, the premises and conditions for multinational collaboration in Europe were defined sufficiently clearly. It is fair to say, therefore, that in the situation described such collaboration may be considered "an essential condition for the very survival of the European aircraft industries"[4].

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[1] Nominated by the government agency.

[2] The first chiefly for aircraft and the second for space work.

[3] See Sections 2.2 et seq.

[4] M. Ziegler: Speech at the Symposium on "The importance of the aircraft industry for Europe's economic and technical future" organized by AICMA (13-14 September 1967).

It is by no means easy to strike a balance of European collaboration because the problem involves so many variables.

The first point is to repeat our original premise that the approach is correct in the sense that European collaboration is essential.

Consequently, however important the qualifications which follow they must all be evaluated by reference to this major premise.

European collaboration[1] has been started over the last ten years both within the EEC and between the Community countries and the United Kingdom by:

- NATO (e.g., Atlantic, F 104 and Hawk programmes)
- firms (e.g., F 28, VFW 614, SA 330, SA 340 and WG 13 programmes)
- governments (e.g., Concorde, Airbus and MRCA 75 programmes).

In general, collaboration has related to R&D and/or production and in many cases has been initiated by governments who have provided the necessary money and assumed the risks involved.

It is important to note that even in the case of programmes launched by private firms, the governments of the countries concerned have provided some of the money required for R&D.

It is immediately apparent, therefore, that the outstanding feature of European collaboration is active intervention by governments, which finance and often promote military and commercial programmes, in addition to purchasing the defence equipment produced.

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[1] Regarding European cooperation in space activities, see Chapter 2, Section B - "Space Activities".

This at once reveals two of the main advantages of collaboration. When several countries cooperate in the same programme it is possible:

a) to spread the cost of R&D and the relevant risks proportionately;

b) to increase demand[1] with the attendant possibility of extending production runs and thus cutting unit costs.

These two basic advantages lead on to others:

- the division of R&D work enables each country not only to limit the risks involved, but also to benefit from the experience of others in at least two ways: the first, which is obvious, concerns the contribution of each country to the development of the product; the second, which is less apparent but no less important, is the transfer of knowhow which takes place informally in any group working together;
- the extension of production runs enables the participating countries to acquire sophisticated machines for an outlay which is acceptable overall; otherwise, the individual countries would have to do without modern equipment unless they carried through certain programmes alone, which would involve the necessary R&D and production capabilities in addition to a vast capital outlay;
- collaboration may have the further advantage of overcoming the production bottlenecks which exist in the various European countries. This should not be taken to mean that the aircraft industries of certain countries are unable to undertake major programmes on their own.

  On the other hand, their productive capability is doubtful,

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[1] Especially military.

i.e., their capacity to turn out large numbers of aircraft at a high rate of production.

Having enumerated the main advantages of collaboration, to which we may later wish to add others (actual or potential), we shall now consider the other side of the coin. Some of the disadvantages are technical or concerned with production. They include:

- different units of measurement, standards and regulations;
- test methods and equipment are not always comparable;
- working methods are not the same, with the result that the various elements in production costs are allocated differently;
- differences in methods of organization, in standards relating to interchangeability and in specifications.

Other and more serious disadvantages apply to R&D and production costs. Ziegler[1] maintained that:

- the need to align working methods and standards adds 10-20% to the capital outlay[2] and this figure may rise to 30-50% if there are several versions of the same programme.

  In the case of cooperation between two countries only and limited to this stage of the programme, the cost for each of them may therefore vary between 55 and 75% of what they would have had to spend if they had undertaken the project alone.

On the other hand, Ziegler claims that there are substantial savings on production costs: extension of the production run cuts average production costs - for labour - by 18-20% if twice the number of aircraft are built and 33-36% if four times as many are made.

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1 M. Ziegler: op.cit.

2 R&D, documentation, tooling and testing.

These figures offer a first assessment of the problem in unquestionably objective terms guaranteed by the competence of the author quoted.

A few additional points must be noted, however.

Ziegler was referring to the case of a programme started with the construction of a single prototype - although provision was made for possible variants - and carried through on a single assembly line. This interpretation is supported by the fact that:

- the construction of two prototypes is not specifically mentioned;
- no reference is made to doubling the assembly line (for sub-groups and the airframe);
- the relative cut in labour costs is based on an 80% learning curve; if there were two assembly lines, each with an 80% learning curve, the saving on overall production would be less because learning costs would be doubled.

Among the advantages of collaboration, we mentioned that with several assembly lines it is possible to use the industrial resources of the participating countries to turn out large numbers of aircraft at an acceptable overall rate.

This arrangement, which in our view is essential in almost all cases, does not necessarily double R&D costs through the construction of two prototypes, but it certainly does increase the cost of tooling for production and of actual manufacture.

It is virtually impossible to evaluate these higher costs but their components can be estimated.

Assuming two assembly lines producing the same number of aircraft and with exactly the same rates of production as a single line[1]:

- there should be no increase in cost for the major sub-systems (engines, undercarriages, standard equipment, etc.);
- the cost of tooling for production and for line and final testing will be doubled[2];
- as already stated, the duplication of line launching costs will involve some diseconomies on total production;
- there will be similar effects, although with less incidence on total costs, as regards suppliers of parts, who for reasons connected with the organization of production will only be able to feed one of the two assembly lines.

In addition to these specific observations, there is another of greater importance.

Duplication of assembly lines was assumed because no European firm is at present capable of turning out large numbers quickly. It was added that the same result could be obtained by subdividing the production run between two or more manufacturers to make optimum use of the existing production potential of each of them.

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[1] As already stated, this assumption cannot be regarded as valid for European countries if long aircraft production runs are involved.

[2] The same applies, to a slightly less extent, when both assembly lines are set up in a single firm.

In other words, this means that:

- none of the participating firms has to invest large sums in premises, plant, machinery and fixed equipment;
- the rate of production of the individual firms is thus not increased;
- the production costs of the separate firms cannot be lowered because they lack adequate fixed assets.

Thus, while large orders can be handled by cooperative production, this system does not yet appear capable of resolving certain fundamental problems of the European aerospace industry. The cyclic (and indeed, episodic) character of both the national and international demand generated by collaboration between a number of countries, combined with the short runs which, for a variety of reasons, firms have to produce, prevent any long-term planning. The effects, which have already been discussed in part, seem to be:

- consistent investment plans cannot be formulated;
- the rationalization of production and firms is not started;
- consequently, firms do not specialize adequately.
- there is no coordination or specialization of the productive structure of contractors and sub-contractors.

A frequent feature of European collaboration is the formation of various types of consortium and association for the time required to complete specific programmes. These are major instruments for centralizing the management of projects and allow a constructive exchange of information, technical knowledge and knowhow.

On the other hand, their limited life implies a considerable dispersal of experience acquired under circumstances which virtually cannot be repeated.

The formation of such associations also raises legal problems; the law varies from country to country in Europe and this is an obstacle to the formulation of standard statutory regulations.

When there is no centralized body or when one exists but does not work properly, there may be substantial diseconomies on programmes, with additional costs which can be very considerable and serious delays on deliveries.

There has been, and still is, a large measure of multinational cooperation in Europe. The main aeronautical and missile projects handled in this way are listed on the next page (Fig. 13).

The progress of some of them (MRCA 75, Panther, Transall, Phantom[1], Jaguar, Concorde and Airbus A 300) is described in detail in Annex 10: "International Collaboration in Aircraft Production", while the Atlantic and Tyne programmes are briefly outlined in the next few pages.

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[1] As an example of collaboration between the United Kingdom and the United States.

FIG. 13

Main Joint European Aircraft Projects (1959–67)
(by country and firm)

Projects	EEC Countries					United Kingdom
	France	Germany	Italy	Belgium	Netherlands	
ATLANTIC *	BREGUET,	DORNIER, BOLKOW, SIAT,		ABAP,	FOKKER,	
TRANSALL *	NORD AVIATION,	VFW, HFB,				
F 104 (under licence)*		ARGE 104 SUD e NORD,	FIAT, MACCHI, AERFER, PIAGGIO	SABCA, FAIREY,	FOKKER, AVIOLANDA,	
HAWK[1] (under licence)**	THOMSON HOUSTON,	TELEFUNKEN,	FINMECCANICA,	ACEC,	PHILIPS	
CONCORDE *	SUD AVIATION,					BAC,
JAGUAR *	BREGUET,					BAC,
VAK 191 B *		VFW,	FIAT,			
F 28 *		VFW, KFB			FOKKER,	SHORT BROTHERS
VFW 614 *		VFW,			FOKKER,	
A.F.V.G. (abandoned)*	DASSAULT,					BAC,
SA 330, SA 340, WG 13 (*)	SUD AVIATION,					WESTLAND,
MARTEL **	MATRA,					HAWKER SIDDELEY
HOT, MILAN, ROLAND **	NORD AVIATION,	BOLKOW,				
TYNE (under licence)***	HISPANO SUIZA,	MAN TURBO,		FABRIQUE NATIONALE,		ROLLS-ROYCE,
J 79 (under licence)***		BMW,	FIAT,	FABRIQUE NATIONALE,		
OLYMPUS 593 ***	SNECMA,					BRISTOL SIDDELEY
M 45 ***	SNECMA,					BRISTOL SIDDELEY
RB 172 ADOUR ***	TURBOMECA,					ROLLS-ROYCE,
RB 153 (abandoned)***		MAN TURBO,				ROLLS-ROYCE,
RB 193 ***		MAN TURBO,				ROLLS-ROYCE,

* Airframe ** Missile *** Engine or power plant

1 The firms taking part were joined together in SETEL.

- <u>Atlantic programme</u> (sea reconnaissance aircraft)

  Studies started in 1956 by the larger powers - France, the United Kingdom and the United States; the scope of the basic programme was then extended to all the NATO countries. The final operational definition was approved by NATO at the end of 1957.

  The United States put up some of the money and the manufacturing licence was granted free of charge to the American firm of Grumman.

  The industrial agreement (late 1959) brought together Dutch, Belgian and German firms, under Breguet (France) as prime contractor.

  A multinational steering committee[1] was set up by the governments, with unified, centralized management which adopted the principle of fixed-price contracts and unanimous decisions[2]. At industrial level, a limited liability company (SECBAT) was formed and managed by Breguet.

  The first production aircraft were delivered in December 1965[3]; production is still continuing.

---

[1] Five countries.

[2] Each member (including those not concerned with production as the United States) has the right of veto; this is why the United States were able to block an order of 60 aircraft for South Africa.

[3] Within the planned time limit.

- Tyne programme (engine for Atlantic and Transall aircraft)

  This is an agreement to collaborate in production under licence.

  At government level, the two Atlantic and Transall Committees are responsible for management; at industrial level, the work of the committee is greatly complicated by the absence of a company.

  Owing to the existence of the Atlantic Committee, the preliminary work lasted only six months.

  The need to move parts and sub-groups have caused time to be lost in carrying out the work; there has also been duplication of assembly tools and test benches because the French and German governments each wishes to have maintenance and overhaul facilities.

  Full-scale production is now in progress.

4. CHANGES IN THE ECONOMIC CHARACTERISTICS OF THE AERONAUTICAL AND SPACE INDUSTRY

4.1 Employment

4.1.1 General

Before 1960, and particularly from 1957 to 1960 numbers employed throughout the aircraft industry showed a declining trend.

The main reason for this, at least in the United States and the United Kingdom, was the change in military strategy, whereby military aircraft were replaced by missiles in defence programmes.

Quite apart from the problem of technical retraining, missiles caused a substantial amount of unemployment and underemployment, especially among operatives.

The production of large numbers of heavy military aircraft was stopped almost without warning and, in their place, work was started on missiles, which at first involved much more research than actual production.

In addition to this element, which had a marked effect on employment in the United Kingdom and the United States, a further cause of the decline in numbers employed in the EEC industry (excluding France) was the completion of work under licence on major defence programmes, followed by a sharp drop in the demand for new aircraft.

Since then, however, employment in the aerospace industry has risen almost continuously in the Community countries and the United States, but not in the United Kingdom (Fig. 14).

In the United States, numbers employed in the aerospace industry rose from 956,000 in 1960 to 1,168,000 in 1967 (Tables 2 /1 and

2/1a), with slight drops in 1961, 1964 and 1965[1].

The average annual increase of 2.9% can be attributed to partial reconversion of aeronautical firms[2] from aircraft to missiles and space material.

Employment in the actual construction of aircraft continued to fall until 1965 (458,000) and despite a renewed rising trend[3], numbers employed had still not regained the 1960 level by 1967 (610,000 as against 638,000).

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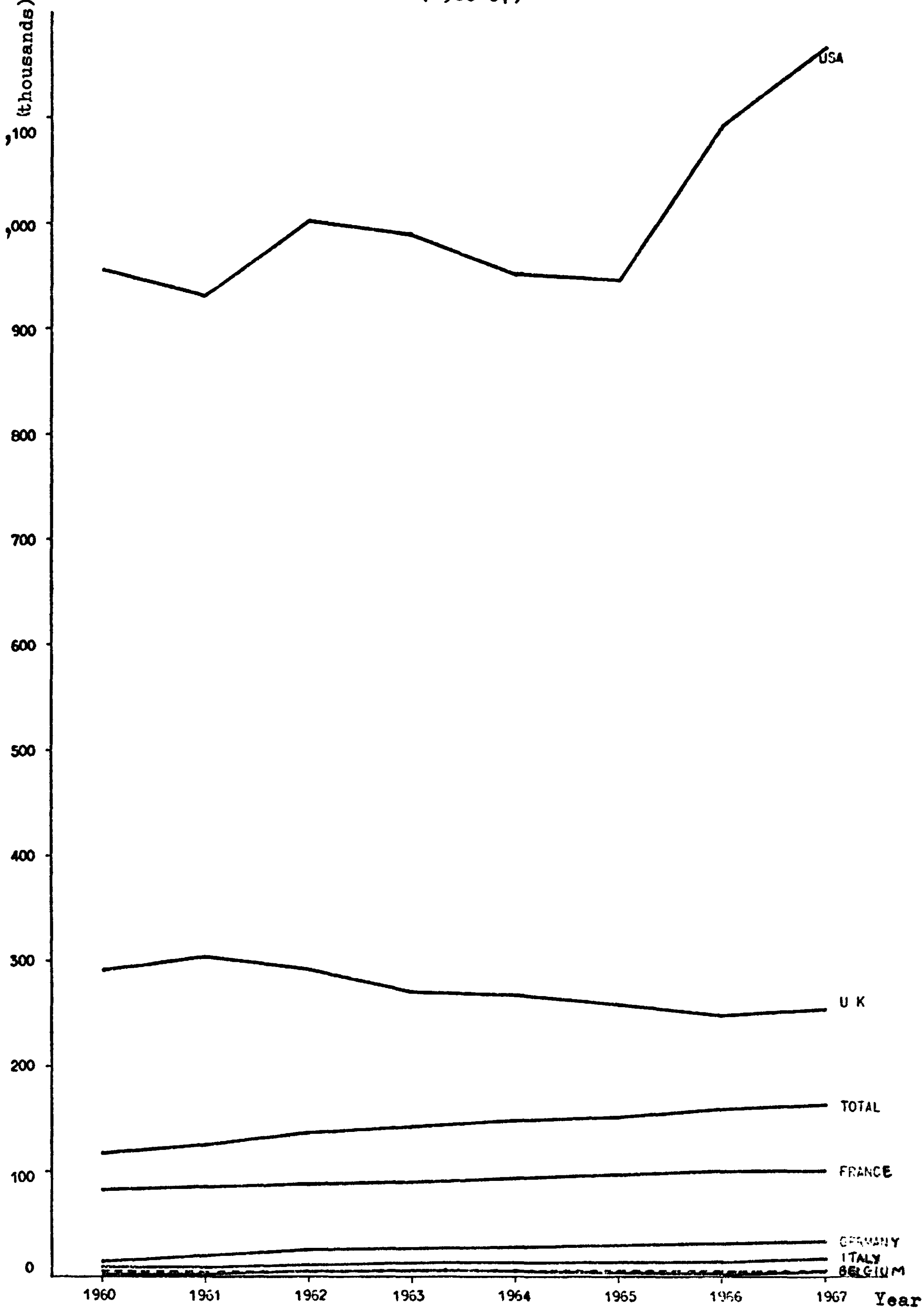
[1] This decline is linked with the completion of certain missile programmes (source: Department of Commerce). According to official AIA statistics numbers employed in the aerospace industry rose from 1,074,000 to 1,392,000. It is inadvisable to use these figures for purposes of comparison because they include some men from SIC 36 (electrical machinery industry) employed on missile and space work, but not belonging to the aerospace sector.

[2] See also Section 4.1.2 below.

[3] Due to increased demand for military aircraft and a marked rise in demand for commercial types.

Fig. 14 Labour Force in Aerospace Industry (1960-67)



In the United Kingdom, the diversification of activities did not solve the problem of excess labour in the aerospace industry in 1960.

In this respect, the role of commercial aircraft and, even more, of space activity proved inadequate. Furthermore, the cancellation of many missile and military aircraft projects aggravated the inevitable downward trend of employment in the United Kingdom, where numbers fell by an average of 2.7% per annum, from 291,000 in 1960 to 254,000 in 1967.

In the European Community, employment in the aerospace industry rose continuously over the period under review, at an average rate of 4.8% per annum, from 118,000 in 1960 to 164,000 in 1967, distributed as follows between the member countries:

Employment in the EEC Aerospace Industry

(1967)

	Numbers (thousands)	Percentages
France	101	61.5
Germany	35	21.3
Italy	17	10.3
Belgium	5	3.0
Netherlands	6	3.9
Total EEC	164	100.0

The overall increase, amounting to 46,000, is due to a rise in numbers employed in France, Germany and Italy; numbers have remained steady in the Netherlands while there was a drop in Belgium in 1964 and 1965.

In all the EEC countries except France, the biggest increase took place at the start of the period, when the various national industries began production under licence (USA) on the F 104 military programme. When this project was completed (1965), all the countries concerned were left with excess production capacity but there was no drop in numbers employed, except in Belgium.

In France, the combination of military, missile and space programmes, with a less significant amount of commercial production, maintained a more regular increase at a rate of 2,000 to 4,000 per annum.

In 1967, the United States reached the record figure of 1,168,000[1] which was one million more than the number employed in the EEC industry and 900,000 more than in the United Kingdom.

Even if some 150,000-200,000 employed in branches not strictly forming part of the aeronautical industry[2] are deducted from the American figure, the US aerospace industry still employs six times as many men as its counterparts in the EEC.

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[1] Department of Commerce statistics; the AIA, which includes some workers from the electronics branch in the aerospace figures, gives a total of 1,392,000 for 1967.

[2] Such as chemicals and alloys, machinery, etc.

However, this gap is considerably narrowed when labour employed on missiles and space work[1] are deducted from the American employment figures.

In that case, if we exclude 1966 and 1967, when there was a sharp recovery in American aircraft production, numbers employed in the USA are only three times[2] the EEC figure and about twice the British.

It should be noted, however, that over the period under review employment rose relatively faster in the United States. Of the total labour force of the EEC, British and American aerospace industries, the EEC's percentage rose from 8 to 10% between 1960 and 1967 while the American percentage increased from 70 to 74%.

The following points may next be noted concerning the distribution of labour in the aerospace industries of the three areas under examination:

- at firm level, the concentration of labour in the three biggest aerospace firms in each area was as follows, in 1967:

	% of total numbers employed in the aerospace industry in each area
EEC countries	32.9[3]
United Kingdom	62.2
United States	33.9

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1 Where EEC activity is minimal in terms of numbers employed.

2 Around 450,000.

3 This percentage will be increased by the following mergers which have already been approved: Nord-Aviation, Sud-Aviation and Sereb; Bölkow, Messerschmitt and HFB; Fokker and VFW

- at productive unit level we find, in the United States, a relative concentration of labour in the places of origin of the various firms. In practice, this is also true of Europe, but the process of concentration which has marked the last few years, affecting firms rather than productive structures, has to some extent led to the dispersal of production centres from the centre where decisions are taken.

In this respect, the limited mobility of European aerospace labour is another factor, in addition to the virtual total lack or reorganization within individual firms.

In the aerospace industry, technological advances have had a marked influence on the structure of employment and in particular on the skills required.

The ratio of operatives to trained staff has been substantially reduced by the transfer of some men from aircraft to work on missiles and space material and by the increased sophistication of air transport.

This trend is clearly visible in the USA[1], where the impact of the new technology has undoubtedly been greatest.

The table on the next page compares the growth of output with the increase in numbers of operatives (both expressed as index numbers) and shows how the importance of operatives in the American aerospace industry has declined. While output[2] rose to 135 between 1960 and 1967, the index for operatives reached only 117.

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[1] For example, at the Douglas company the ratio of operatives to engineers was 10.5 : 1 in 1947, 3 : 1 in 1956 and only 1.6 : 1 in 1963.

[2] In constant values.

Index (1960 = 100) of Output and Operatives Employed in the USA (1960-67)

	1960	1961	1962	1963	1964	1965	1966	1967
Aerospace output (at constant values)	100	102	108	109	111	110	122	135
Operatives employed in the aerospace industry	100	92	96	90	87	88	107	117

The percentage of operatives to total numbers employed in the aerospace industry was as follows in 1966:

EEC countries	53.2[1]
United Kingdom	61.5[2]
United States	54.3

As the table on the next page shows, the technical qualifications of employees also varied considerably:

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1 In France the greater emphasis on missiles and space material had cut this percentage to 47.4 by 1967.

2 In 1965.

Technical and scientific work	% of number employed	
	1953	1963
Aerodynamics and astrodynamics	8	18
Airframes	29	10
Systems	17	11
Engines	6	6
Electronics	20	31
Computers	5	16
Biology	2	2
Nuclear	-	2

The higher qualifications of labour employed in the aerospace industry[1] raise the cost per employee above the figure for manufacturing industry. In 1966, in both the USA and the EEC, the average cost per employee in the aerospace industry was about 30% above the figure for manufacturing industry; the actual figures were $4,815 compared with $3,650 in the Community and $8,655 against $6,690 in the United States. The breakdown of average annual cost per employee[2] according to qualifications in the aerospace industries of the EEC and the United States was as follows:

	Operatives	Office staff	Average cost
EEC countries (dollars)	4,080	5,695	4,815
USA (dollars)	7,540	9,905	8,655

1 In the EEC, the percentage of operatives in manufacturing industry was 77% in 1966 as compared with 53.2% in the aerospace industry.

2 Engineers, technicians and administrative staff.

For the British aerospace industry, the average annual cost per employee is estimated at $3,315 in 1966.

Between 1959 and 1964, the average annual cost per employee in the aerospace industry rose in all three areas, but at different rates as appears from the table below[1]:

	1959	1966	
EEC countries (dollars)	2,700	4,815	(+ 78%)
United Kingdom (dollars)	2,240	3,315	(+ 48%)
United States (dollars)	6,585	8,655	(+ 31%)

The contribution of the aerospace branch to the national economy, measured in terms of the proportion of the total labour force of manufacturing industry employed on aerospace work, was 2.9% in the United Kingdom[2], 6% in the United States[3] and only 0.7% in the EEC[4].

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[1] The various sources used in all probability reflect non-comparable methods of calculation; allowance must also be made for the varying incidence of "indirect costs" (social security charges, etc.) in the three areas. For the above reasons, the estimates of the average cost of aerospace labour should be taken as a guide only.

[2] 3.3% in 1960.

[3] 7.2% (in 1967) according to AIA statistics.

[4] The figure of 0.7% for the EEC refers to 1965 which is the last year for which employment figures for the manufacturing industry of all member countries are available.

Allowing for the earlier trend, the percentage can, however, be accepted for 1967 also.

The percentage of numbers employed by aerospace firms in the total labour force of manufacturing industry varies substantially between the members of the Community, as can be seen from the table below:

EEC Countries: Numbers Employed in the Aerospace Industry as a Percentage of the Total Labour Force of Manufacturing Industry

(1965)

	%
France	1.73
Germany	0.37
Italy	0.25
Belgium	0.31
Netherlands	0.43
EEC	0.69

Only France has a percentage above the average and is clearly the only country to raise the figure for the Community.

4.1.2 **By branches**[1]

In 1967, the labour force was distributed as follows by branches in the three areas considered:

Branch	EEC Number ('000)	EEC %	UK Number ('000)	UK %	USA Number ('000)	USA %	EEC + UK + USA Number ('000)	EEC + UK + USA %
Airframes	91	55.5	99	40.0	488	41.8	678	42.9
Missiles[2]	16	9.8	20	8.0	378	32.4	414	26.2
Engines	30	18.2	77	31.0	122	10.4	229	14.4
Equipment[3]	27	16.5	52	21.0	180	15.4	259	16.5
Total	164	100.0	248	100.0	1,168	100.0	1,580	100.0

Expressing the EEC figures from the above table as unity we then have:

	EEC	United Kingdom	United States
Airframes	1	1.08	5.36
Missiles and space vehicles	1	1.25	23.62
Engines	1	2.56	4.06
Equipment	1	1.92	6.66
Total	1	1.51	7.12

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1 See Tables 2/2, 2/2a and 2/3 series.

2 Including space vehicles for the USA.

3 Including parts of airframes and engines for the UK.

Ignoring missiles and space vehicles, which are clearly an American preserve, the figures show a maximum difference of 2.56 (engines) in comparison with the United Kingdom and of 6.66 (equipment) in comparison with the United States.

They further show that, when the EEC + UK figure is compared with that for the United States, the difference is least in the case of engines as a result of the number employed in the United Kingdom.

The situation so revealed cannot be properly assessed, however, without considering changes over the last few years and current trends.

In the United States, while numbers employed in the engines branch remained almost constant, the figure for the airframes branch fell sharply early in the sixties (from 514,000 in 1960 to 342,000 in 1962) but this drop was offset by a marked increase in numbers employed on missiles and space vehicles and on equipment. As total numbers employed remained virtually constant at the start of the decade, part of the labour force was obviously transferred from airframes to missiles and space vehicles and this trend was repeated in individual firms[1].

This means, therefore, that part of the labour force has been converted and retrained for employment in technologically more advanced branches.

It seems possible that the same sort of movement took place in the engines branch but the extent cannot be calculated because no separate figures are available.

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1 See Annex 7, "Description of the American Aerospace Industry".

Apart from transfers between branches, the tables also clearly show the desire to maintain a steady total level of employment; and this aim was unquestionably achieved over the period under review.

During the last two years of the period (1966-67), the rapid growth of commercial aviation and the renewed demand for military aircraft increased employment in the airframes branch[1] (from 353,000 in 1965 to 488,000 in 1967) and consequently in the industry as a whole.

The percentages reveal the drop in employment in the airframes branch even more clearly: 53.8% in 1960, this figure had fallen to 41.8% by 1967, whereas the relative importance of the equipment branch almost doubled over the same period (from 8.4 to 15.4%)[2]; the figure for engines fell slightly (from 12.9 to 10.4%) while that for missiles and space vehicles rose (from 24.9 to 32.4%)[3].

In the United Kingdom, for which reliable figures are available only from 1963 onwards, numbers employed fell sharply in the airframes branch (from 131,000 in 1963 to 99,000 in 1967) but remained virtually unchanged in the other branches. As a result the percentage for the engines branch, which was already high in 1963 (27%), had reached 31% by 1967, with a labour force of 77,000.

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[1] But still without regaining the 1960 figure.

[2] Stimulated by the missiles and space programmes.

[3] After a peak of 39.7% in 1963.

Substantial numbers were employed in the equipment branch (52,000 in 1967) and fewer on missiles (20,000 in 1967).

In the European Community, the period 1960-67 was marked by a steady increase in numbers employed, both overall and in the separate branches, so that the percentages of each in the total did not vary much during that time. In our opinion, this balanced growth conceals a number of negative aspects; for the Community as a whole no special effort was made as regards engines and equipment (even though numbers employed in the EEC were not and still are not very large) or as regards missiles and space vehicles, which might perhaps merit greater interest because of the advanced techniques involved.

Between 1960 and 1967, the position in the individual members of the European Community was as follows:

- in France, there was a balanced increase in numbers employed in all branches, with airframes occupying the leading position with a labour force of 44,000 in 1967;
- in Germany, numbers employed in the airframes branch almost doubled (from 14,000 to 27,000); the engines and missiles branches which were virtually non-existent in 1960 now employ 5,000 and 3,000 men respectively. This development, which does not involve large numbers, is mentioned as an example of positive action.
- in Italy, the only branch to show some increase in employment was airframes (from 5,000 to 11,000); numbers employed on missiles and space work are insignificant.
- in Belgium, numbers employed rose slightly in the two branches with which the national aerospace industry is chiefly concerned, i.e., airframes and engines; the figures for 1967 were 3,000 and 5,000 respectively.

- in the Netherlands, where aerospace activity is concentrated on airframes, numbers employed remained unchanged.

4.2 Output

4.2.1 General

The 1967 output figures for the aerospace industries of the countries under review were as follows[1]:

	Value ($ millions)	Percentage	Member countries' turnover as a percentage of the value of EEC output
France	1,250	4.7	71.1
Germany	261	1	14.9
Italy	160	0.6	9.1
Belgium	27	0.1	1.5
Netherlands	60	0.2	3.4
EEC	1,758	6.6	100.0
United Kingdom	1,610	6.0	
United States	23,258	87.4	
Total EEC + UK + USA	26,626	100.0	

The foregoing table provides a basis for a preliminary assessment. Both in value and as a percentage, American production is outstandingly high; against this, EEC and United Kingdom output amounts respectively to only about one-fifth and one-sixth of the turnover of the American aerospace industry. Within the European Community, the French industry predominates (71.1%) and accounts for a by no means negligible 4.7% of the total turnover of the three large areas.

[1] See Tables 2/4, 2/4a and 2 /5 series.

Behind the situation so described lies a decade marked by many major events, including three which may be identified as of capital importance:

- the arrival of the space age;
- the growth of commercial aviation;
- the reduced importance of military aircraft, offset from the operational standpoint by the use of missiles.

The aerospace industries and governments of the various countries have operated in this wide, overall context, which has naturally differed in various respects from country to country.

We shall first consider how the position changed from 1960 to 1967 in terms of quantities.

Turnover and added value figures[1] (at constant 1967 values) for the aerospace industries of the EEC, the United Kingdom and the United States are given on the next pages (Figs. 15 and 16).

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[1] The estimates for added value must be considered in the light of a number of conditioning factors:

- the methods of calculation employed by the various sources used are probably not strictly comparable;
- the original data are taken from national matrices for years prior to 1966 and have been brought up to date by estimating.

FIG. 15 EEC Countries, United Kingdom, United States - Estimated Value of the Output ot the Aerospace Industry

(constant 1967 values)

	1960	1961	1962	1963	1965	1965	1966	1967
	Value (millions of dollars)							
FRANCE	620	668	727	782	941	1,041	1,136	1,250
GERMANY	88	134	146	313	306	225	185	261
ITALY	64	80	110	144	161	164	146	160
BELGIUM	10	11	28	59	104	40	31	27
NL	65	67	105	120	103	76	64	60
TOTAL EEC	847	940	1,116	1,418	1,615	1,546	1,562	1,758
UK	1,433	1,634	1,449	1,428	1,553	1,682	1,669	1,610
USA	17,193	17,576	18,657	18,798	19,166	18,833	20,982	23,258
TOTAL	19,473	20,170	21,222	21,644	22,334	22,061	24,213	26,626
	Percentages							
FRANCE	3.2	3,3	3.4	3,6	4,2	4.7	4.7	4,7
GERMANY	0.4	0,7	0.7	1.4	1.4	1,0	0,8	1,0
ITALY	0.3	0,4	0,5	0,7	0,7	0,7	0.6	0,6
BELGIUM	0,1	0.1	0.2	0,3	0.4	0,2	0,1	0,1
	0.3	0,3	0,5	0,6	0.5	0,4	0,3	0,2
TOTAL EEC	4.3	4,8	5,3	6.6	7,2	7.0	6.5	6,6
UK	7.3	8,1	6.8	6,6	7.0	7.6	6.9	6,0
USA	88.4	87,1	87,9	86,8	85,8	85.4	86,6	87,4
TOTAL	100,0	100.0	100,0	100.0	100,0	100,0	100.0	100.0

FIG. 16 EEC Countries, United Kingdom, United States - Estimate of Value Added by the Aerospace Industry (constant 1967 values)

	1960	1961	1962	1963	1964	1965	1966
	Value (millions of dollars)						
FRANCE	458	518	566	603	645	692	734
GERMANY	52	74	99	110	119	131	150
ITALY	39	40	49	66	72	67	74
BELGIUM	5	5	16	28	37	21	15
NL	21	22	27	29	30	29	29
TOTAL EEC	575	659	757	836	903	940	1,002
UK	1,056	1,158	1,089	1.019	1,083	1,089	1,075
USA	9,658	9,881	11,099	11.607	11,523	11,638	13,767
TOTAL	11,289	11,698	12,945	13.462	13,509	13,667	15,844
	Percentages						
FRANCE	4,0	4.4	4,4	4,5	4,8	5,1	4,6
GERMANY	0,5	0,6	0.8	0,8	0,9	1,0	0.9
ITALY	0,3	0,3	0,4	0,5	0,5	0,5	0,5
BELGIUM	0,1	0,1	0,1	0,2	0,3	0,1	0,1
NL	0,2	0,2	0,2	0,2	0.2	0,2	0,2
TOTAL EEC	5,1	5,6	5,9	6,2	6,7	6,9	6,3
UK	9,4	8,4	8,4	7,6	8,0	8,0	6,8
USA	85,5	85,7	85,7	86,2	85.3	85,1	86,9
TOTAL	100,0	100,0	100,0	100,0	100.0	100,0	100,0

Over the period, the total aerospace output of the three zones rose by 36.7% overall, at an average rate of 4.6% per annum. The figures for the individual areas are:

	% total increase	average increase per annum
EEC	107.5	11
United Kingdom	12.3	1.7
United States	35.2	4.4

The increase was therefore greatest in the EEC and least in the United Kingdom, where turnover did in fact increase overall (but dropped in certain years).

The satisfactory growth of the EEC industry is mainly due to France, whose turnover, accounting as already stated for 71.1% of the EEC total in 1967, rose overall by 101.6% with an average increase of 10.5% per annum.

The different rates of growth in the three areas changed the percentage of total turnover accounted for by each, as follows:

Turnover of the EEC, United Kingdom and United States Aerospace Industries as a Percentage of Total Turnover

	1960	1967
EEC	4.3	6.6
United Kingdom	7.3	6.0
United States	88.4	87.4
Total	100.0	100.0

The 2.3 points gained by the EEC industry were therefore at the expense of the British (-1.3) and American (-1) industries.

From 1960 to 1967, the growth of value added by the aerospace industries of the three areas under review was not quite the same as for the increase in turnover as can be seen from the following tables:

Growth of Value Added by the EEC, United Kingdom and United States Aerospace Industries 1960-66

	% total increase	Average increase per annum
EEC	74.2	9.7
United Kingdom	1.8	0.3
United States	42.5	6.1
Overall	40.3	5.8

Value Added by the EEC, United Kingdom and United States Aerospace Industries as a Percentage of Overall Added Value

	1960	1967
EEC	5.1	6.3
United Kingdom	9.4	6.8
United States	85.5	86.9
Total	100.0	100.0

These figures show that the annual increase in added value exceeded the increase in turnover in the United States (6.1% as compared with 4.4%) but that the reverse was true in the EEC and the United Kingdom (9.7 and 0.3% for the average annual increase in added value as against 11 and 1.7% for turnover).

Comparing the shares of the three industries in turnover and total added value from 1960 to 1967 we find that:

- for the EEC, added value increased less than turnover (+1.2 as compared with +2.3%);
- for the United Kingdom, added value fell more than turnover (-2.6 as compared with -1.3%);
- for the United States, added value increased (1.4%) while turnover dropped (-1.0%).

This indicates one of the most important aspects of our comparison between the three major areas. We shall return to this point later when we have identified the importance of the various factors in demand (and in particular the weight of government demand) and the characteristics of the various branches of production.

A quantitative approach can be made to the last problem by estimating the pattern of aerospace production in the EEC, the United Kingdom and the United States on the basis of sales to final customers in 1967[1], as shown in the table on the next page (Fig. 17).

In the United States, government demand accounts for 75.3% of the industry's turnover; other domestic sales account for 15% and exports for 9%. From 1960 to 1967, the former increased by 27%[2], which was proportionately less than private domestic demand with an increase of 140%[2] achieved over the last two years. The increase in American output is therefore due essentially to two factors, namely, the rise in government

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[1] Table 2/5h is reproduced on the next page for ease of reference.

[2] Constant values.

Fig. 17

Estimated Pattern of the Output of the Aerospace Industry Based on the Value of Sales to Final Purchasers in 1967

	Government				Other domestic purchasers	Foreign	TOTAL
	Military R&D	Purchases	Subsidies[1]	TOTAL			
	Values (millions of current dollars)						
FRANCE	246	423	115	784	44	422	1,250
GERMANY	124	99	9	232	-	29	261
ITALY	5	107	-	112	2	46	160
BELGIUM	-	13	-	13	-	14	27
NL	-	7	-	7	-	53	60
TOTAL EEC[2]	375	649	124	1,148	46	564	1,758
UK	294	574	140	1,008	165	437	1,610
USA	17,347		159	17,506	3,503	2,249	23,258
	Percentages						
FRANCE	19.7	33,8	9,2	62.7	3.5	33,8	100,0
GERMANY	47.5	37,9	3.5	88.9	-	11,1	100,0
ITALY	3.1	66.9	-	70,0	1.3	28.7	100.0
BELGIUM	-	48.1	-	48.1	-	51.9	100,0
NL	-	11.7	-	11.7	-	88,3	100.0
TOTAL EEC[2]	21.3	36.9	7.1	65.3	2.6	32.1	100,0
UK	18,3	35.7	8.7	62,7	10,2	27.1	100.0
USA	74.6		0.7	75.3	15,0	9.7	100,0

1 Government finance for commercial aviation.

2 In 1966, a total of $16,021 million spent on purchases and military R&D was made up of $4,690 million (30%) for military R&D and $11,331 million (70%) for purchases.

spending, which was decisive, not only because of its scale[1] but also because of the new branches to which it was directed (space, missiles and more sophisticated aircraft), and, secondly, the growth of commercial aviation, where the sharp rise in domestic demand[2] provided major new outlets for the American industry and at the same time offered a real opportunity for diversification.

On the other hand, there was no substantial change in demand in the United Kingdom and the EEC.

In both areas, government involvement was less than in the United States (65-66% of the industry's turnover), sales to domestic commercial operators were low[3] and exports were high, accounting for 32.1% of total production in the EEC and 27.1% in the United Kingdom. Within the European Community, France made the biggest contribution to exports, with a figure of $422 million[4], representing 33.8% of the national industry's turnover.

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[1] Over the period under review, government demand continuously absorbed more than 80% of the industry's turnover except in the last few years.

[2] From 1960 to 1967, exports rose by only 14% (at constant values).

[3] The percentage is in fact down as compared with 1960.

[4] 75% of EEC exports.

The limited character of the domestic private market and the heavy dependence on exports[1] leave the Community's aerospace industry in a very delicate position; the first factor, in particular, has so far[2] militated against any proper diversification of production and of the risks involved.

The breakdown of government expenditure shows that the percentage spent on military R&D is almost identical in the three cases (30%); but there are differences as regards purchases (60% in the EEC and the United Kingdom as against 70% in the United States) and as regards civil R&D (around 10% in the EEC and the UK as against 0.7% in the USA)[3].

These last percentages are a sign that both EEC and British firms:

- lack sufficient funds for commercial R&D;
- assume only a limited part of the associated risks;
- depend on government finance and decisions even in the case of commercial aircraft programmes.

Regarding the first two of these points, it should be noted that, even in the United States, the government has provided

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[1] The opposite applies in the USA.

[2] With only two notable exceptions: the Caravelle and the F 27.

[3] Even though, in absolute figures, the sums provided by the American government for the SST programme, which is the only case of government support for commercial aviation in the USA, exceeded government spending in both the EEC and the United Kingdom in 1967.

substantial funds for major projects such as the SST. Moreover, the trend seems likely to continue, at least within this range; reliable American sources[1] agree that in all probability it will not be possible to develop a commercial VTOL aircraft without government assistance in the form of a military programme or along the same lines as for the SST.

It should be borne in mind that the development of military projects, which are obviously financed by the government, has in many cases led on to the development of the corresponding commercial versions in the United States, particularly in the case of big, long-range aircraft[2].

This situation is not repeated in Europe[3], where no big military transport has in fact been developed.

In this case also, the objective conclusions which may be drawn from the figures will later be adjusted or at least considered in a wider context.

The third point would appear to be the most difficult; the diversification of demand which has been successfully carried through in the USA for the reasons already indicated (sharing

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[1] Department of Commerce BDSA in "US Industrial Outlook 1968".

[2] The outstanding example is the Boeing B 707, developed from the military KC 135, which opened the long-range jet market to the USA; a further example will almost certainly be the commercial version (carrying 800 to 1,000 passengers) of the Lockheed C 5A Galaxy military transport.

[3] Where the opposite process sometimes occurs; for example, the British Nimrod sea reconnaissance aircraft was developed from the Comet 4C.

of risks, optimization of profits, stability of production and employment) is not taking place in Europe, with the consequences described.

Before proceeding to a detailed description of production trends in the individual branches, it may be helpful to outline activities in the aeronautical and missile fields[1] in the three areas from 1960 to 1967.

Over this period, the United States spent a total of $22,939 million[2] on missile R&D and purchases, covering all fields of research in this sector, including the recent addition of the anti-missile-missile system. In Europe, only France has begun work on projects of any substance involving major research (SSBS and MSBS).

As regards military aircraft, the United States, despite some reductions in expenditure and activity, built something like 16,000 aircraft between 1960 and 1967, as compared with 500 to 1,000 in the United Kingdom, 1,000 in France and 1,500[3] in the other EEC countries.

The types of research undertaken in the United States and the European countries have also differed substantially.

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[1] For space activities, see Section B of this chapter (vol. 3).

[2] Including $15,016 million (65.4%) for the Air Force.

[3] Including around 1,000 under American licence.

In the United States, virtually all possible types of military conventional aircraft, helicopters and compounds[1] were constructed or developed between 1960 and 1967.

Over the same period, the United Kingdom produced one supersonic fighter, one jet strike aircraft and two transports and developed one V/STOL tactical fighter and one sea reconnaissance aircraft[2].

On the other hand, the EEC industry has concentrated on building fighters, bombers and helicopters and, in France, on developing a swing-wing aircraft and strike aircraft[3], while the other EEC countries have built one American aircraft under licence and have developed a sea reconnaissance aircraft, a ground strike and trainer aircraft[4] and a transport.

The differences between the United States and Europe are even more marked in the field of commercial aircraft.

From 1960 to 1967, the United States built about 1,800 jet aircraft as compared with 230 in the United Kingdom and much the same number in France.

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[1] The major programmes included: F 105, F 5, F 111, Phantom, B 58, A 4R, LTV (A 7 and F 8D), Grumman (A 6A, C 2A, E 2, OV 1, S 2D), Orion, B 70, Vigilant, C 130, UH 1, Vertol (CH 46, CH 47), S 61, S 65, Lockheed Cheyenne, C 5A Galaxy, YF 12A.

[2] In order: Lightning, Buccaneer, Andover, Argosy, Harrier and Nimrod.

[3] Mirage, Alouette, Mirage G and Jaguar projects.

[4] The Atlantic and G 91 programmes were partly financed by the United States.

The American industry has practically monopolized the market for long-range jets and medium-range three-jet types[1] and is now getting ready to do the same with the huge Jumbo jets. Meanwhile, Europe has concentrated on medium/short range twin jets[2] and on the supersonic Concorde.

As regards Airbus-type jets, the United States are currently engaged on the development of two machines, the L 1011 and the DC 10, while Europe still delays a decision.

From the economic standpoint - ignoring the technological advantages and direct and indirect benefits to other branches of industry - the contribution of the aerospace industry can be measured by expressing its turnover as a percentage of the gross national product (A) and its added value as a percentage of value added by manufacturing industry (B)[3], as follows:

	EEC countries	United Kingdom	United States
(A) 1966	0.5	1.5	2.7
(B) 1966	0.8[4]	2.9	6.1

In both cases the figure for the aerospace industry is low in the EEC countries, although B rose from 0.6% in 1960 to the present 0.8%[5].

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1 Sales of the comparable European models - Comet 4C, VC 10 and Trident have been fairly limited.

2 Caravelle, BAC 111, Mercure (at planning stage).

3 For this figure, see Tables II/6 and II/6a.

4 1964 percentage.

5 Whereas B remained almost constant in the USA from 1960 to 1966, the figure for the United Kingdom fell from 3.3 to 2.9% over the same period.

Possibly because the percentage is low, output and added value show much more elastic variations than the American figures.

The two coefficients of elasticity for the EEC and the USA are as follows:

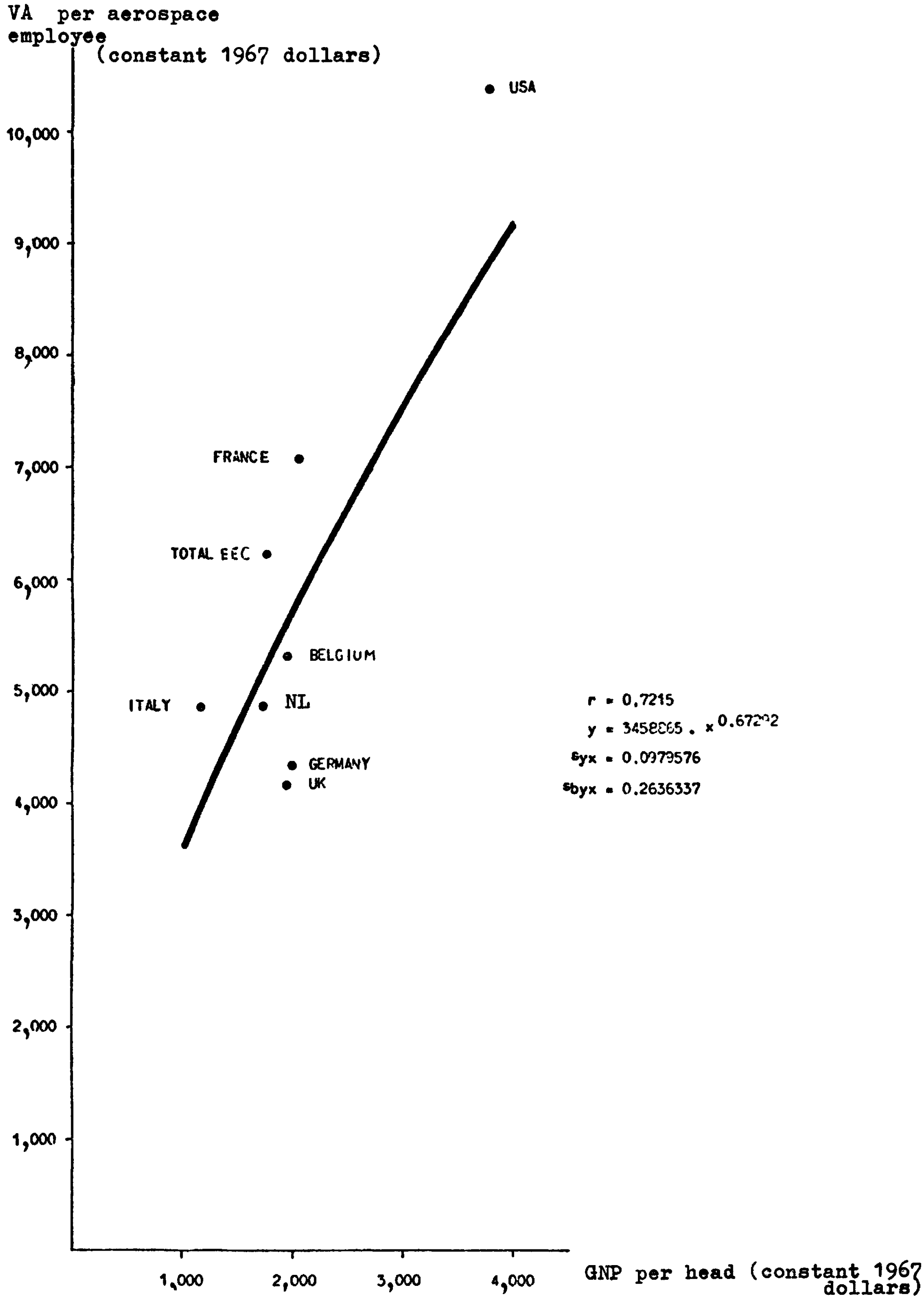
	EEC	USA
Aerospace production in relation to GNP	2.2	0.7
Aerospace added value in relation to manufacturing added value	2.2	1.0
Aerospace added value in relation to GNP	1.9	1.1

A cross-section analysis at constant values of the gross national product and of aerospace added value gives a mean coefficient of elasticity of 0.7 for the EEC countries taken together, for the United Kingdom and for the United States (Fig. 18).

In other words, while gross national product per head rose by 1%, added value per employee in the aerospace industry rose less than proportionately, by only 0.7%.

FIG. 18 **Correlation between GNP per Head of Population and Added Value per Employee in the Aerospace Industry**

(Mean values 1964-66)



4.2.2 By branches[1]

In 1967, the breakdown by value of the output of the different branches of the aerospace industry in the three areas under review was as follows:

Branch	EEC Value ($ millions)	EEC %	UK Value ($ millions)	UK %	USA Value ($ millions)	USA %	EEC+UK+USA Value ($ millions)	EEC+UK+USA %
Airframes[2]	930	52.9	764	47.5	9,238	39.7	10,932	41.1
Missiles (and space vehicles)	265	15.1	78	4.8	4,753	20.5	5,096	19.1
Engines	402	22.9	608	37.8	4,111	17.6	5,121	19.2
Equipment[3]	161	9.1	160	9.9	5,156	22.2	5,477	20.6
Total	1,758	100.0	1,610	100.0	23,258	100.0	26,626	100.0

Airframes[4] formed the biggest item in aerospace output in all three areas, with the other branches roughly equal at 20% each.

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[1] See Tables 2 /7, 2 /7a and 2 /8 series.

[2] The Belgian statistics include missiles and space activities under airframes.

[3] Excluding the German industry.

[4] Particularly the EEC industry (in relation to the value of its own output).

Taking the EEC figures as unity we then have:

	EEC	United Kingdom	United States
Airframes	1	0.82	9.93
Missiles (and space vehicles)	1	0.29	17.93
Engines	1	1.51	10.22
Equipment	1	0.99	32.02
Total	1	0.90	13.22

As compared with the United Kingdom, Community output is slightly higher[1] in all branches except engines.

At the same time, it should be noted that British production is concentrated in a few firms as against the large number operating in the EEC.

American production is very high, particularly in the case of missiles, space vehicles and aircraft equipment.

In the period 1960-67, output rose in all three areas[2] with variations between branches as shown in the table on the next page (Fig. 19).

These figures show the effort made by France and Germany in the missiles branch and by all the EEC countries (except the Netherlands) in the engines branch; nevertheless the absolute levels achieved in 1967 were still not particularly high.

In the United States, the average increase of 6.6% per annum in the airframes branch was attained over the last two years, following a sharp downturn.

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[1] The difference between the EEC and the UK is marked in the case of missiles only.

[2] At constant 1967 values.

Fig. 19 EEC Countries, United Kingdom and United States: Average increase in aerospace output per annum, overall and by branches, 1960-67

Branch / Area	Airframes	Missiles and space vehicles	Engines	Equipment	Total
France	+9.4	+16.4	+17.7	+0.3	+10.5
Germany	+11.9	+25.3	+42.6	-[1]	+16.8
Italy	+16.0	-	+10.4	+12.1	+13.7
Belgium	+6.7	-	+21.9	-	+13.7
Netherlands	-1.1	-	-	-	-1.1
Total EEC	+9.3	+17.1	+19.0	+1.9	+11.0
United Kingdom	+2.3	+2.4	+2.0	-2.2	+1.7
United States	+6.6	+2.6	+5.5	+2.0	+4.4

[1] No production figures available for Germany.

When the figures for output by branches are combined with those for numbers employed for the years 1963[1] and 1967 (Figs. 20 and 21), analysis of the percentage of each in the total for the branch reveals the following facts:

- in the United States, rises or falls in numbers employed are matched, in each branch, by changes in the output figure;
- in the United Kingdom, the same applies (except in the equipment branch) but to a lesser extent;
- on the other hand, the position in the EEC is as follows:

  airframes branch: a slight drop in the employment figure from 14.9 to 13.4% is accompanied by a sharp drop in the share in total output (from 13.5 to 8.5%).

  Missiles branch: slight increase in the employment percentage and sharp increase in the output percentage.

  Engines branch: slight increase in both the employment and the output percentages; in France the former remained constant at 8.7% while the production figure rose from 3.7 to 5.6%.

  Equipment branch: the employment percentage remained steady while the output figure fell slightly.

The relationship between output and numbers employed can be expressed in terms of turnover per employee (Fig. 22); this presentation may possibly illustrate the above percentage variations more clearly and it can further be noted that[2]:

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[1] First year for which reliable data are available concerning the distribution of employment by branches in the United Kingdom.

[2] In addition to the area-by-area comparison in Section 2.4 below.

FIG. 20 EEC Countries, United Kingdom, United States - Output[1] and Labour Force Employed by Branches as a Percentage of Branch Totals

(1963)

	Airframes		Missiles (and space vehicles)		Engines		Equipment	
	Labour force	Output	Labour force	Output	Labour force	Output	Labour force	Output
FRANCE	7,3	5,7	2,6	1.5	8.7	3.7	9.1	3.2
GERMANY	4,4	4,3	- [2]	0,2	1,3	1,1	-	-
ITALY	1,4	1,3	-	-	1,3	1,1	1,3	0,3
BELGIUM	0,7	0,5	-	-	0.9	0,6	-	-
NL	1,1	1,7	-	-	-	-	-	-
TOTAL EEC	14,9	13,5	2,6	1,7	12,2	6,5	10,4	3.5
UK	24,2	11,3	4.2	1.3	35,0	12,0	24,3	2,5
USA	50,9	75,2	93.2	97,0	52,7	81,5	65,3	94,0
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

[1] At constant 1967 values.

[2] No employment figures available.

FIG. 21 EEC Countries, United Kingdom, United States - Output and Labour Force Employed by Branches as a Percentage of Branch Totals

(1967)

	Airframes		Missiles (and space vehicles)		Engines		Equipment	
	Labour force	Output	Labour force	Output	Labour force	Output	Labour force	Output
FRANCE	6.5	5,5	3,1	4,5	8,7	5,6	9.2	2,4
GERMANY	4.0	1.5	0.7	0,7	2.2	1,2	-	-
ITALY	1,6	0,9	-	-	1.3	0.7	1.2	0.5
BELGIUM	0,4	0,1	-	-	0.9	0,3	-	-
NL	0.9	0,5	-	-	-	-	-	-
TOTAL EEC	13.4	8,5	3.8	5.2	13,1	7,8	10.4	2,9
UK	14,6	7.0	4.8	1.5	33.6	11,9	20.1	2.9
USA	72.0	84,5	91.4	93.3	53,3	80,3	69.5	94,2
TOTAL	100.0	100.0	100.0	100,0	100,0	100.0	100,0	100,0

FIG. 22 EEC Countries, United Kingdom, United States - <u>Value of Output[1] per Head in All Branches of the Aerospace Industry in 1963 and 1967</u>

	Airframes		Missiles		Engines		Equipment		TOTAL	
	1963	1967	1963	1967	1963	1967	1963	1967	1963	1967
FRANCE	8,675	13,613	9,000	17,769	8,777	14,400	8,523	5,500	8,700	12,376
GERMANY	10,708	6,185	-	11,333	15,333	12,000	-	-	11,592	7,457
ITALY.	10,000	8,454	-	-	15,666	12,666	5,666	9,666	10,285	9,411
BELGIUM	8,500	3,666	-	-	12,500	8,000	-	-	9,833	5,400
NL	20,000	10,000	-	-	-	-	-	-	20,000	10,000
TOTAL EEC	10,283	10,219	9,000	16,562	10,222	13,400	8,250	5,962	9,909	10,719
UK	5,312	7,717	4,444	3,900	6,636	7,896	2,500	3,076	5,060	6,491
USA	13,487	18,930	15,160	12,574	28,646	33,696	33,773	28,644	19,007	19,912

[1] At constant 1967 values.

- the value of output per employee rose substantially in France except in the equipment branch, but fell sharply in all branches in the other EEC countries. This is not surprising in view of the fact that, in 1963, Germany, Italy, Belgium and the Netherlands were heavily engaged on the production of military aircraft under licence. On the other hand, France followed another line, directed mainly to the development and production of its own aircraft or to joint R&D programmes.

- the influence of the recent demand for commercial aircraft and the resumption of military orders is clearly apparent in the United States (increase in output per head in the airframe and engine branches), as is the relative falling off of missile and space programmes, which is reflected by the reduced value of output per head in this branch and by the falling off in the equipment branch.

Lastly, it should be stressed that the Community industry has succeeded, owing mainly to the French contribution, in developing a number of original programmes in the airframe and missile branches[1]. Particularly as regards airframes, a number of very interesting military programmes and of short/medium range commercial aircraft have been developed in succession. The main effort is now concentrated on supersonic flight (with the Franco-British Concorde) and, at study level, on VTOL aircraft (especially in Germany).

In the engine branch, however, the Community industry, despite considerable efforts, is still unable to compete and depends on the main foreign constructors in the United States and the United Kingdom.

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[1] Full details of programmes are given in the "National Reports".

4.3 Productivity[1]

The indices used to compare productivity in the three areas (EEC, United Kingdom, United States) in 1966[2] were in turn compared with the value of production and costs per employee, as set out in the table below:

Aerospace industry (1966)		EEC	United Kingdom	United States
Value of output[2] per employee	$	9,509	6,515	18,562
Added value[2] per employee	$	6,100[3]	4,192[4]	12,179[3]
Added value as a percentage of output	%	64.1	64.4	65.6
Annual cost per employee	$	4,815	3,315	8,655
Cost of labour as a percentage of added value	%	78.8	79.0	71.0
Cost of labour as a percentage of value of output	%	50.6	50.9	46.6

[1] Added value/number employed.

[2] At current values.

[3] At factor cost.

[4] At market prices.

Taking output per head and added value per head to be unity for the EEC, the comparable figures for the United Kingdom and the United States are as follows[1]:

1966	EEC	UK	USA
Value of output per head	1	0.68	1.95
Added value per head	1	0.68	1.99

It will be seen that the American figures for value of output per head and value added per head are 1.95 and 1.99 times the corresponding EEC figures and 2.84 and 2.9 times the British values.

Again taking the EEC figure as unity, the relative cost of labour in the three areas is as follows:

1966	EEC	UK	USA
Cost of labour	1	0.68	1.79

Cost per employee in the United States was therefore 1.79 times the EEC figure and 2.6 times the British figure.

Some reserves may be expressed concerning the comparability of the data used because returns are not compiled on the same basis for either added value or manpower (on this point, see the previous chapter).

There are no such reserves concerning the figures for numbers employed and value of output. However, the differences between value of output per head and added value per head are strictly in proportion for the three areas under review; since added value as a percentage of production is also virtually identical for the three areas, the magnitudes of the values considered would appear to be acceptable in principle.

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[1] The series for the period 1960-70 are given in Tables 2/9 and 2/10.

The following remarks are therefore appropriate:

1) - The higher proportion of labour costs to added value in Europe (both in the EEC and the UK) as compared with the USA is evidence of lower amortization costs in Europe as against the USA, because they relate to substantially lower investments, and of lower return earned by the European aerospace industry as compared with its American counterpart.

2) - The higher proportion of labour costs to value of output in Europe (both the EEC and the UK) as compared with the United States reflects the relative cost of labour in the three areas.

3) - The practically identical proportion of added value to output in all three areas suggests (on the basis of the reciprocal relationships between the various internal factors affecting the formation of added value) that the breakdown between internal inputs and factors in the aerospace industry is structurally similar in the three areas.

- The difference in output per head between the three areas (the American figure is almost twice that for the EEC and three times that for the United Kingdom), taken together with the equal percentage of inputs in output, can only mean that it takes twice as long in the EEC and three times as long in the United Kingdom to turn out a similar product.

This ratio is probably too low in the aircraft sector proper in view of the higher percentage of missile and space production in the USA (20% of the total) as compared with Europe (15% in the EEC and 4.8% in the UK), where production times are proportionately longer than in the aircraft sector because of the small numbers produced.

- The difference in output per head between the three areas is partly, but substantially, offset by the differences in labour costs between the USA, the EEC and the UK. It may therefore be concluded that the only point at which the European industry is almost competitive is linked with the lower cost of labour.

  It should be noted, however, that between 1959 and 1966 the cost of labour in the aerospace industry rose by 78% in the EEC, 48% in the United Kingdom and only 31% in the United States. If, as seems likely, this trend continues, the competitivity of the European aerospace industry, which is based solely on labour costs, would be wiped out fairly quickly.

  There is almost certain to be a trend towards equalization of wages because, as is well known, less-developed countries are carried along by the more developed.

- The difference noted in output per head between the three areas is probably due to the following factors:

  (a) Better organization and management in the American industry as compared with the EEC and UK industries.

  Such management takes the form of the identification of patterns of production adapted to the final product, with all the consequent economies of scale, the harmonization of factors, the optimization of size as compared with the position in Europe, where the product is generally adapted to use existing and underemployed structures and factors.

(b) Bigger investments in the American aerospace industries in machinery and equipment as compared with Europe[1], with a consequent increase in labour productivity.

(c) Achievement, in the United States, but not in Europe, of optimum production flows which benefit from the effects of the learning curve and therefore minimize labour costs per unit produced. It may be noted in this connection that in Europe the country with the biggest output per head - France - is also the country which has achieved the longest runs for equivalent or similar types with its Caravelle and various military aircraft, although the total length of the period over which these runs were completed has partly cancelled out the effects of the learning curve.

(d) Government spending on R&D and the production of aircraft, missiles and space material, which is a higher percentage in the United States than in Europe, aims at the maximum return for the lowest costs. With organized and competitive sources of supply (which do not exist in the individual European countries) this policy is a strong incentive to rationalize structures and increase the productivity of all the factors involved.

Here again, the outstanding example is France, where increased government subsidies for R&D and a rise in production are accompanied by a level of productivity higher than that achieved in the other EEC countries and the United Kingdom. Nevertheless, a contracting

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[1] See Section 2.2.4.

policy aimed more at raising productivity might have produced even more outstanding results in this case.

5. CONCLUSIONS

5.1 General Remarks

In the preceding pages we have described the main features of the EEC aerospace industry as compared with the American and British industries.

By way of conclusions, we feel that we should recall the most obvious and abnormal differences revealed by this comparison and should indicate their apparent and hidden causes.

The validity of our comparison may perhaps be contested on grounds of methods, since the industries under review operate in different national circumstances and serve markets of varying size.

In our view, this comment is not wholly justified, because the aerospace industry can be regarded as aiming at an open world market, within which the American industry is the uncontested leader with products of the highest quality at more than competitive prices.

Only by investigating the causes which have produced this leadership can we find guidance for an action policy designed to remove the restrictions which have hitherto prevented the European aerospace industry from occupying the important position to which it is entitled.

The most important subjects for thought from this chapter would seem to be:

- European aerospace firms are not big enough.

Even when the biggest European companies are set against their American counterparts, there is no real comparison; this is amply proved by the single fact that, in 1967, the total output of the five biggest EEC firms added to that of the three biggest in the United Kingdom did not amount to 60% of the output of the biggest American aerospace company or to 75% of the fifth in size.

A big undertaking ensures reaching the levels required for the production of optimum runs of aircraft, with maximum economies of scale, maximum reliability thanks to the sequence of large government orders and substantial commercial orders and the capacity to carry through major programmes independently.

In Europe, considerable efforts have been made towards the financial and economic concentration of aerospace firms, but no serious attempt has been made to bring production structures into line with the new financial and economic dimensions.

The smallness, dispersal and sub-division of plant prevent the concentration of technical investments and the adoption of new methods of organization which are the hallmark of the American industry.

- The value of output per head varies very widely between the aerospace industries of the EEC, the United Kingdom and the United States (the American figure is almost twice that for the EEC and three times that for the United Kingdom).

Since the percentages of external and internal inputs in production are practically the same, this means that productivity per head is almost twice as high in the American industry as in the EEC industry and three times as high as in that of the United Kingdom.

This brings us back to our earlier observations concerning the organization and size of firms; we would again stress that with the high labour intensity which is a feature of the industry in all three areas, the only possibility of offsetting Europe's low productivity at present lies in the relatively low cost of labour. However, in view of the trend which is likely to cancel out this factor in the fairly near future, it is obvious that action will have to be directed to structural features and to investments to overcome what is the most unfavourable feature of the European aerospace industry.
It may be noted that variations in productivity per head between Europe and the United States are much the same in many other branches of manufacturing industry as in the aerospace sector.

In particular, even in the motor vehicle industry, which is easier to compare, the difference in productivity per head is of the same order as for manufacturing industry as a whole.

However, in the specific case of the aerospace industry this difference in productivity leaves European aircraft firms with a completely unsatisfactory return; in other branches of industry, the productivity gap is largely made good and firms' earn a high enough return to provide completely adequate profits and funds for self-financing.

Over and above the difference in labour costs, which also applies to aerospace activities, the other branches of manufacturing industry benefit from a further substantial "geographical return".

Indeed, for almost all branches of industry except the aerospace branch, European demand (government and private) still turns for preference to firms operating within the European market and, in the case of the European Community, to firms operating in member countries.

In the case of the aerospace branch, the "geographical return" would appear to be very slight.

To begin with, the cost of transporting the finished products cannot, by definition, be very high; nor is the cost of transporting inputs of appreciable significance.

Secondly, in this branch the special features of national demand do not provide a "geographical return", i.e., advantages for local manufacturers.

The structure of this industry is, of course, characterized by the fact that military demand is in the hands of single customers in each country and the demand for commercial aircraft is in the hands of a tight group of customers (in the European countries there is in fact only one flag company and even in the United States there are not many airline companies which have a significant effect on demand).

On the supply side, there is a tight world group of producers (or at least in the Western countries).

In these circumstances, the characteristics of demand are very similar and, within certain limits, there are no separate or differentiated markets.

- As compared with the American aerospace industry, the return on capital and capital turnover are very low in the EEC and British aerospace industries. For 1966 (the last year for which comparable data could be obtained), we have the following figures for some of the biggest aerospace firms in France (no information could be obtained for the other EEC countries), the United Kingdom and the United States:

Profits as percentage of own capital

France	UK	USA
3.80	5.34	15.8

Annual rate of turnover of total net assets (number of times per year)

France	UK	USA
0.56	1.12	2.1

We consider that the position in the other EEC countries was much the same as in France.

In these circumstances, we feel that the aerospace industry is not particularly likely to attract resources and capital in Europe; but the situation is reversed in the United States, where the aerospace industry has now become the biggest customer for capital and resources in the whole economy.

- Output in all three areas under review rose almost continuously, with an average increase of 11% per annum in the EEC, 1.7% in the United Kingdom and 4.4% in the United States.

  It should be added, however, that in 1966-67 the average rate of increase per annum was 17.4% in the United States as against 7.4% for the EEC and a decline of 2.6% for the United Kingdom.

  While the EEC trend may appear satisfactory at first sight, a more detailed analysis reveals the following:

- The rise in production in the EEC from 1960 to 1967 was mainly due to an increase in government purchases and R&D contracts, from $427 million in 1960 to $1,148 million in 1967.

- In the United States the rise was due to a combination of increased government expenditure, rising from $12,124 million in 1960 to $17,506 million in 1967, and higher sales to other countries, increasing from $1,282 million in 1960 to $3,503 million in 1967.

- In the United States the rising trend of output has been associated with a process of reorganization, with the following features:

  a) firms have reached practically optimal size;

  b) risks have been shared between military and civil production, with the biggest firms aiming at parity;

  c) long-term integration and programming of government finance and private investment;

  d) the biggest and leading firms in the industry, who hold the contracts and jointly organize the whole complex sub-contracting system, operate so that the whole industry benefits, on a centralized basis, from government contracts and finance[1];

  e) production units specialize in specific types of finished product, so that duplication of assembly, coordination, purchases, etc., is eliminated;

  f) marketing times have been cut (time from the start of specific R&D to the delivery of the first production

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[1] In 1966, 82.5% of all NASA contracts were concentrated in the hands of five aerospace firms.

aircraft) from five years for the Boeing 707 to three years for the Boeing 747);

- On the other hand, the position was as follows in Europe over the same period:

  a) except in France, governments have intervened only occasionally or to provide temporary economic support and have never produced definite programmes for reorganizing the industry.

  b) economic and financial concentration has taken place but this has not spread to organization and structure, so that there has been no major specialization of firms;

  c) the almost total lack of commercial production has prevented the sharing or risks between civil and military production;

  d) joint industrial projects have in no case furthered operational centralization but have in almost all cases led to the doubling or trebling of production and assembly lines;

  e) marketing times have remained virtually unchanged (eight years for the Comet, seven for the Caravelle and six for the VC 10).

All these obvious structural and operational shortcomings in the European aerospace industry are the product of a single factor from which they derive.

In our opinion, this factor is the inability of the European aerospace industry, and of the public authorities concerned with it, to programme and carry through (dealing with all the associated problems of R&D, markets, marketing, etc. together) the production of optimum runs which can benefit from the effects of the learning curve and can impose all the advanced forms of organization which are vital to complete such runs.

5.2 Projections for the Eighties

From sheer curiosity, we have extrapolated the existing data (at constant prices) to produce a number of graphs[1] tentatively forecasting employment figures, output per head and added value per head for the EEC, the United Kingdom and the United States, on the assumption that the trend observed from 1960 to 1967 remains constant.

Such an extrapolation is unreliable for the following reasons:

- The output of the EEC aerospace industry in the seventies, calculated from the extrapolation for output per head and numbers per head, is wholly incompatible, as regards the EEC's possible share, with our estimates of the size of the overall market for aerospace products during the same period;

- The forecast of added value per head in the EEC is valid only if it is assumed that labour costs in the Community will move into line with the present cost in the United States.

  The forecast of added value per head in the USA will only be fulfilled if there is a proportionate increase in factor costs which seems unlikely in the light of past trends. On the contrary, it is probable that the present figure for added value per head in the United States already represents an optimum percentage distribution between external

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[1] See Tables 2/11, 2/12 and 2/13.

and internal inputs in production.

- The rising trend of EEC output in recent years is due to the following three factors:

  1) the exceptional effort made by France (in terms of government expenditure) which cannot be expected to continue at the same level of spending in future;

  2) the re-equipment of European air forces, now completed; it may reasonably be assumed that replacements but no additions will be required in future;

  3) the technical, organizational and financial decision of the United States to unify and rationalize aircraft and missiles within NATO; this is unlikely to be repeated on the same scale.

Rather than reason in terms of extrapolation trends, all who have direct or indirect responsibility for the EEC aerospace industry will therefore have to work out reasoned and reasonable forecasts, based on an analysis of structures and of the market and then use this joint forecast to formulate the elements of a policy which will be directed first and foremost to reorganize all the firms in the industry, in order to make them really competitive and give them an organization compatible with the technical and commercial problems associated with aerospace production.

In our view, the market opportunities to justify such an effort are not lacking. The likely demand for both military and civil purposes over the next ten years is substantial; in particular, the trend towards diversification of aircraft types must not be overlooked as it could offer major outlets for the European industry.

TABLES ANNEXED TO CHAPTER 2

Section A

The aeronautical and space industry

List of Tables

Sources of data for production, employment and added value

As stated in our introduction, our sources of information varied so greatly that they had to be scrutinized and evaluated very carefully in order to produce comparable data.

We obtained our production and employment figures from the following sources (by countries):

a) France: USIAS - L'industrie aéronautique et spatiale 1960-67.

b) Germany: the official German statistics for the aeronautical industry are published by the Federal Statistical Office ("Statistisches Bundesamt") in the annual Statistical Yearbooks under the heading "Aircraft Construction" in the section dealing with "Capital goods industries". The term "aircraft construction" is not defined in the yearbooks but it can be deduced from the number of firms and employees that this heading covers only the aircraft industry proper, comprising the production of airframes, engines and missiles, to the exclusion of branches making non-electronic equipment.

   Hence, since we used the official statistics and had no basis for estimating for the equipment branch, the German employment and production figures are too low.

c) Italy: the statistics for the Italian aeronautical and space industry were derived from the following publications:

   1. ISTAT, 4th General Census of Industry and Trade, 16 October 1961
   2. ISTAT, value added by undertakings 1961-65, Notes and Reports No. 34, November 1967

3. Confindustria, Study and Statistical Division. Outlook for Italian industry

4. Ministry for the Budget and Economic Planning, Working Group on the Aircraft Industry. Final Report, Rome, July 1967

5. Statistical Office of the European Communities, "Input-Output" Tables for the countries of the European Economic Community, December 1965

6. Statistical Office of the European Communities, Statistical Studies and Surveys, 1968 Supplement.

The figures used in this chapter are taken from sources 1, 2, 5 and 6 combined with information supplied by individual aerospace firms; the series for numbers employed in the aerospace industry was not calculated from the sources listed.

Source 3 mentions the aerospace industry from 1960 to 1962 and in 1965 only; the relevant data were used for comparison.

d) Belgium: The official Belgian statistics classify aerospace firms under the wider industrial heading "Mechanical engineering" and therefore do not give separate data for the aerospace industry. The figures in this chapter were calculated from the Trade Union Seminar[1] of Mr Decoster, National Secretary of the "Centrale des Métallurgistes"

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[1] OECD. Regional Trade Union Seminar, Paris, 21-22 Sept. 1966. These figures were corrected, on the basis of others supplied by the aerospace firms, to eliminate electronics firms.

and from the "Input-Output" Table for 1959, Heading 48, Aircraft Construction[1].

e) Netherlands: No official Netherlands statistics give figures for the aeronautical and space industry.

The data for employment, production and added value in the aerospace industry were, therefore, estimated on the basis of figures[2] taken from the Fokker Company's annual reports, and the data given in the "Input-Output" Table for 1959, Heading 48, Aircraft Construction[3].

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1 Source: Statistical Office of the European Communities, "Input-Output" Tables for the countries of the European Economic Community, December 1965.

2 Mainly: employment, hours of work, wages, investments, depreciation and profits.

3 Source: Statistical Office of the European Communities, "Input-Output" Tables for the countries of the European Economic Community, December 1965.

f) United Kingdom: In the British statistics, the aircraft industry appears under Part 8 "Vehicles" of Heading 383 of the Minimum List of the Standard Industrial Classification, which classifies firms on the basis of 51% of the main type of activity.

Heading 383 of the SIC describes the aircraft industry as follows:

"383 - Aircraft Manufacturing and Repairing
Manufacturing and assembling airframes or complete aircraft and gliders, guided missiles; modifying or repairing airframes and aircraft. Manufacture and repair of aero-engines and power plant. Manufacturing parts and accessories other than electrical and electronic equipment is included". Although not specified, this heading also includes firms making hovercraft; in addition, over half the numbers employed on space research are considered to be employed in the aircraft industry. The reason for this is that "hovercraft" and "space" are not separate items in the SIC, because they have come into being since the statistical headings were last revised.

g) United States

Employment

The figures for total numbers employed in the various branches of the aerospace industry were taken from two sources: "AIA Facts and Figures, 1968" and "USA Industrial Outlook, 1968", published by the US Department of Commerce, BDSA.

The two sources do not agree either as regards the total numbers employed or as regards their breakdown by branches, because they use different classifications, as follows:

US Industrial Outlook, 1968

a) Complete airframes for aircraft (SIC 3721);

b) Engines and their components for aircraft, missiles and space vehicles (SIC 3722 and 3723);

c) Missiles and space vehicles (SIC 1925);

d) Components and equipment (SIC 3729).

Aerospace Industries Association of America, Inc.

a) Aircraft: sub-divided into airframes and engines and power plant, with general reference to SIC 372.

b) Missiles and space work: this comprises "the employees in the aircraft, complete missile and space and electronic industries, engaged in missile and space work", as well as "employees in the electrical machinery industry (SIC 36) engaged in missile and space work".

c) Others: includes employees in industry classification (SIC 28, 35, 38, 73, 89 and others) engaged in missile and space work.

The AIA statistics also include among employees in the aerospace industry a number of employees from non-aerospace branches (SIC 36, 28, 35, 38, 73, 89 and others) while the returns of the US Department of Commerce are based on the SIC aerospace headings only.
While quoting the AIA figures[1], therefore, because they

[1] In Annex 7, "Description of the United States Aerospace Industry".

come from the industrial association and represent a wider phenomenon[1], the Department of Commerce returns are used in this chapter both because they are more relevant and because they are more in line with the statistics of the EEC countries and the United Kingdom.

Output

The statistics for the value of output, or better for sales, of the American aerospace industry are estimates[2] published annually by the Aerospace Industries Association of America Inc., in "Aerospace Facts and Figures".

Other American publications dealing with the subject include:

- "US Industrial Outlook", published annually by the US Department of Commerce, BDSA. In this document, sales by the American aerospace industry are related to the relevant SIC headings, as follows: 3721, 3722, 3723, 3729 and 1925[3];
- "Current Industrial Report", issued by the US Bureau of Census; reports and balance-sheet data for the 60 leading American aerospace firms[4];

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1 Because the employment figures for the aerospace industry include a number of employees from other branches of industry whose output is absorbed by the aerospace industry.

2 "Estimated sales of the aerospace industry by product group" in "Aerospace Facts and Figures", 1968, page 8, and 'Estimated sales of the aerospace industry by customer", page 9 of the same report.

3 The SIC Classification is based on firms' main activities.

4 The turnover of these firms accounts for about 80% of that of the whole industry.

- various publications of the National Science Foundation concerning research and development in the United States, including: "Research and Development in Industry" (published annually) and "Federal Funds for Research, Development and Other Scientific Activities" (issued every three years).

The data produced by the AIA are those most often quoted in specialized publications and reviews; moreover, as they come from the industrial association, they must be given due weight and are, therefore, reproduced in Tables 4-7.

However, the following comments must be made concerning the turnover figures for the American aeropsace industry as given by the AIA:

- they are estimates and not verified figures;
- all government expenditure on aerospace R&D is included in the aerospace industry's turnover by the AIA[1].

Confirmation that this method is used to estimate the industry's turnover is obtained by comparing the AIA data with those of the National Science Foundation[2] for R&D expenditure, as set out in "Facts and Figures, 1968"[3].

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[1] Adjusted, using mean values, to relate government expenditure during the fiscal year (1 July to 30 June) to the calendar year.

[2] National Science Foundation: Research and Development in Industry, 1966 (NSF 68-20).

[3] Op. cit., page 66: Industrial R&D, all industries and the aerospace industry; calendar years 1956 to date.

From this comparison it would appear that the AIA included all government expenditure on aerospace R&D in the aerospace industry's turnover and not merely the sums which went to the industry itself; the difference, which is in fact quite substantial, comprises internal expenditure by the government agencies and sums going to non-aerospace industries for R&D relating to aerospace products.

In view of this fact, and the need to have data comparable with those produced for the European countries, a fresh estimate had to be made for the total turnover of the aerospace industry and for its distribution by final customer.

Thus reconstituted, the variously distributed output of the aerospace products of the American aerospace industry was subjected to various checks, with the following results:

- the estimated figures do not vary unduly from those in the Bureau of Census "Current Industrial Report", Series M 37 D, verified as from 1961 from the balance sheets of the 60 biggest aerospace firms in the United States, which, as already stated, account for about 80% of American aerospace output by value.
- the same remark applies to the comparison with the figures published by the US Department of Commerce, BDSA, in the US Industrial Outlook, 1968, with reference to SIC items 3721, 3722, 3723, 3729 and 1925 (i.e., the items relating more specifically to aerospace activities);
- SORIS estimates of government expenditure on R&D in the aerospace industry agree with the figures of the

National Science Foundation for SIC items 372 and 19.

Except in the cases of the Netherlands and the United States, value added by the aerospace industry is derived from national matrices.

In the case of data for years prior to 1966, an estimate was made for subsequent years by extrapolating the initial data on the basis of the index for the rise in labour costs.

Table 2/1

EEC Countries, United Kingdom, United States - Labour Force Employed in Aerospace and Manufacturing Industries (1960-67)

(In thousands)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Aerospace industry	118	126	137	143	148	151	159	164
Manufacturing industry	20,198	20,744	13,476[1]	21,427	21,655	21,757	16,082[2]	
Aerospace as % of total for all manufacturing ind.	0.6	0.6		0.7	0.7	0.7		
United Kingdom								
Aerospace industry	291	304	292	270	268	259	249	254
Manufacturing industry	8,851	8,975	8,893	8,582	8,731	8,827	8,977	8.701
Aerospace as % of total for all manufacturing ind.	3.3	3.4	3.3	3.1	3.1	2.9	2.8	2.9
United States								
Aerospace industry	956	931	1,003	989	951	945	1,092	1.168
Manufacturing industry	16,796	16,326	16,853	16,995	17,274	18,062	19,186	19,336
Aerospace as % of total for all manufacturing ind.	5.7	5.7	6.0	5.8	5.5	5.2	5.7	6.0

[1] No figures are available for labour force of manufacturing industry in Germany.

[2] No figures are available for labour force employed in manufacturing industry in France.

Table 2/1a

EEC Countries, United Kingdom, United States - Labour Force Employed in the Aerospace and Manufacturing Industries (1960-67)

	1960	1961	1962	1963	1964	1965	1966	1967
	Aerospace industry (in thousands)							
FRANCE	84	86	88	90	94	97	101	101
GERMANY	15	21	26	27	29	30	33	35
ITALY	10	10	12	14	14	14	15	17
BELGIUM	3	3	5	6	5	4	4	5
NL	6	6	6	6	6	6	6	6
TOTAL EEC	118	126	137	143	148	151	159	164
UK	291	304	292	270	268	259	249	254
USA	956	931	1,003	989	951	945	1,092	1,168
	Manufacturing industry (in thousands)							
FRANCE	5,202	5,277	5,308	5,404	5,549	5,580	-	-
GERMANY	7,160	7,416	-	7,747	7,805	7,986	7,949	-
ITALY	5,353	5,485	5,557	5,654	5,645	5,526	5,487	5,618
BELGIUM	1,191	1,233	1,251	1,262	1,282	1,278	1,272	-
NL	1,292	1,333	1,360	1,360	1,374	1,387	1,374	1,333
TOTAL EEC	20,198	20,744	13,476	21,427	21,655	21,757	16,082	-
UK	8,851	8,975	8,893	8,582	8,731	8,827	8,977	8,731
USA	16,796	16,326	16,853	16,995	17,274	18,062	19,156	19,336

Table 2/2
EEC Countries, United Kingdom, United States - Labour Force Employed in Each Branch of the Aerospace Industry (1960-67)
(In thousands)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Airframes[1]	66	71	79	81	84	84	89	91
Missiles	10	11	11	11	13	14	15	16
Engines	21	22	24	27	27	28	29	30
Equipment[2]	21	22	23	24	24	25	26	27
TOTAL	118	126	137	143	148	151	159	164
United Kingdom								
Airframes				131	116	110	104	99
Missiles				18	23	23	22	20
Engines				77	77	78	79	77
Equipment[3]				56	55	56	52	52
Total[4]				282	271	267	257	248
United States								
Airframes	514	436	342	330	325	353	442	488
Missiles and space vehicles	238	256	388	393	369	317	360	378
Engines	124	121	116	116	109	105	118	122
Components and equipment	80	118	157	150	148	170	172	180
TOTAL	956	931	1,003	989	951	945	1,092	1,168

1 Belgium, including missile and space work.

2 No figures for numbers employed on equipment in Germany.

3 Including parts of airframes and engines.

4 The figures should be taken as a guide only; in returns, the whole labour force of a factory is assigned to the latter's main product. Furthermore, they do not agree with Table 2/1, because they come from a different source (Ministry of Technology).

Table 2/2a

EEC Countries, United Kingdom, United States - Percentage of Labour Force Employed in Each Branch of the Aerospace Industry

(1960-67)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Airframes[1]	55,9	56,3	57.7	56,6	56.8	55.6	56.0	55.5
Missiles	8.5	8.7	8.0	7,7	8,8	9.3	9,4	9.8
Engines	17.8	17.5	17,5	18.9	18.2	18,5	18,2	18,2
Equipment[2]	17.8	17.5	16.8	16.8	16,2	16.6	16,4	16,5
TOTAL	100,0	100,0	100.0	100,0	100.0	100.0	100,0	100.0
United Kingdom								
Airframes				47,0	43,0	41,0	40,0	40,0
Missiles				6,0	9.0	9,0	9,0	8.0
Engines				27.0	28,0	29.0	31,0	31,0
Equipment[3]				20,0	20.0	21.0	20,0	21.0
TOTAL[4]				100.0	100.0	100,0	100,0	100,0
United States								
Airframes	53,8	46,8	34,1	33,4	34,2	37,4	40,5	41,8
Missiles and space vehicle	24,9	27,5	38,7	39,7	38,8	33,5	33,0	32,4
Engines	12.9	13,0	11,6	11,7	11,4	11,1	10,8	10,4
Components and equipment	8,4	12,7	15,6	15,2	15,6	18,0	15.7	15,4
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

1, 2, 3 and 4 See notes to Table 2/4.

Table 2/3a

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1960

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	39	10	16	19	84
GERMANY	14	-	1	-	15
ITALY	5	-	3	2	10
BELGIUM	2	-	1	-	3
NL	6	-	-	-	6
TOTAL EEC	66	10	21	21	118
UK	n.a.	n.a.	n.a.	n.a.	n.a.
USA	514	238	124	80	956
FRANCE	46,5	11,9	19,0	22,6	100,0
GERMANY	93.3	-	6.7	-	100,0
ITALY	50,0	-	30,0	20.0	100.0
BELGIUM	66,7	-	33,3	-	100.0
NL	100,0	-	-	-	100,0
TOTAL EEC	55,9	8.5	17.8	17.8	100.0
UK	n.a.	n.a.	n.a.	n.a.	n.a.
USA	53,7	24,9	13,0	8,4	100,0

Table 2/3b

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1961

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	39	10	17	20	86
GERMANY	19	1	1	-	21
ITALY	5	-	3	2	10
BELGIUM	2	-	1	-	3
NL	6	-	-	-	6
TOTAL EEC	71	11	22	22	126
UK	n.a.	n.a.	n.a.	n.a.	n.a.
USA	436	256	121	118	931
	Percentages				
FRANCE	45,3	11,6	19,8	23,3	100,0
GERMANY	90,4	4,8	4,8	-	100,0
ITALY	50,0	-	30,0	20,0	100,0
BELGIUM	66,7	-	33,3	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	56,3	8,7	17,5	17,5	100,0
UK	n.a.	n.a.	n.a.	n.a.	n.a.
USA	46,8	27,5	13,0	12,7	100,0

Table 2/3c

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1962

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	40	10	18	20	88
GERMANY	24	1	1	-	26
ITALY	7	-	3	2	12
BELGIUM	3	-	2	-	5
NL	6	-	-	-	6
TOTAL EEC	79	11	24	23	137
UK	n.a.	n.a.	n.a.	n.a.	n.a.
USA	342	388	116	157	1.003
	Percentages				
FRANCE	45,4	11,4	20,5	22,7	100,0
GERMANY	92,4	3,8	3,8	-	100,0
ITALY	54,5	-	27,3	-	100,0
BELGIUM	58,3	-	25,0	16,7	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	57,7	8,0	17,5	16,8	100,0
UK	n.d.	n.d.	n.d.	n.d.	n.d.
USA	34,1	38,7	11,6	15,6	100,0

Table 2/3d

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1963

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	40	11	18	21	90
GERMANY	24	-	3	-	27
ITALY	8	-	3	3	14
BELGIUM	4	-	2	-	6
NL	6	-	-	-	6
TOTAL EEC	81	11	27	24	143
UK	131	18	77	56	282
USA	330	393	116	150	989
	Percentages				
FRANCE	44,5	12,2	20,0	23,3	100,0
GERMANY	88,9	-	11,1	-	100,0
ITALY	57,2	-	21,4	21,4	100,0
BELGIUM	66,7	-	33,3	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	56,6	7,7	18,9	16,8	100,0
UK	46,4	6,4	27,3	19,9	100,0
USA	33,4	39,7	11,7	15,2	100,0

Table 2/3e

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1964

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	43	11	19	21	94
GERMANY	25	1	3	-	29
ITALY	8	-	3	3	14
BELGIUM	3	-	2	-	5
NL	6	-	-	-	6
TOTAL EEC	84	13	27	24	148
UK	116	23	77	55	271
USA	325	369	109	148	951
	Percentages				
FRANCE	45,7	11,7	20,2	22.3	100,0
GERMANY	86.2	3.5	10,3	-	100,0
ITALY	57,1	-	21,4	21,4	100,0
BELGIUM	60.0	-	40,0	-	100,0
NL	100,0	-	-	-	100.0
TOTAL EEC	56.8	8,8	18.2	16.2	100.0
UK	42,8	8.5	28.4	20,3	100.0
USA	34.2	38,8	11.4	15,6	100,0

Table 2/3f

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1965

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	43	12	20	22	97
GERMANY	24	2	4	-	30
ITALY	8	-	3	3	14
BELGIUM	3	-	1	-	4
NL	6	-	-	-	6
TOTAL EEC	84	14	28	25	151
UK	110	23	78	56	267
USA	353	317	105	170	945
	Percentages				
FRANCE	44,3	12,4	20.6	22,7	100.0
GERMANY	80,0	6,7	13,3	-	100,0
ITALY	57,1	-	21,4	21,4	100,0
BELGIUM	75,0	-	25.0	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	55,6	9,3	18,5	16,6	100,0
UK	41,2	8,6	29,2	21,0	100,0
USA	37,4	33,5	11,1	18,0	100.0

Table 2/3g

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1966

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	45	13	20	23	101
GERMANY	26	3	4	-	33
ITALY	9	-	3	3	15
BELGIUM	3	-	1	-	4
NL	6	-	-	-	6
TOTAL EEC	89	15	29	26	159
UK	104	22	79	52	257
USA	442	360	118	172	1,092
	Percentages				
FRANCE	45,0	12,0	20,0	23,0	100,0
GERMANY	78,8	9,1	12,1	-	100,0
ITALY	60,0	-	20,0	20,0	100,0
BELGIUM	75,0	-	25,0	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	56,0	9,4	18.2	16,4	100,0
UK	40,5	8,6	30,7	20,2	100,0
USA	40,5	33,0	10,8	15,7	100,0

Table 2/3h

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Labour Force by Branches in 1967

	Airframes	Missiles	Engines	Equipment	TOTAL
	In thousands				
FRANCE	44	13	20	24	101
GERMANY	27	3	5	-	35
ITALY	11	-	3	3	17
BELGIUM	3	-	2	-	5
NL	6	-	-	-	6
TOTAL EEC	91	16	30	27	164
UK	99	20	77	52	248
USA	488	378	122	180	1,168
	Percentages				
FRANCE.	43.6	12.9	19,8	23.7	100,0
GERMANY	77.1	8,6	14,3	-	100,0
ITALY	64.8	-	17.6	17.6	100,0
BELGIUM	60.0	-	40,0	-	100,0
NL	100,0	-	-	-	100.0
TOTAL EEC	55.5	9.7	18.3	16.5	100,0
UK	39.9	8,1	31.0	21,0	100,0
USA	41,8	32.4	10.4	15.4	100,0

Table 2/4

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers (Millions of current dollars)

Value

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Government	427	472	581	782	971	917	956	1,148
of which: R&D[1]	124	143	184	187	201	275	287	375
Purchases	288	313	376	562	710	562	541	649
Subsidies*	15	16	21	33	60	80	128	124
Other national purchasers	47	29	28	45	33	38	33	46
Foreign[2], [3]	179	264	319	410	463	495	523	564
TOTAL	653	765	928	1,237	1,467	1,450	1,512	1,758
United Kingdom								
Government	770	910	932	924	938	986	946	1,008
of which: R&D	252	297	300	302	302	325	291	294
Purchases	510	582	599	588	602	605	563	574
Subsidies*	8	31	33	34	34	56	92	140
Other national purchasers	81	140	70	81	213	224	118	165
Foreign	305	311	249	246	243	366	557	437
TOTAL	1,156	1,361	1,251	1,251	1,394	1,576	1,621	1,610
United States								
Government	12,124	12,913	14,276	15,026	15,198	14,510	16,134	17,506
of which: R&D	3,150	3,438	3,588	4,261	4,610	4,476	4,690	{17,347
Purchases	8,974	9,475	10,677	10,745	10,519	10,014	11,331	
Subsidies*	-	-	11	20	69	20	113	159
Other national purchasers	1,282	1,117	611	514	990	1,672	2,463	3,503
Foreign	1,726	1,623	1,923	1,627	1,608	1,619	1,673	2,249
TOTAL	15,132	15,653	16,810	17,167	17,796	17,801	20,270	23,258

1, 2, 3, * See notes to Table 2/4a

Table 2/4a

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers (1960-67)

Percentages

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Government	65.4	61,7	62.7	63,2	66.2	63,2	63,2	65.3
of which: R&D[1]	18.9	18,7	19.8	15,1	13.7	19.0	19,0	21,3
Purchases	44.2	40.9	40.6	45.4	48.4	38,7	35,8	36.9
Subsidies*	2.3	2,1	2.3	2,7	4,1	5,5	8,4	7,1
Other national purchasers	7.2	3.8	3.0	3.6	2.3	2.6	2.2	2,6
Foreign[2, 3]	27.4	34,5	34.3	33,2	31,5	34,2	34,6	32,1
TOTAL	100,0	100,0	100.0	100.0	100,0	100,0	100,0	100,0
United Kingdom								
Government	66.6	66.9	74.5	73.8	67,3	62,6	58,4	62,6
of which: R&D	21,8	21,8	24,0	24,1	21,7	20,6	18,0	18,3
Purchases	44.1	42,8	47.9	47,0	43.2	38,4	34.7	35.6
Subsidies*	0,7	2,3	2,6	2,7	2,4	3,6	5,7	8,7
Other national purchasers	7,0	10.3	5,6	6.5	15,3	14,2	7,3	10,2
Foreign	26.4	22.8	19,9	19,7	17,4	23,2	34,3	27,2
TOTAL	100.0	100,0	100.0	100,0	100.0	100.0	100,0	100,0
United States								
Government	80,1	82,5	84,9	87,5	85.4	81.5	79,6	75.3
of which: R&D	20,8	22.0	21,3	24,8	25.9	25,1	23,1	74,6
Purchases	59,3	60,5	63.5	62,6	59.1	56.3	55,9	
Subsidies*	-	-	0,1	0,1	0.4	0.1	0.6	0,7
Other national purchasers	8.5	7,1	3,6	3,0	5.6	9.4	12,2	15,0
Foreign	11,4	10,4	11.5	9.5	9,0	9.1	8,2	9,7
TOTAL	100,0	100.0	100.0	100.0	100.0	100,0	100.0	100.0

[1] Germany: including space activity.

[2] Germany, Italy, United Kingdom, Belgium, Netherlands: not the same as exports because the figure relates to the value of the product sold and not that of the goods exported.

[3] France: including the value of joint projects.

* Government finance for commercial aviation.

Table 2/5a

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1960

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies	TOTAL			
	Values (Millions of current dollars)						
FRANCE	105	194	15	314	40	126	480
GERMANY	15	54	-	69	-	2	71
ITALY	1	27	-	28	7	12	47
BELGIUM	1	5	-	6	-	3	9
NL	2	8	-	10	-	36	46
TOTAL EEC	124	288	15	427	47	179	653
UK	252	510	8	770	81	305	1,156
USA	3,150	8,974	-	12,124	1,282	1,726	15,132
	Percentages						
FRANCE	21,9	40,4	3.1	65,4	8.3	26.3	100,0
GERMANY	21,1	76.1	-	97.2	-	2,8	100,0
ITALY	2,1	57,4	-	59,6	14,9	25.5	100.0
BELGIUM	11,1	55,6	-	66.7	-	33.3	100,0
NL	4,3	17,4	-	21.7	-	78,3	100.0
TOTAL EEC	19.0	44,1	2.3	65,4	7.2	27,4	100,0
UK	21.8	44,1	0.7	66.6	7.0	26,4	100,0
USA	20.8	59,3	-	80,1	8,5	11,4	100,0

[1] Government finance for commercial aviation.

Table 2/5b
EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1961

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	91	201	16	308	24	202	534
GERMANY	47	62	-	109	1	3	113
ITALY	1	36	-	37	4	19	60
BELGIUM	1	5	-	6	-	3	9
NL	3	9	-	12	-	37	49
TOTAL EEC	143	313	16	472	29	264	765
UK	297	582	31	910	140	311	1.361
USA	3,438	9,475	-	12,913	1,117	1,623	15,653
	Percentages						
FRANCE	17,1	37,6	3,0	57.7	4,5.	37,8	100,0
GERMANY	41,6	54.9	-	96,5	0.9	2.6	100,0
ITALY	1,7	60,0	-	61.7	6.7	31.6	100.0
BELGIUM	11,1	55,6	-	66.7	-	33.3	100,0
NL	6,1	18,4	-	24,5	-	75,5	100.0
TOTAL EEC.	16,7	40.9	2.1	61,7	3.8	34,5	100.0
UK	21,8	42,8	2.3	66,9	10.3	22,9	100.0
USA	22,0	60.5	-	82,5	7.1	10,4	100,0

[1] Government finance for commercial aviation.

Table 2/5c
EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1962

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	131	214	21	366	22	220	608
GERMANY	46	66	-	112	1	16	129
ITALY	2	59	-	61	5	22	88
BELGIUM	2	13	-	15	-	9	24
NL	3	24	-	27	-	52	79
TOTAL EEC	184	376	21	581	28	319	928
UK	300	599	33	932	70	249	1,251
USA	3,588	10,677	11	14,276	611	1,923	16,810
	Percentages						
FRANCE	21.5	35.2	3.5	60.2	3.6	36,2	100,0
GERMANY	35,7	51.1	-	86,8	0,8	12,4	100,0
ITALY	2,3	67.0	-	69.3	5.7	25.0	100,0
BELGIUM	8,3	54.2	-	62.5	-	37.5	100,0
NL	3,8	30.4	-	34.2	-	65,8	100,0
TOTAL EEC	19,8	40.5	2.3	62.6	3,0	34,4	100,0
UK	24.0	47.9	2,6	74,5	5,6	19,9	100,0
USA	21.3	63.5	0.1	84,9	3,6	11,5	100,0

[1] Government finance for commercial aviation.

Table 2/5d

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1963

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	109	264	29	402	40	248	690
GERMANY	73	166	4	243	1	36	280
ITALY	2	70	-	72	4	48	124
BELGIUM	1	24	-	25	-	24	49
NL	2	38	-	40	-	54	94
TOTAL EEC	187	562	33	782	45	410	1,237
UK	302	588	34	924	81	246	1,251
USA	4,261	10,745	20	15,026	514	1,627	17,167
	Percentages						
FRANCE	15.8	38.3	4,2	58.3	5.8	35,9	100.0
GERMANY	26.1	59.3	1.4	86.8	0.4	12,9	100,0
ITALY	1,6	56.5	-	58.1	3,2	38.7	100.0
BELGIUM	2,0	49,0	-	51,0	-	49.0	100,0
NL	2,1	40.4	-	42.6	-	57,4	100,0
TOTAL EEC	15,1	45.4	2,7	63,2	3,6	33.2	100,0
UK	24.1	47.0	2,7	73,8	6,5	19.7	100,0
USA	24.8	62.6	0,1	87,5	3,0	9,5	100.0

[1] Government finance for commercial aviation.

Table 2/5e

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1964

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	105	387	50	542	30	289	861
GERMANY	93	154	5	252	1	28	281
ITALY	3	98	-	101	2	44	147
BELGIUM	-	48	-	48	-	43	91
NL	-	23	5	28	-	59	87
TOTAL EEC	201	710	60	971	33	463	1,467
UK	302	602	34	938	213	243	1,394
USA	4,610	10,519	69	15,198	990	1,608	17,796
	Percentages						
FRANCE	12,2	44.9	5,8	62.9	3.5	33,6	100.0
GERMANY	33.1	54.8	1,8	89.7	0.3	10,0	100.0
ITALY	2.0	66,7	-	68.7	1.4	29.9	100.0
BELGIUM	-	52.7	-	52.7	-	47.3	100.0
NL	-	26.4	5.7	32,2	-	67.8	100.0
TOTAL EEC	13.7	48.4	4,1	66.2	2,2	31,6	100.0
UK	21.7	43.2	2.4	67.3	15.3	17.4	100.0
USA	25.9	59,1	0.4	85.4	5.6	9.0	100.0

[1] Government finance for commercial aviation.

Table 2/5f

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1965

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	178	356	69	603	28	345	976
GERMANY	94	97	4	195	-	18	213
ITALY	3	89	-	92	10	54	156
BELGIUM	-	14	-	14	-	23	37
NL	-	6	7	13	-	55	68
TOTAL EEC	275	562	80	917	38	495	1,450
UK	325	605	56	936	224	366	1,576
USA	4,476	10,014	20	14,510	1,672	1,619	17,801
	Percentages						
FRANCE	18.2	36,5	7.1	61.8	2,9	35,3	100,0
GERMANY	44.1	45.5	1,9	91.5	-	8,5	100.0
ITALY	1,9	57.1	-	59.0	6,4	34.6	100.0
BELGIUM	-	37,8	-	37,8	-	62,2	100,0
NL	-	8,8	10.3	19,1	-	80,9	100,0
TOTAL EEC	19,0	38,8	5,5	63.3	2.6	34,1	100,0
UK	20,6	38.4	3.6	62,6	14,2	23,2	100,0
USA	25,1	56.3	0,1	81,5	9,4	9.1	100,0

[1]Government finance for commercial aviation.

Table 2/5g

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1966

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	182	377	114	673	31	391	1,095
GERMANY	101	58	6	165	-	17	182
ITALY	4	87	-	91	2	50	143
BELGIUM	-	13	-	13	-	17	30
NL	-	6	8	14	-	48	62
TOTAL EEC	287	541	128	956	33	523	1.512
UK	291	563	92	946	118	557	1,621
USA	4,690	11,331	113	16,134	2,463	1,673	20.270
	Percentages						
FRANCE	16.6	34.5	10,4	61.5	2,8	35.7	100,0
GERMANY	55.5	31.9	3.3	90,7	-	9.3	100,0
ITALY	2,8	60,8	-	63.6	1.4	35.0	100.0
BELGIUM	-	43.3	-	43.3	-	56.7	100.0
NL	-	9,7	12,9	22,6	-	77.4	100,0
TOTAL EEC	19,0	35.8	8,4	63,2	2.2	34.6	100,0
UK	18.0	34,7	5,7	58.4	7.3	34.3	100.0
USA	23.1	55.9	0.6	79,6	12,1	8.3	100.0

[1] Government finance for commercial aviation.

Table 2/5h

EEC Countries, United Kingdom, United States - Estimated Pattern of Output in the Aerospace Industry Based on Sales to Final Customers in 1967

	Government				Other national customers	Foreign	TOTAL
	Military R&D	Purchasers	Subsidies[1]	TOTAL			
	Values (Millions of current dollars)						
FRANCE	246	423	115	784	44	422	1,250
GERMANY	124	99	.9	232	-	29	261
ITALY	5	107	-	112	2	46	160
BELGIUM	-	13	-	13	-	14	27
NL	-	7	-	7	-	53	60
TOTAL EEC	375	649	124	1.148	46	564	1,758
UK	294	574	140	1,008	165	437	1,610
USA	17,347		159	17.506	3,503	2,249	23,258
	Percentages						
FRANCE	19.7	33.8	9,2	62,7	3,5	33,8	100,0
GERMANY	47.5	37.9	3,5	83.9	-	11,1	100,0
ITALY	3.1	66.9	-	70.0	1,3	28,7	100,0
BELGIUM	-	48.1	-	48.1	-	51,9	100,0
NL	-	11.7	-	11,7	-	88,3	100,0
TOTAL EEC	21.3	36.9	7,1	65,3	2,6	32,1	100,0
UK	18.3	35.7	8,7	62,7	10,2	27,1	100,0
USA	74.6		0.7	75,3	15,0	9,7	100,0

[1] Government finance for commercial aviation.

Table 2/6

EEC Countries, United Kingdom, United States - Estimate of Value Added by the Aeronautical and Space Industry and by Manufacturing Industry (1960-66) (Millions of current dollars)

	1960	1961	1962	1963	1964	1965	1966
EEC							
Aerospace industry[1]	443	525	629	730	821	882	970
Manufacturing industry[2]	70,876	77,344	84,597	91,349	100,377	101,954(2)	108,326(2)
Value added by the aerospace industry as a percentage of the total for manufacturing industry	0,6	0.7	0,7	0,8	0,8		
United Kingdom							
Aerospace industry[1]	852	964	940	893	972	1,020	1,044
Manufacturing industry	20,013	26,779	27,224	28,760	31,949	34,756	36,267
Value added by the aerospace industry as a percentage of the total for manufacturing industry	3,3	3,6	3,5	3,1	3,0	2,9	2,9
United States							
Aerospace industry[3]	8,500	8,800	10,000	10,600	10,700	11,000	13,300
Manufacturing industry[3]	144,400	144,200	158,600	167,000	180,300	197,700	218,600
Value added by the aerospace industry as a percentage of the total for manufacturing industry	5,9	6,1	6,3	6,3	5,9	5,6	6,1

[1] At market prices.

[2] No figures for value added by Netherlands manufacturing industry.

[3] At factor cost.

Table 2/6a

EEC Countries, United Kingdom, United States - Estimate of Value Added by the Aeronautical and Space Industry and by Manufacturing Industry (1960-66) (Millions of current dollars)

	1960	1961	1962	1963	1964	1965	1966
	Aerospace industry						
FRANCE	354	413	472	531	590	649	708
GERMANY	42	62	86	98	109	124	147
ITALY	28	30	38	56	65	64	72
BELGIUM	4	4	13	23	32	19	15
NL	15	16	20	22	25	26	28
TOTAL EEC	443	525	629	730	821	882	970
UK	852	964	940	893	972	1,020	1,044
USA	8,500	8,800	10,000	10,600	10,700	11,000	13,300
	Manufacturing industry						
FRANCE	22,189	23,933	26,241	28,917	31,547	32,870	35,219
GERMANY	30,545	33,887	36,705	38,207	42,105	46,432	48,417
ITALY	10,782	11,970	13,355	15,300	16,418	17,520	19,270
BELGIUM	3,404	3,596	3,882	4,206	4,780	5,132	5,420
NL	3,956	4,158	4,414	4,719	5,527	6,123	-
TOTAL EEC	70,876	77,544	84,597	91,349	100,377	101,954	108,326
UK	20,013	26,779	27,224	28,760	31,949	34,756	35,267
USA	144,400	144,200	158,800	167,000	180,300	197,700	218,600

Table 2/7

EEC Countries, United Kingdom, United States - Breakdown by Value of Aerospace Output by Branches (1960-67)

(Millions of current dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Airframes[1]	384	436	531	727	857	765	805	930
Missiles	68	73	84	96	137	194	222	265
Engines	92	134	174	241	285	317	334	402
Equipment[2]	109	122	139	173	188	154	150	161
TOTAL	653	765	928	1,237	1,467	1,450	1,512	1,758
United Kingdom								
Airframes	526	694	593	610	719	826	837	764
Missiles	53	70	59	70	73	81	81	78
Engines	426	440	426	448	437	487	521	608
Equipment	151	157	173	123	165	182	182	160
TOTAL	1,156	1,361	1,251	1,251	1,394	1,576	1,621	1,610
United States								
Airframes	5,197	4,387	4,398	4,065	4,987	5,363	6.743	9,238
Missiles	3,486	3,891	4,559	5,441	4,710	4,248	4,945	4,753
Engines	2,492	2,751	3,032	3,035	3,184	3,285	3,391	4,111
Equipment	3,957	4,624	4,821	4,626	4,915	4,905	5,191	5,156
TOTAL	15,132	15,653	16,810	17,167	17,796	17,801	20,270	23,258

[1] Belgium: including missile and space work.

[2] Excluding this branch for Germany.

Table 2/7a

EEC Countries, United Kingdom, United States - Breakdown per Percentages of Aerospace Output by Branches (1960-67)

(Millions of current dollars)

	1960	1961	1962	1963	1964	1965	1966	1967
EEC								
Airframes [1]	58.8	57.0	57.2	58.8	58,4	54,1	53,3	52.9
Missiles	10.4	9.6	9.1	7.7	9.4	13.4	14.7	15,1
Engines	14.1	17.5	18.7	19.5	19.4	21.9	22.1	22.9
Equipment [2]	16.7	15.9	15.0	14.0	12.8	10.6	9.9	9.1
TOTAL	100.0	100.0	100.0	100.0	100,0	100.0	100.0	100.0
United Kingdom								
Airframes	45.5	51.0	47.4	48.8	51.6	52.4	51.6	47.5
Missiles	4.6	5.2	4.7	5.6	5.2	5.1	5,0	4,8
Engines	36.8	32.3	34.1	35.8	31.4	30.9	32.2	37.8
Equipment	13.1	11.5	13.8	9.8	11.8	11.6	11.2	9.9
TOTAL	100.0	100.0	100.0	100.0	100,0	100.0	100.0	100,0
United States								
Airframes	34.3	28.0	26.2	23.7	28.0	30.1	33.3	39.7
Missiles	23.1	24.9	27.1	32.2	26.5	23.9	24.4	20.5
Engines	16.4	17.5	18.0	17.2	17.9	18.4	16.7	17.6
Equipment	26.2	29.6	28.7	26.9	27.6	27.6	25.6	22.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100,0	100.0	100.0

1, 2 See notes to Table 2/5.

Table 2/8a

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1960

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	247	62	71	100	480
GERMANY	61	6	4	-	71
ITALY	24	-	14	9	47
BELGIUM	6	-	3	-	9
NL	46	-	-	-	46
TOTAL EEC	384	68	92	109	653
UK	526	53	426	151	1,156
USA	5,197	3,486	2,492	3,957	15,132
	Percentages				
FRANCE	51.5	12.9	14.8	20,8	100,0
GERMANY	85.9	8.5	5.6	-	100,0
ITALY	51.1	-	29.8	19,1	100.0
BELGIUM	66.7	-	33.3	-	100,0
NL	100.0	-	-	-	100,0
TOTAL EEC	58,8	10.4	14,1	16.7	100,0
UK	46.3	4.7	37.5	13,3	100.0
USA	34.3	23.0	16.5	26.2	100,0

Table 2/8b
EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1961

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	258	69	95	112	534
GERMANY	96	4	13	-	113
ITALY	29	-	21	10	60
BELGIUM	4	-	5	-	9
NL	49	-	-	-	49
TOTAL EEC	436	73	134	122	765
UK	694	70	440	157	1,361
USA	4,387	3,891	2,751	4,624	15,653
	Percentages				
FRANCE	48.3	12.9	17.8	21,0	100.0
GERMANY	85.0	3.5	11.5	-	100.0
ITALY	48.3	-	35.0	16.7	100.0
BELGIUM	44.4	-	55.6	-	100.0
NL	100.0	-	-	-	100.0
TOTAL EEC	57.0	9.5	17.5	16.0	100.0
UK	51.0	5.1	32.3	11.5	100.0
USA	28.0	24,9	17.6	29.5	100.0

Table 2/8c

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1962

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	290	80	110	128	608
GERMANY	99	4	26	-	129
ITALY	50	-	27	11	88
BELGIUM	13	-	11	-	24
N.L	79	-	-	-	79
TOTAL EEC	531	84	174	139	928
	593	59	426	173	1,251
USA	4.398	4,559	3,032	4.821	16.810
	Percentages				
FRANCE	47,7	13,2	18,1	21,0	100,0
GERMANY	76,7	3,1	20,2	-	100,0
ITALY	56,8	-	30,7	12,5	100,0
BELGIUM	54,2	-	45,8	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	57,2	9,1	18,7	15,0	100,0
UK	47,4	4,7	34,1	13,8	100,0
USA	26,2	27,1	18,0	28,7	100,0

Table 2/8d

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches 1963

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	306	87	139	158	690
GERMANY	230	9	41	-	280
ITALY	69	-	40	15	124
BELGIUM	28	-	21	-	49
NL	94	-	-	-	94
TOTAL EEC	727	96	241	173	1,237
UK	610	70	448	123	1,251
USA	4,065	5,441	3,035	4,626	17,167
	Percentages				
FRANCE	44,3	12.6	20,1	22.9	100,0
GERMANY	82,1	3,2	14,7	-	100,0
ITALY	55,6	-	32,3	12,1	100,0
BELGIUM	57,1	-	42,9	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	58,8	7.7	19.5	14,0	100,0
UK	48,8	5.6	35.8	9.8	100,0
USA	23,7	31,7	17,7	26,9	100.0

Table 2/8e

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1964

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	401	119	174	167	861
GERMANY	224	18	39	-	281
ITALY	83	-	43	21	147
BELGIUM	62	-	29	-	91
NL	87	-	-	-	87
TOTAL EEC	857	137	285	188	1,467
UK	719	73	437	165	1,394
USA	4,987	4,710	3,184	4,915	17,796
	Percentages				
FRANCE	46,6	13.8	20.2	19,4	100,0
GERMANY	79,7	6,4	13.9	-	100.0
ITALY	56,5	-	29,2	14,3	100,0
BELGIUM	68,1	-	31.9	..	100,0
NL	100.0	-	-	-	100,0
TOTAL EEC	58.4	9,4	19,4	12,8	100,0
UK	51.6	5.2	31,4	11,8	100,0
USA	28.0	26.5	17,9	27.6	100,0

Table 2/8f

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1965

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	459	163	226	128	976
GERMANY	145	31	37	-	213
ITALY	90	-	40	26	156
BELGIUM	23	-	14	-	37
NL	68	-	-	-	68
TOTAL EEC	785	194	317	134	1.450
UK	826	81	487	182	1.576
USA	5,363	4,248	3,285	4,905	17,801
	Percentages				
FRANCE	47.0	16.7	23,2	13,1	100,0
GERMANY	68,1	14,5	17.4	-	100,0
ITALY	57,7	-	25,6	16.7	100.0
BELGIUM	62,2	-	37.8	-	100.0
NL	100,0	-	-	-	100.0
TOTAL EEC	54,1	13.4	21,9	10.6	100.0
UK	52.4	5.1	30,9	11.6	100.0
USA	30,1	23.9	18.4	27.6	100.0

Table 2/8g

EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1966

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	530	192	250	123	1.095
GERMANY	117	30	35	-	182
ITALY	83	-	33	27	143
BELGIUM	14	-	16	-	30
NL	62	-	-	-	62
TOTAL EEC	806	222	334	150	1,512
UK	837	81	521	182	1,621
USA	6,743	4,945	3,391	5,191	20,270
	Percentages				
FRANCE	48.4	17.5	22.8	11.2	100.0
GERMANY	64.3	16.5	19.2	-	100,0
ITALY	58,0	-	23.1	18.9	100,0
BELGIUM	46,7	-	53.3	-	100,0
NL	100,0	-	-	-	100,0
TOTAL EEC	53,3	14.7	22.1	9,9	100,0
UK	51.6	5.0	32,1	11.2	100,0
USA	33.3	24.4	16,7	25.6	100,0

Table 2/8h
EEC Countries, United Kingdom, United States - Breakdown of Aerospace Output by Branches in 1967

	Airframes	Missiles	Engines	Equipment	TOTAL
	Millions of current dollars				
FRANCE	599	231	288	132	1,250
GERMANY	167	34	60	-	261
ITALY	93	-	38	29	160
BELGIUM	11	-	16	-	27
NL	60	-	-	-	60
TOTAL EEC	930	265	402	161	1,758
UK	764	78	608	160	1,610
USA	9,238	4,753	4,111	5,156	23,258
	Percentages				
FRANCE	47,9	18.5	23.0	10.6	100.0
GERMANY	64,0	13,0	23,0	-	100.0
ITALY	58.1	-	23,8	18.1	100.0
BELGIUM	40,7	-	59.3	-	100.0
NL	100.0	-	-	-	100.0
TOTAL EEC	52.9	15.1	22.9	9.1	100.0
UK	47.5	4,8	37.8	9,9	100,0
USA	39.7	20,4	17.7	22.2	100.0

Table 2/9

EEC Countries, United Kingdom, United States - Output per Head at Constant Prices in the Aerospace Industry

(1960-67)
In dollars

	1960	1961	1962	1963	1964	1965	1966	1967
FRANCE	7,381	7,767	8,261	8,689	10,011	10,732	11,248	12,376
GERMANY	5,867	6,381	5,615	11,593	10,552	7,500	5,606	7,457
ITALY	6,400	8,000	9,167	10,286	11,500	11,714	9,733	9,412
BELGIUM	3,333	3,667	5,600	9,833	20.800	10,000	7,750	5,400
NL	10,833	11,167	17,500	20,000	17,167	12,667	10,667	10,000
TOTAL EEC	7,178	7,619	8,146	9,916	10,912	10,238	9,824	10,720
UK	4,924	5,375	4,962	5,289	5,795	6,494	6.703	6.339
USA	17,984	18,879	18,601	19,007	20.153	19,929	19.214	19,913

Table 2/10

EEC Countries, United Kingdom, United States - Added Value per Head at Constant Prices in the Aerospace Industry (1960-66)

(in dollars)

	1960	1961	1962	1963	1964	1965	1966
FRANCE	5,452	6,023	6,432	6,700	6,862	7,134	7,267
GERMANY	3,467	3,524	3,808	4,074	4,103	4,367	4,545
ITALY	3,900	4,000	4,083	4,714	5,143	4,786	4,933
BELGIUM	1,667	1,667	3,200	4,667	7,400	5,250	3,750
NL	3,500	3,667	4,500	4,833	5,000	4,833	4,833
TOTAL EEC	4,873	5,230	5,526	5,846	6,101	6,225	6,302
UK	3,629	3,809	3,729	3,774	4,041	4,205	4,317
USA	10,103	10,613	11,066	11,736	12,117	12,315	12,607

Table 2/11

EEC Countries - <u>Forecast of the Growth of Labour Force Employed in the Aerospace Industry in the Seventies</u>

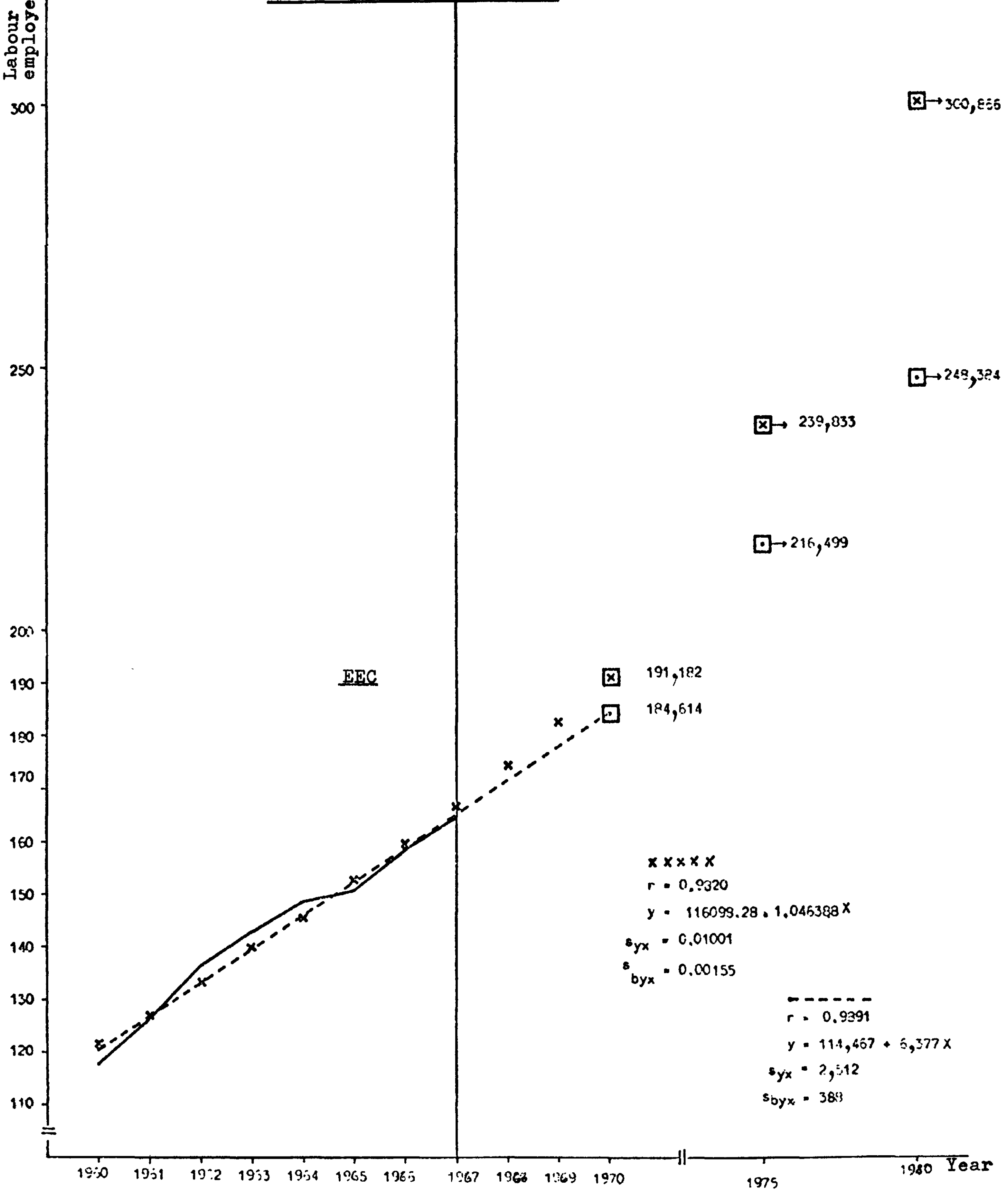


Table 2/11a

United Kingdom - Forecast of the Growth of Labour Force Employed in the Aerospace Industry in the Seventies

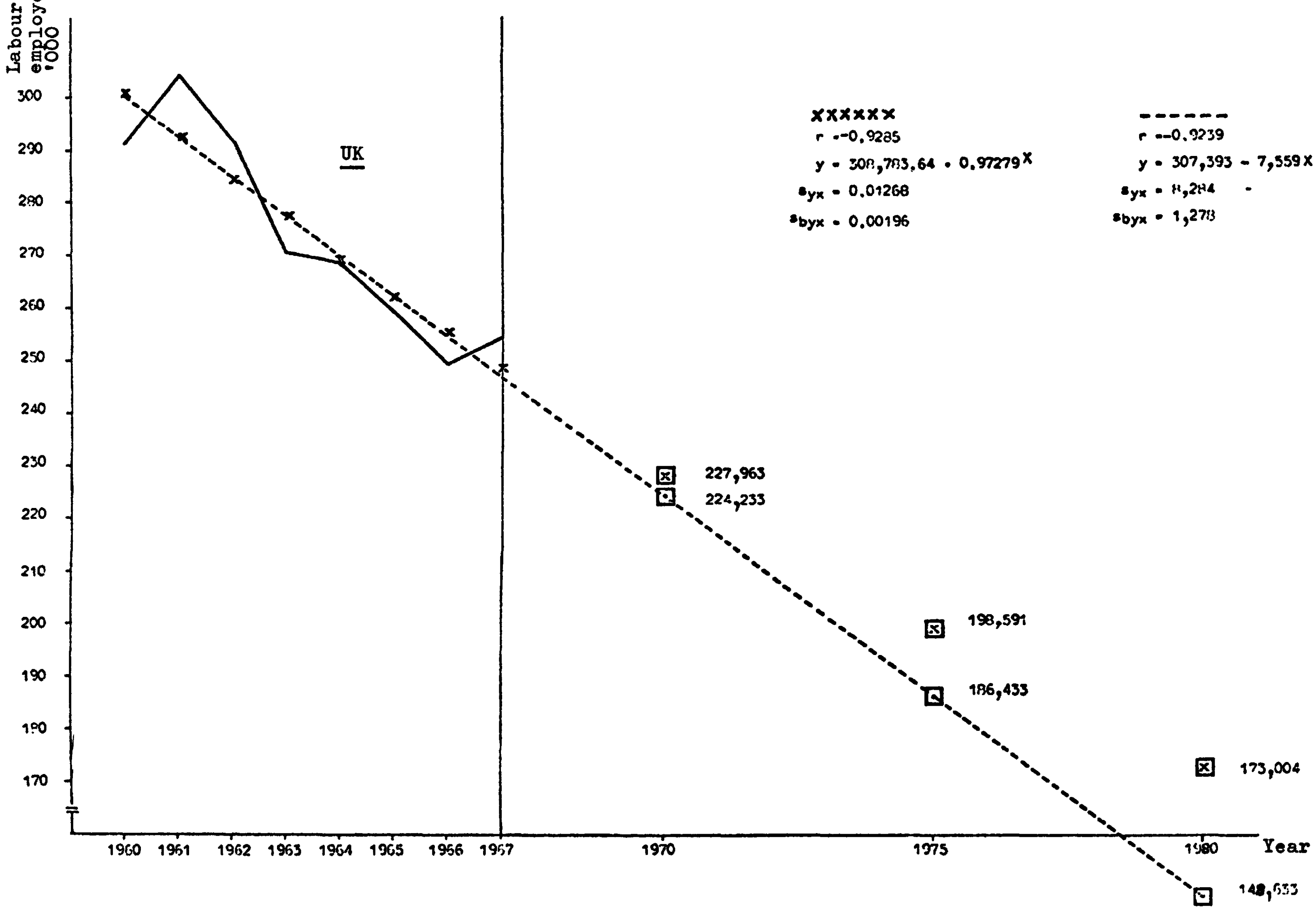


Table 2/11b

United States- **Forecast of the Growth of Labour Force Employed in the Aerospace Industry in the Seventies**

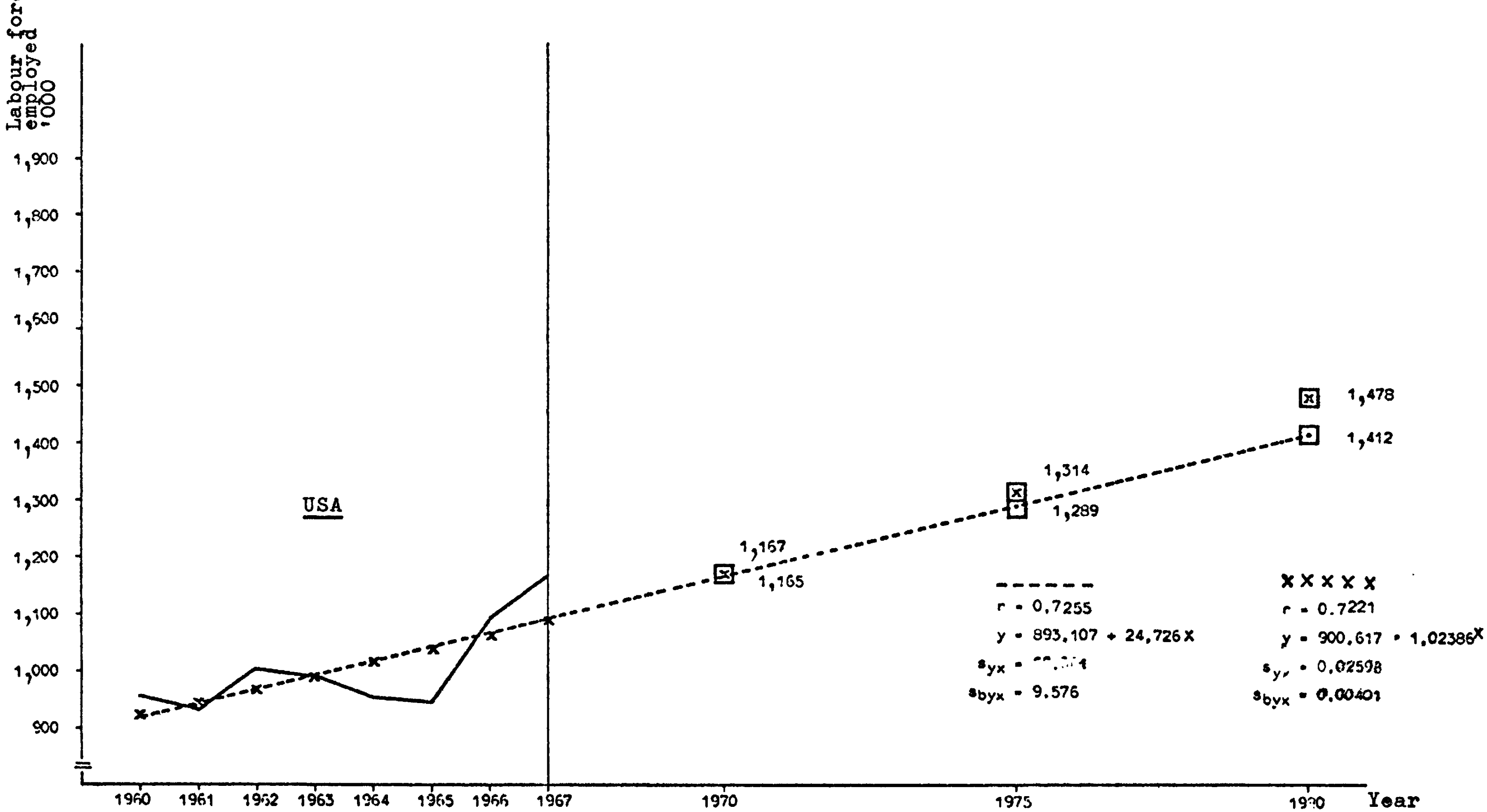


Table 2/12

EEC - Forecast of the Growth of Aerospace Output per Head by Value in the Seventies

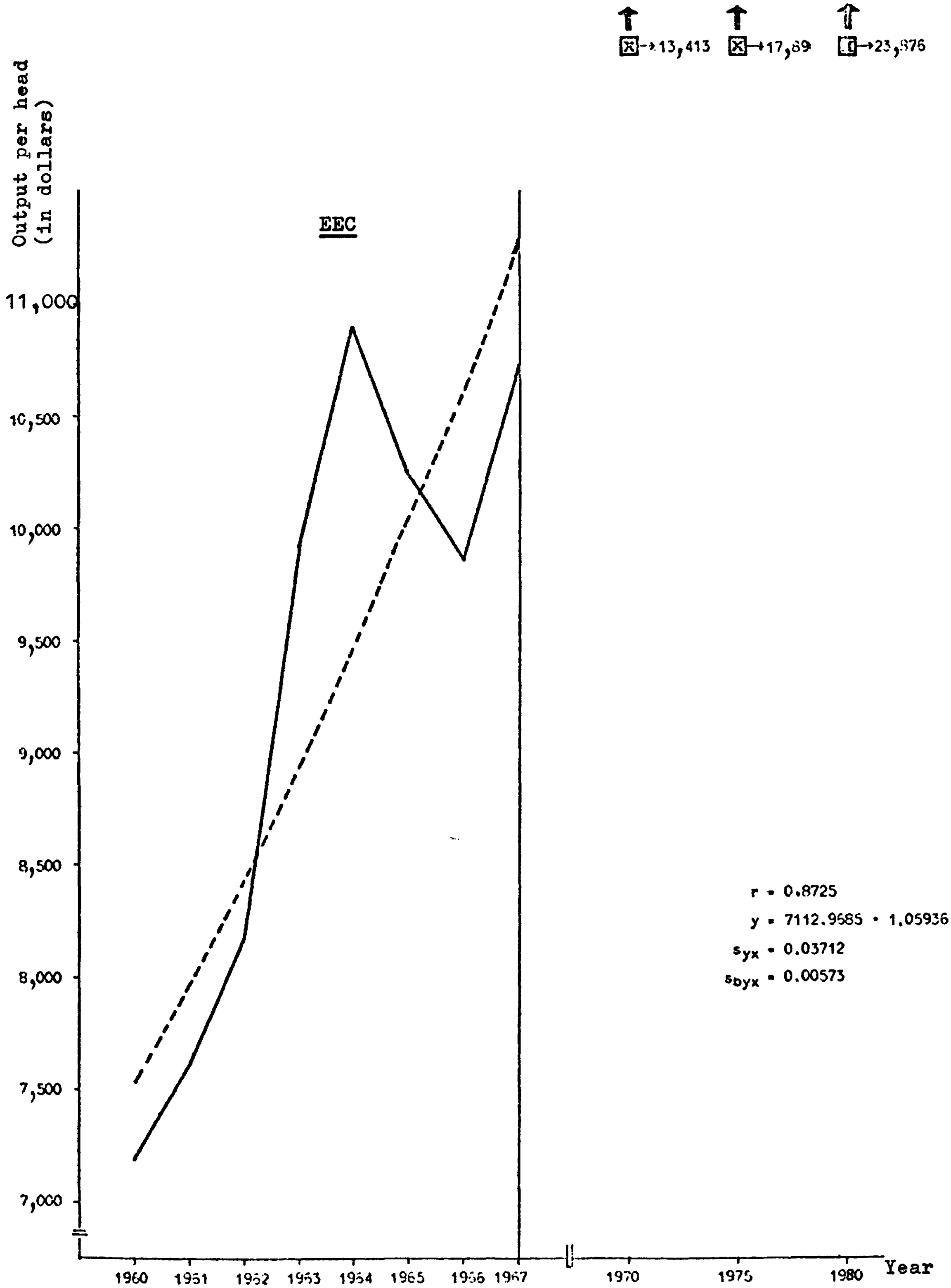


Table 2/12a

United Kingdom - **Forecast of the Growth of Aerospace Output per Head by Value in the Seventies**

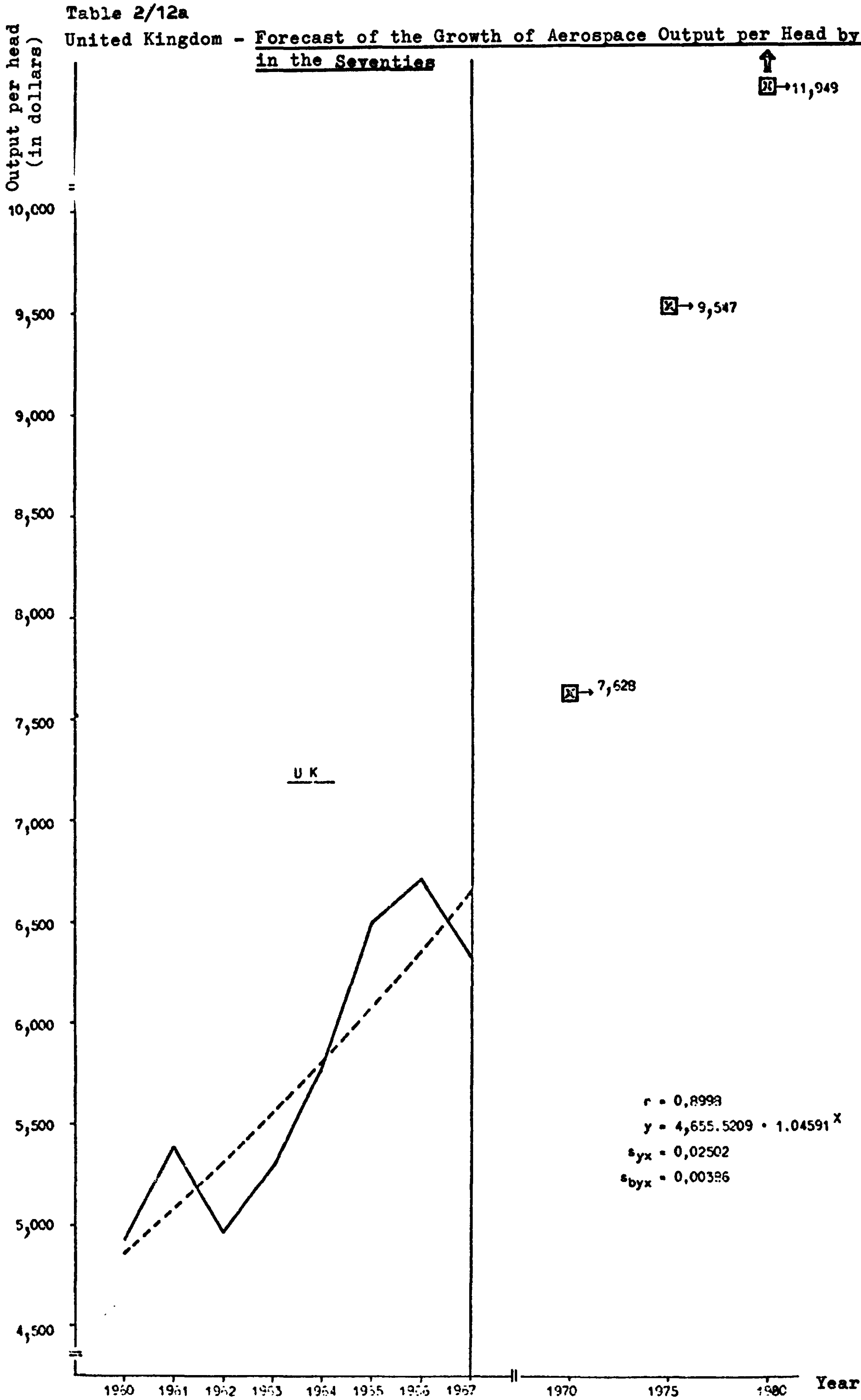


Table 2/12b

United States - Forecast of the Growth of Aerospace Output per Head by Value in the Seventies

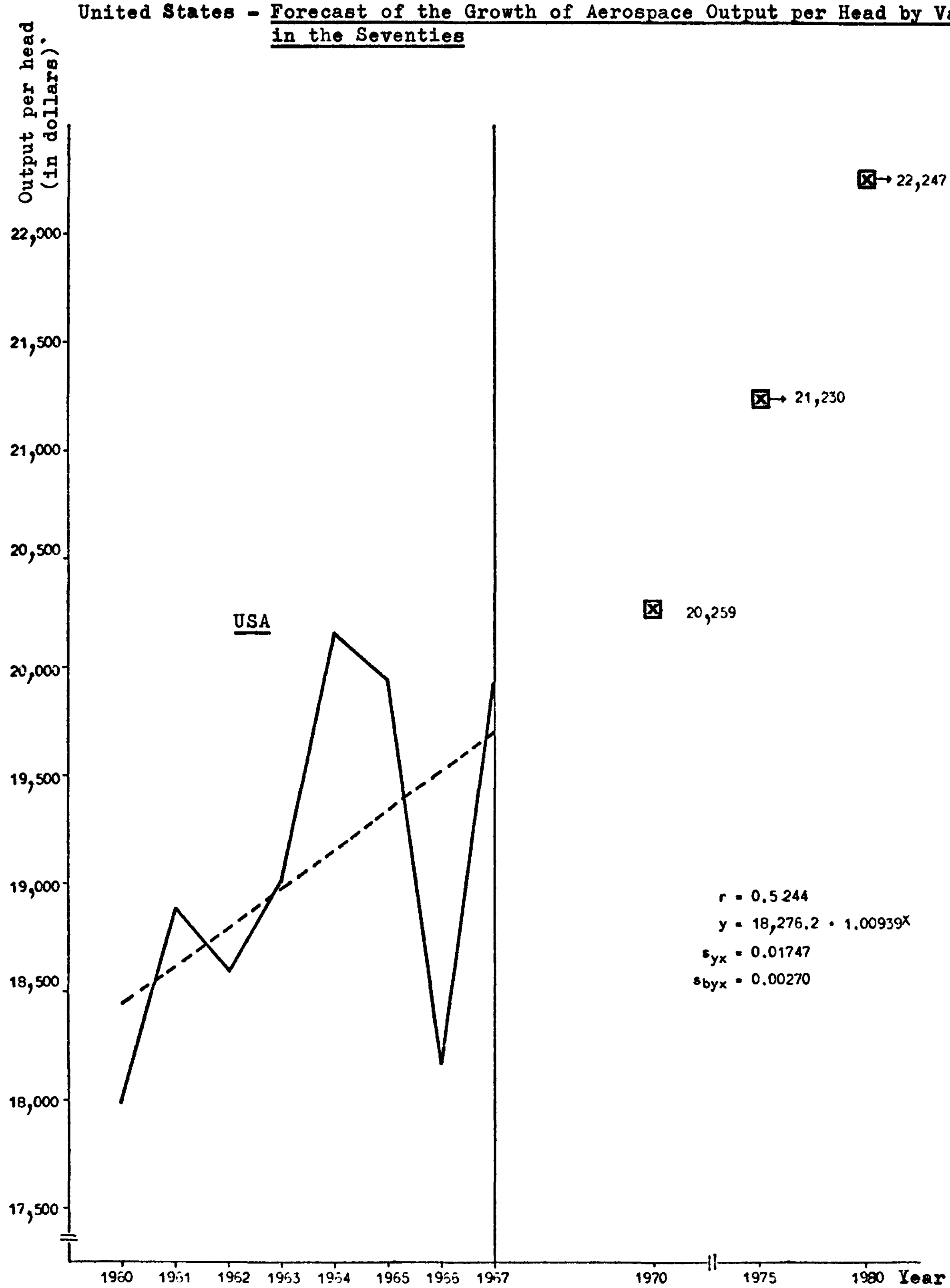


Table 2/13

EEC - Forecast of the Growth of Added Value per Head in the Aerospace Industry in the Seventies

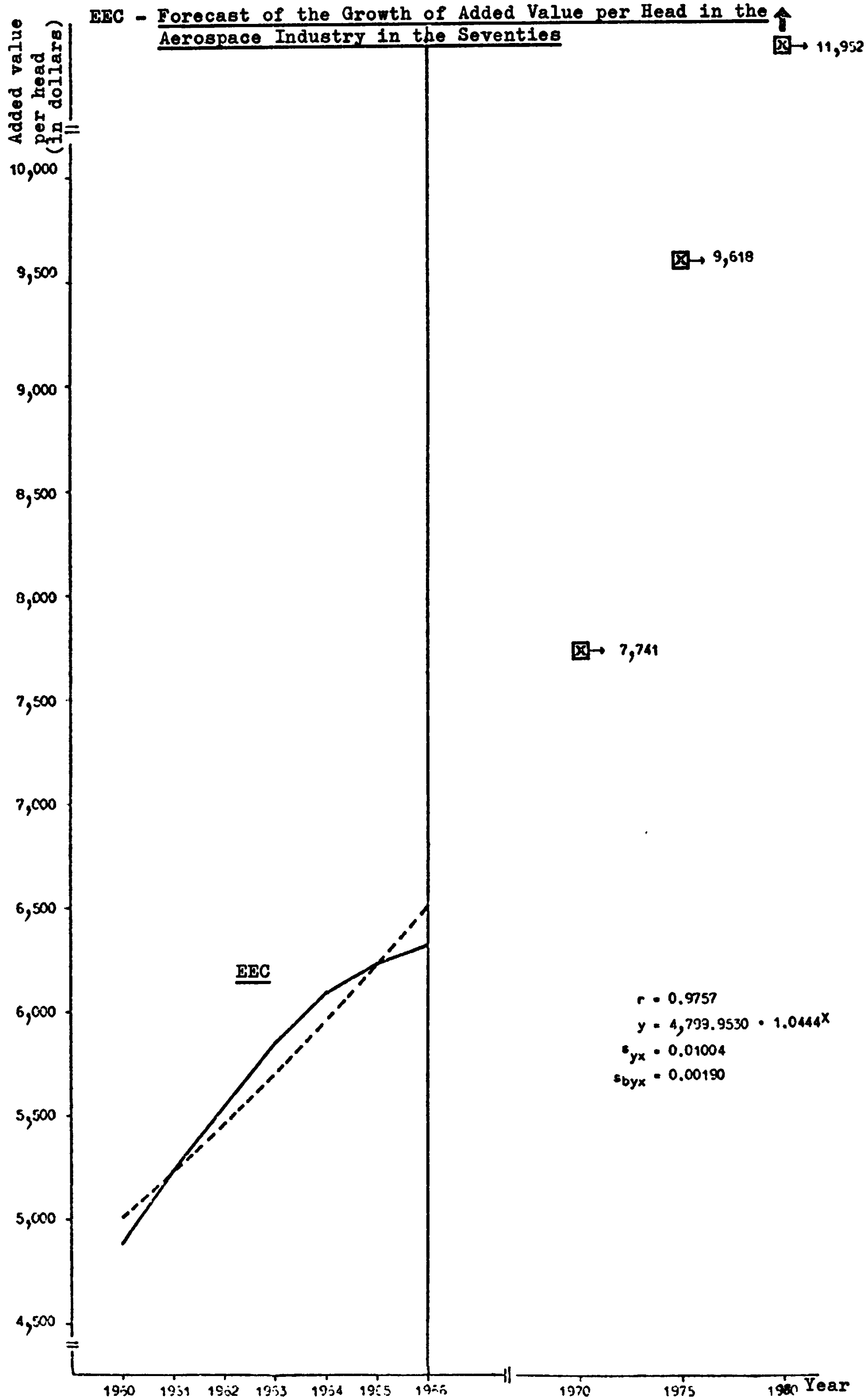


Table 2/13a

United Kingdom - Forecast of the Growth of Added Value per Head in the Aerospace Industry in the Seventies

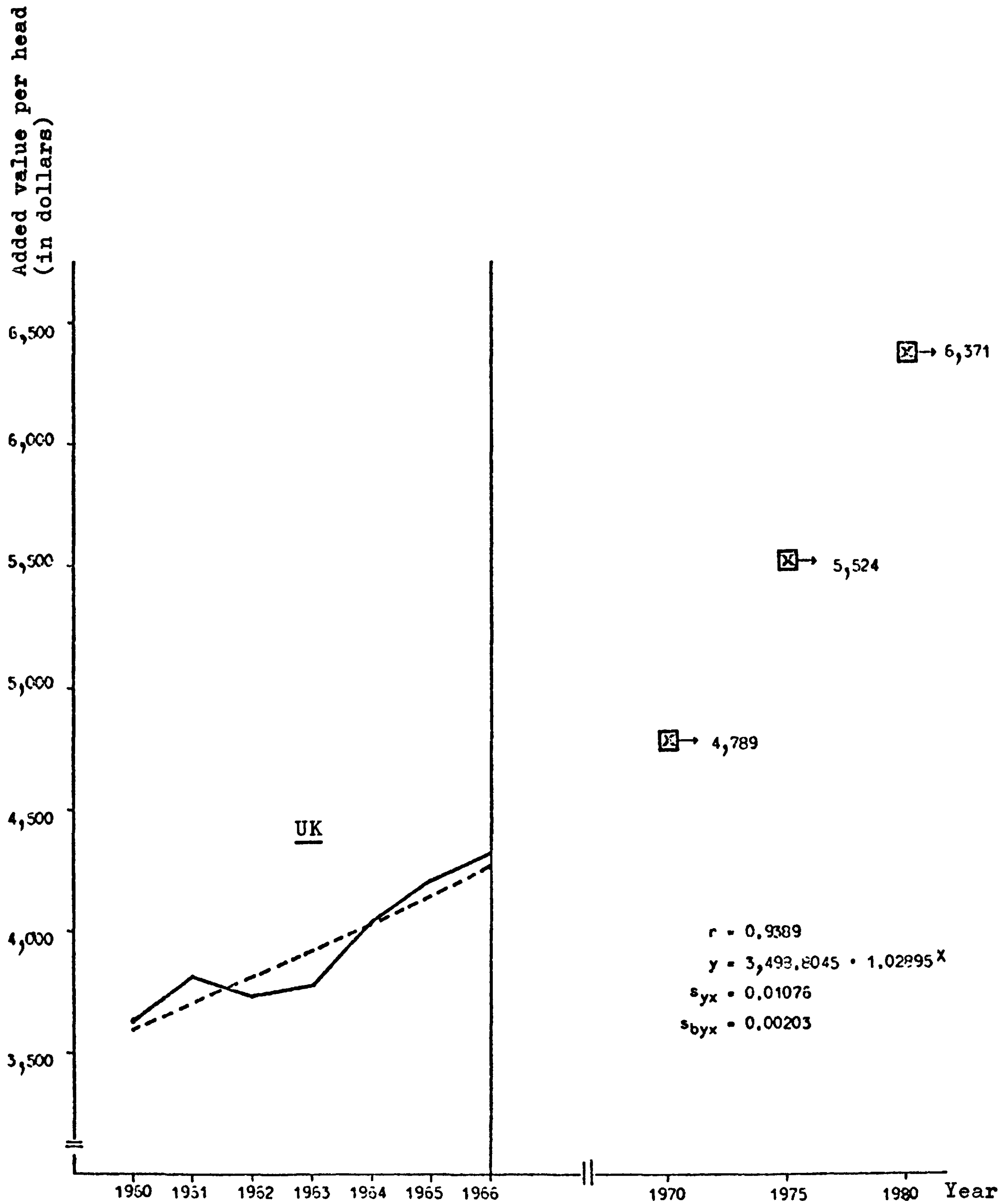
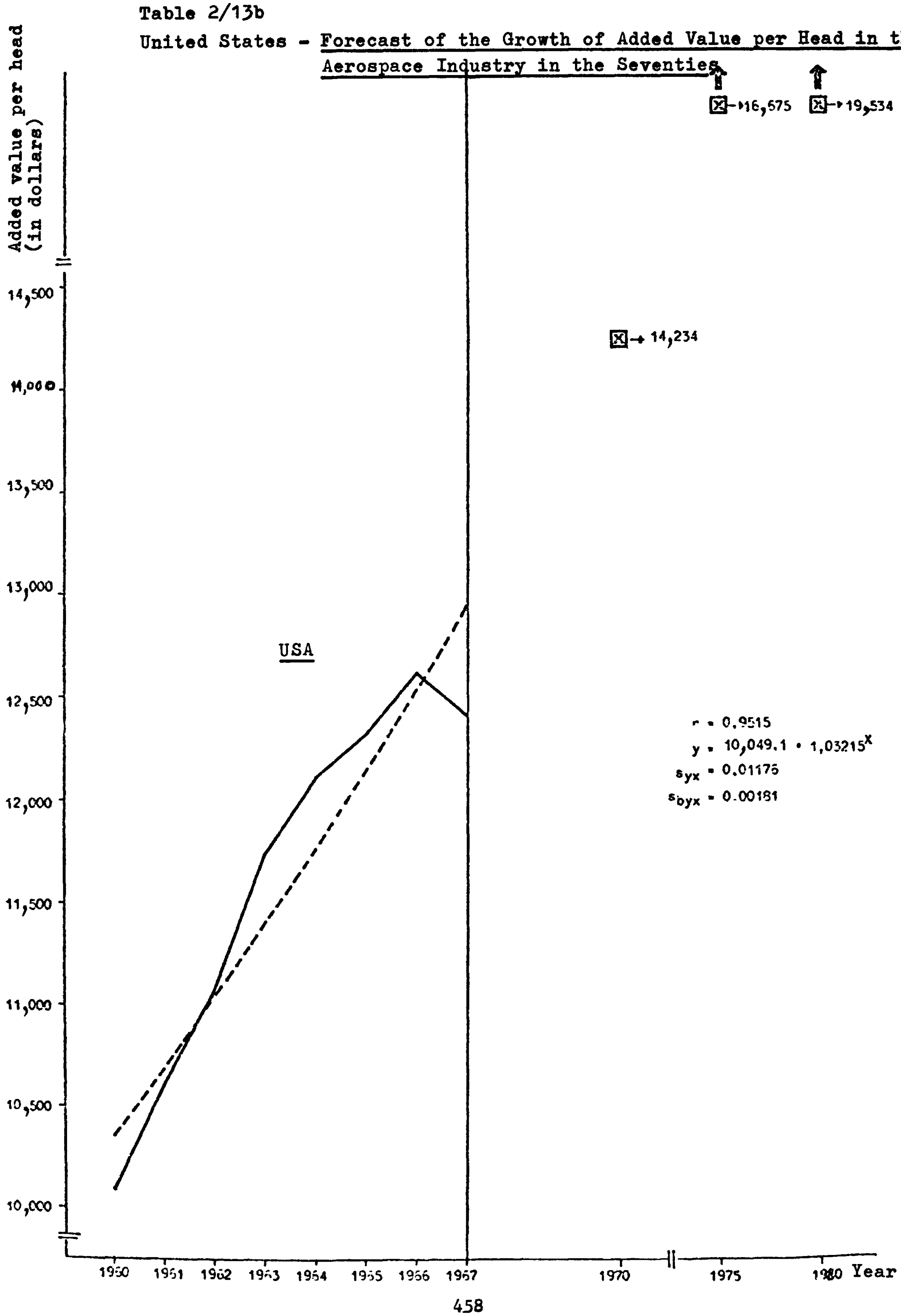


Table 2/13b

United States - Forecast of the Growth of Added Value per Head in the Aerospace Industry in the Seventies



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