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Europe German Aerospace Industry Competitiveness

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A. Introduction

Importance and Characteristics of Aerospace Industry

For the Federal Republic of Germany, as a country with high salaries and a limited base of raw materials, long term prosperity can be assured only if the country can support itself in international competition with a large share of exports of high quality goods on the world market.

Because it is R&D intensive, the aerospace industry is one of the few industries tailored to highly developed industrialized countries.

Although it is not economically essential to be active or to be a leader in all high technology areas, in its special expert report on the Daimler-Benz/MBB merger, the Monopoly Commission considered an appropriate presence of German companies in the aerospace sector as positive from an economic as well as a foreign and defense policy standpoint.

In 1988 in an expert report, the German Institute for Economic Research (DIW) in Berlin characterized the aerospace industry as follows:

"Aerospace has many singular characteristics and is extremely difficult to compare with other industries: It is a branch of industry

- which is organized in the private sector, but is highly dependent on government contracts and subsidies;
- which is indisputably small, but very research intensive; ...
- in which numerous new technologies are adopted and enhanced, finding application in production and in products and providing impetus beyond the sector itself;
- which has obtained a high share of the division of labor on the European level; ...
- which is heavily oriented toward foreign trade and whose products serve in part as a market-driven indicator of the productivity of domestic industry;
- in which the opportunities for technological support of industry are particularly great through hidden and open subsidies and are also applied internationally;
- in which political processes directly and indirectly determine production objectives and market opportunities to a great extent, and not merely in the military area;
- which contributes to the solution of social, security, and economic policy problems and affords the country a greater range of technical and economic action.

Characteristics which differentiate this sector from other industrial sectors even more than those mentioned above include the extraordinarily high capital requirement and the exceptionally long capital commitment with the associated risks. Aerospace projects are distinguished not only by their high R&D costs and investments but also by long development periods—it can take

from five to 10 years to prepare a project for series production—and long program life—between 20 and 30 years—with low numbers of units produced. Amortization is correspondingly slow. For example, currently, for a commercial aircraft program, it is necessary to reckon with development and prefinancing costs of approximately \$5 million with a market projection of some 600 to 1,000 units over 20 years.

These special characteristics of aerospace projects result in the fact that they frequently exceed the economic capacities and technical capabilities of single companies—even of single national economies. Large projects are therefore increasingly handled by international industrial consortiums or within the framework of international organizations.

Cooperation of partners is only possible with virtually equal capabilities and performances. For this, competitiveness is necessary not only in research and development but also in production.

The aerospace industry considers overall systems leadership the most demanding but also the most lucrative form of economic activity. Therefore, competition between national aerospace industries will increasingly become first and foremost competition for system leadership. Systems competence on the various levels from the partial to the entire system is an important prerequisite for comprehensive success in aerospace markets.

B. State of the Art

I. The German Aerospace Industry in an International Context

In a statistical comparison with the countries of the West, the German aerospace industry is in fourth place behind the U.S., Great Britain, and France in terms of personnel and sales. Japan follows in fifth place in terms of sales. However, Canada is ahead of Japan in terms of overall employees.

The critical weakness of the German aerospace industry in competition is its limited systems competence—which cannot be expressed in numbers. The reason for this is that, in contrast to the competing countries, the German aerospace industry has thus far only carried out a few relatively small domestic programs and projects. This is true even in comparison with considerably smaller countries such as Italy or the Netherlands. On the international level, it enjoys the role of system leader in only a few programs (e.g., with Columbus, the European contribution to the international space station) or has only integration know-how (e.g., with the Tornado including its RB 199 engine).

1.1 The German Aerospace Industry in a European Context

The most important indicators of the national aerospace industry are summarized below and related to some national economic indicators.

a. Germany Compared With France and Great Britain

In 1988, the German aerospace industry had sales of approximately 10 billion European Currency Units [ECU] (1 ECU = approximately 20.8 billion German marks [DM]) with 98,330 employees. Here, the 13.4-percent average growth rate of sales over the 10-year period 1978-1988 is particularly gratifying. It is the highest of all national industries for this period, even when we consider that reporting period surges are also reflected in the aerospace industry figures. The following are comparative figures for the three largest competing European countries as of 31 December 1988 (ECU1 = DM2.076):

Table 1
Aerospace Industry Indicators Compared With European Countries (1988)

Indicator	Germany	France	Great Britain
Sales (billion ECU)	10.020	11.930	12.579
Average annual growth of sales from 1978-88 (%)	13.4	5.0	3.9
GNP (billion ECU)	1,017.6	802.6	682.8
Sales/GNP (%)	1.0	1.5	1.8
Employees	98,330	119,871	209,855
Sales/Employee (MECU)	0.102	0.099	0.060

Source: EC 1

The number of employees is distributed as follows over the individual sectors of the aerospace industry:

Table 2
Number of Employees by Aerospace Industry Sector (1988)

Sector	Germany	France	Great Britain
Airframes	50,939	58,178	82,039
Engines	9,935	24,881	38,656
Equipment	30,992	29,247	86,135
Astronautics	6,464	7,565	3,022

Source: EC 1

Despite the mentioned growth of the German aerospace industry, in terms of sales and employees it still falls significantly behind France (by about 20 percent) and Great Britain (by about 25 percent). This is particularly obvious in the ratio of sales to the gross national product. It confirms the still very limited economic contribution of the German aerospace industry (approximately 1 percent)—in contrast to 1.5 in France and 1.8 in Great Britain.

The lack of systems competence in the airframe area of the German aerospace industry is not reflected in the quantitative comparison. It is, however, a characteristic of this sector, which is, with the exception of the manufacture of small planes, a commuter plane, and two makes of helicopters, only a cooperative partner in relatively large programs (e.g., Airbus, Tornado, Jaeger 90, PAH 2).

In contrast, the systems weakness of the two German engine manufacturers is also reflected quantitatively. With a work force of approximately 8,500, they obviously have fewer employees than their European competitors Rolls Royce (40,900) and SNECMA (13,500). Whereas these last two—in competition with the two U.S. manufacturers General Electric (GE) and Pratt & Whitney (PW)—produce their own complete engines for the international market (SNECMA, however, only in 50/50 cooperation with GE), the German engine industry is only active in this area in cooperative programs. The German share in the larger civilian programs amounts to between 8 and 12.5 percent at most. As a result, German industry is not currently represented as an identifiable manufacturer in the large commercial aircraft engine market.

German systems knowledge is present only in the area of military engines. However, systems leadership is only seen within the framework of the international cooperative projects of international management firms (e.g., Turbo-Union for the Tornado, EUROJET for the Jaeger 90). The largest concentration of employees of German manufacturers is also found in military engine construction (with approximately two-thirds of their workers).

Whereas it has been possible for the two large U.S. manufacturers, and to a limited extent also for Rolls Royce (RR) and SNECMA, to spin off civilian engine versions from developments for large military aircraft, the German industry has not had this opportunity. Skills from fighter engine construction, in which the German aerospace industry is involved (Alpha Jet, Tornado, Jaeger 90), are not directly transferable, since they deal with different thrust classes and extremely different specifications, e.g., for fuel consumption, noise, and exhaust; however, they do constitute a significant technological potential for civilian projects.

Recently, cooperative programs have been introduced (MTU/PW as well as BMW/RR), which should compensate for this deficit in the large engine area. The objective is to come closer to systems leadership through the development of additional components.

b. Comparison of Italy, the Netherlands, and Spain

Table 3
Aerospace Industry Indicators Compared With Other European Countries (1988)

Indicator	Italy	The Netherlands	Spain
Sales (billion ECU)	3.292	0.879	0.609
Average annual growth of sales from 1978-88 (%)	8.8	7.1	8.6
GNP (billion ECU)	705.2	193.3	288.0
Sales/GNP (%)	0.47	0.45	0.21
Employees	49,500	12,690	11,770
Sales/Employee (MECU)	0.067	0.069	0.052

Source: EC 1

Table 4
Number of Employees by Aerospace Industry Sector in Italy, the Netherlands, and Spain (1988)

Sector	Italy	The Netherlands	Spain
Airframes	27,918	9,870	9,601
Engines	6,830	0	633
Equipment	11,138	1,548	1,135
Astronautics	3,614	272	371

Source: EC 1

Table 3 reveals that Italy in particular is exerting extraordinary effort in the expansion of its aerospace industry with an average annual sales growth rate of 8.8 percent over the last 10 years. A similar orientation is seen for Spain. Likewise noteworthy is the position of the Netherlands, which has managed, thanks to its continuous efforts in the last 30 years in the F27 and F28 projects, to become systems leader for a relatively large commuter aircraft (F-50) and a relatively large regional commuter aircraft (F-100). Both planes are extremely successful on the market. German industry (MBB, i.e.: Deutsche Airbus GmbH—after its merger with Daimler-Benz) is participating in the F-100 at the 25-percent level.

All three countries are continuing the rapid expansion of their aerospace industries and, in the process, are attaching particular importance to space. Also in light of this pressure “from below,” with the added advances of the countries of Belgium, Portugal, and Greece, it is advisable to carefully monitor the competitive position of the German aerospace industry with regard to higher valued activities.

I.2 The European Aerospace Industry Compared to North American and Japanese Competition

For worldwide comparison of aerospace industries, indicators for the aerospace industries of the European

Community are combined and compared to the corresponding data from the U.S., Canada, and Japan. Here, the dominant position of the United States is obvious; it considers its aerospace industry a strategic industry and pursues the political goal of worldwide leadership both in aviation and in space:

Table 5
Aerospace Industry Indicators Comparing the EC, the U.S., Japan, and Canada (1988)

Indicator	EC	U.S.	Japan	Canada
Sales (billion ECU)	32.402	75.209	4.352	4.054
Average annual growth of sales from 1978-88 (%)	6.2	4.6	7.1	10.9
GNP (billion ECU)	5,111.2	4,104.2	2,404.4	410.0
Sales/GNP (%)	0.63	1.83	0.18	0.99
Employees	507,192	971,000	(30,000)*	49,000
Sales/Employee (MECU)	0.064	0.077	(0.145)*	0.083

* Estimate

Source: EC 1

Although the United States generates a GNP 20 percent smaller than that of the European Community, its aerospace industry has virtually twice the sales. In the large commercial aircraft sector the United States is not merely the market leader, but also the monopoly supplier—with the B 747 jumbo. The U.S. aerospace industry exports represent a significant item in the American balance of trade.

Japan's still weak and apparently hardly competitive position should not to conceal the fact that this country is purposefully expanding its aerospace industry. By acquiring licenses and basing additional developments on them as well as through strategic cooperative projects for transfer of “know-how,” Japan is gradually mastering all promising technology areas. Japanese autonomy in astronautics is just a matter of time.

I.3. Comparison of Companies

a. Comparison of the Most Significant European Companies Among Each Other

A quantitative comparison of the companies of the European aerospace industry based on sales and employees (Appendix 1) reveals the differences between the German companies and the other European companies, particularly in France and Great Britain.

Considered individually, the German companies MBB, Telefunken Systemtechnik (TST), Dornier, and MTU do not appear until the 4th, 9th, 12th, and 13th positions respectively—both in sales and in the number of employees. Following the merger of the companies mentioned, with the resulting Deutsche Aerospace AG (DASA) a German company assumes, according to calculations, the number two position in Europe ahead of the French Aerospatiale (AS). However, with Thompson-CSF, SNECMA, and Matra,

France has three additional powerful competitors among the top ten European companies. Great Britain is represented there with the sector leaders British Aerospace (BAe) and Rolls Royce (RR).

Because of the relatively strong diversification within DASA, there is still a lag compared to the current European sector leaders. For example, the following companies are from two to three times larger in the sectors indicated: BAe in regional aircraft, AS in helicopters, RR and SNECMA in engines; in communications satellites the planned ALCATEL/AS combination is ahead of DASA.

In this connection, it should be noted that Israel has a capable aerospace industry which must be placed in the middle of the field in the European comparison.

b. Comparison of the Largest European Companies With the United States and Japan

In the worldwide comparison (Appendix 2), the largest German company to date, MBB, is in the 14th position. Through the merger of MBB, Dornier, MTU, and TST, DASA moves to position seven. The comparative overview confirms the predominance of U.S. companies. Of the 18 largest companies worldwide, 12 (i.e., two-thirds) are U.S. companies. These companies dominate the world market for commercial aircraft and because of this, but also because of the exceptionally large military demand of the U.S., have managed to grow to their impressive size.

The largest Japanese company is at the 18th position. That indicates an inferior competitive position for the time being. The effects of post-war decartelization, which restricted the formation of groups in Japanese industry under anti-trust law, also provided for an imaginary limitation of company size. In reality, Mitsubishi, for example, is part of an international industrial giant with sales (approx. DM284 billion) more than 3.5 times those of Daimler-Benz AG.

II. Interim Balance Sheet

The secondary role of the German aerospace industry in the worldwide context is discernible not only in the absolute quantitative comparison, but also in its still minor role in the overall national economy—in comparison with the other large industrialized countries. As has been shown, at approximately 1 percent, the contribution of the German aerospace industry to the GNP lags significant behind that of the U.S. industry (1.83 percent), but is also behind the British (1.8 percent) and the French (1.5 percent) competition. This higher amount for the aerospace industries in the competing countries is primarily attributable to their extensive defense activities—with a high export component. In 1988, the relationship between civilian and military sales was as follows:

Table 6
Comparison of Civilian and Military Shares of Aerospace Industry Sales (1988)

	D	EC	U.S.	Japan
Civilian products	57	35	29	20
Defense technology	43	65	71	80

Source: EC I, BDLI [Federal Association of the German Aviation, Astronautics, and Equipment Industry e.V.]

The extensive participation of the German aerospace industry in the Airbus and astronautics projects has successfully strengthened its share of civilian activity. Still, it has no domestic programs of its own except for small planes, one commuter plane (DO 228), and two helicopters (BO 105 and BK 117). Thus, independent access to markets is still closed to it at present.

Worldwide, the trend toward cutbacks in defense contracts has created surplus capacities which are exerting pressures on civilian markets. In this situation, the German aerospace industry must concentrate all the more attention on its competitive position in the civilian markets.

However, the high costs and risks of the development of new aircraft, engines, and astronautics projects will in the future restrict single-handed national ventures by the German aerospace industry even more than before. Consequently, the German aerospace industry is relying on cooperation and formation of strategic alliances in the competition. Here, the increased integration of Europe and the development of global cooperative programs offers a solution—a course which above all the German engine industry is currently traveling very purposefully.

The prerequisites for possible competitive strategies for the German aerospace industry shall be investigated through the most significant factors affecting competition as well as the submarkets of the German aerospace industry.

III. Framework Conditions of Competition Compared

The framework conditions of competition include the political and economic systems, the state of the infrastructure, the availability of resources, as well as national economic, financial, technological, and foreign trade policy.

III.1. Political and Economic Overview

The economic systems of the individual countries which have aerospace industries in competition with the Federal Republic of Germany do not differ significantly from each other. Within the European Community differences will largely be eliminated by 1992.

The political relationships in the large industrialized nations of Europe are just as stable as in the competing countries: the United States and Japan. Certain instabilities are introduced through the usual shifts in the political majority relationships in the Western democracies, which repeatedly affect individual aerospace industry programs. In this respect, only France represents an exception. There, aerospace projects are considered to be projects of national interest and are thus not jeopardized even by changes in government.

Social policy conditions can also be considered to be basically stable in all the competing countries. In Europe, only the situations in Great Britain and Italy present certain risks from time to time due to relatively long strikes. This is also true to a certain extent for the U.S.

Export policy plays a great role as a driving economic factor for the aerospace industry, as can be observed in the example of France and Great Britain, the USSR, and even Brazil, as well as smaller countries, some of which are even neutral. The large share of military aerospace activity reinforces the economic viability of the foreign competitors. In contrast, the arms export policy of the German federal government imposes significant restrictions on the German aerospace industry.

The Western industrialized nations are bound in international trade by the GATT Treaties, which Japan in particular, however, attempts to circumvent from time to time. In Japanese practice, non-tariff trade obstacles in particular have a restrictive effect on imports. Above all though, it is the overriding political and military influence of the United States on Japan which makes

access difficult there for the European aerospace industry. Even the United States tends in certain political situations to threaten free trade or the free market in its territory.

The state of the infrastructure is equally good in all the competing countries considered. The supply of both energy and raw materials functions well. A well-developed transportation and communications system is available. The other infrastructural facilities, such as postal and telecommunications systems, are comparably well developed.

Thus, there are no infrastructural disadvantages among the large aerospace industry nations. In contrast, the countries of East Europe and the USSR do not have fully developed transportation and communications infrastructures and are thus disadvantaged if they intend to enter into competition in Western markets in the next few years.

III.2 Job Market and Training

Within Europe, the availability of qualified workers currently presents only insignificant differences. However, in the United States there is no equivalent to the skilled worker training common in the industrialized countries of Europe. Thus, problems can occur there due to an inadequate level of training—particularly during periods of sharply rising production.

The qualification requirements for employees in the European aerospace industry can be seen in the following breakdown by primary activities:

Table 7
Primary Activities of European Aerospace Industry Employees by Sector (1988)

Sector	Research and Development		Production		Marketing and Management		Total
		%		%		%	
Airframes	50,254	21	147,233	61	43,860	18	241,317
Engines	16,170	20	51,671	62	14,743	18	82,584
Equipment	39,412	24	92,798	58	29,319	18	161,529
Astronautics	11,045	51	6,357	29	4,359	20	21,761
Total	116,991	23	298,059	59	92,251	18	507,191

Source: EC 1

Table 7 shows that, on average in the European aerospace industry, more than 20 percent of the work force is involved in R&D. Approximately 60 percent of the employees are in production. Marketing and management include less than 20 percent.

In the equipment industry, the distribution of activities between R&D and production is even more favorably oriented toward R&D. The strong concentration on R&D in astronautics is noteworthy. Compared to aviation, the astronautics sector requires more than twice the share of R&D personnel.

This situation does not differ very much in the aerospace industry worldwide. In the U.S., the share of R&D personnel also averages about 20 percent. The growth potential of the aerospace industry is therefore location-based, determined nationally or EC-wide primarily by the availability of R&D personnel.

Due to this concentration on R&D, the training of engineers for the aerospace industry must be a basic element of planning and must be addressed soon by the education and employment system. For this, not only must appropriate training capacities be provided, but the next generation must also be appropriately motivated.

The following comparison of the total inventory of scientists and engineers with the total population of the EC, the U.S., and Japan indicates an advantageous situation in Japan in this respect:

Table 8
R&D Potential Comparing Population to Scientists and Engineers

R&D Potential	EC	U.S.	Japan
Population (millions)	323	244	122
Scientists and Engineers	500,000	825,000	400,000

Source: EC 2

III.3 Wage and Salary Scales, Productivity

Within the West European metal industry, in which the aerospace industry is classified for wage/salary policy, the Federal Republic of Germany has the highest wages and salaries.

Table 9
Wages and Salaries in the European Metal Industry (1988)

Country	Hourly wages for workers (ECU) (WEM statistics*)	Annual salaries for Executives (ECU) (UIMM, Social International*)
Germany	9.28	47,850-127,189
France	4.36	57,027-110,464
Great Britain	7.03	27,257- 77,264
Italy	5.85	74,615-120,188
The Netherlands	7.56	59,270- 98,782

*Sources quoted according to DASA

The situation varies little in the area of wage supplements:

Table 10
Wage Supplements 1988

	Percentage of direct wages	ECU per hour
Germany	73.3	6.80
France	90.0	3.92
Great Britain	36.4	4.46
Italy	114.0	6.67
The Netherlands	85.6	6.47

Source: WEM statistics according to DASA

The comparison of employee work hours is as follows:

Table 11
Work Time/Free Time

	Annual hours of work	Holidays	Vacation Days
Germany	1,669	10	30
France	1,733 - 1,756	8	25-28
Great Britain	1,778	8	25
Italy	1,792	8	24
The Netherlands	1,786 - 1,696	5	22-31
U.S.	1,756	10	20

Source: ISN [International Social-Political Reports] according to DASA

However, productivity is high in the Federal Republic of Germany even with the high wage level and the short work hours. This is reflected in the following comparison of sales per employee:

Table 12
Productivity in the Aerospace Industry in Terms of Sales per Employee (1988)

Country	MECU/Employee
Germany	0.102
France	0.099
Great Britain	0.060
Italy	0.067
The Netherlands	0.069
Spain	0.052
Japan	(0.015)
U.S.	0.077

Source: EC

The validity of this comparison is necessarily restricted to the extent that the statistical limits of the domestic aerospace industries are in some cases different from those of foreign industries.

III.4 Promotion of Research and Technology

From the standpoint of technological and industrial policy, aerospace technologies are considered to be high technologies which will assure the future. They therefore receive government support for R&D in all the competing countries. By way of comparison, in 1988 this amounted to:

Table 13
Government Support of Aerospace Industry R&D in 1988
(in MECU)

Country	Aviation	Astronautics	Total	Aerospace Share All Government R&D Outlays
Germany	346	592	938	8.7%
France*	—	772	—	—
Great Britain	154	224	378	5.2%
Italy	78	516	594	10.4%
The Netherlands	0	61	61	3.3%
Spain*	—	75	—	—

*For France and Spain, no figures are available concerning support for aviation.

Source: EUROSTAT

For the U.S., the Aerospace Industries Association (AIA) reports the R&D outlays of the federal government for 1986 at approximately ECU11.9 billion.

All the above countries have aerospace research organizations. Personnel and financial provisions for these organizations are listed in the following table:

Table 14
Aerospace Research Organizations

Country	Name	Employees	Budget (MECU)
Germany	DLR	4,100	252
France	ONERA	2,100	200
	CNES	2,300	1,000
Great Britain	RAE	5,300	Contract financed
Italy	CIRA	500 ¹	100 ²
The Netherlands	NLR	800	43
Spain	INTA	1,500	100
Japan	NASDA	938	749
U.S.	NASA	23,000 ³	7,653

1. Planned after completion of construction phase (currently approximately 100)

2. Annual average for five-year construction phase

3. Excluding contractors

Source: DLR, DASA

III.5 Fiscal Aspects, Subsidies

Taxes and duties affect the cost structure and, consequently, the competitiveness of companies. The German federal government is unaware of any deliberate tax policy for the support of competitiveness which excludes the domestic aerospace industry in any competing country. However, particularly in the U.S., several tax measures have been adopted which work to the advantage of the entire export industry and, consequently, of the aerospace industry as well.

Of considerably greater significance for the competitiveness of the aerospace industry are subsidies, which are provided in a variety of forms—both open and hidden.

Using the example of jumbo aircraft engineering, it is possible to demonstrate that subsidy elements have a significant if not decisive affect on the current efficiency and competitiveness of all suppliers in this market.

The U.S. civilian jumbo aircraft programs are based partially or predominantly on military development whose costs therefore no longer have to be amortized in the market price. It is, for example, no secret that the new MD 11 jumbo is being produced at the same factory complex—in part in the same rooms on adjacent assembly lines—with the heavy C 17 military transport.

Furthermore, under U.S. Department of Defense (DOD) contract, research is being conducted for the NASP hypersonic aircraft. Since 1983, American DOD outlays for space projects have been greater than the funds made available to NASA (in 1988, at approximately \$17.2 billion, they were virtually double those for NASA).

A study of the economic impact of U.S. subsidies for defense and space by the A.D. Little company commissioned by the federal government came to the conclusion that arms and space projects with the priority objective of so-called "spin-offs" for the civilian and general industrial sector are less efficient than direct research aid. At the same time, however, it is shown using the example of the United States how much the civilian competitive strengths of the American aerospace industry have benefitted and continue to benefit from high arms and space subsidies.

United States manufacturers were able to use this competitive advantage to gradually improve their capital equipment and, in one instance, to raise it so much that now new developments can be financed from their own resources, without military procurement programs.

With the decision for the Airbus program, the European governments and industrial partners were aware that long-term chances for the success of the product could only be achieved with the assistance of direct public funds. Shoring up the Airbus with military jumbo engineering was impossible due to the lack in Europe of the need for troop transport planes.

Whereas in Great Britain and France civilian commercial aircraft were already being built at the beginning of the 1970's, competitiveness of the German aerospace industry was virtually nonexistent in this sector. This resulted in the necessity for almost complete assumption of risks by the government for the German share of the Airbus program.

With the help of this backing and considerable subsidies in France, Great Britain, and Spain as well, it was possible to establish the Airbus on the market. The German aerospace industry was also able to strengthen its competitive position in comparison to the partners, a fact which was finally recognized in the decision for final assembly of the A321 in Hamburg.

Therefore, the opportunity now offers itself to reduce subsidies and to increasingly transfer the remaining risks to the

industry itself. With the so-called "new regulation concept" of Airbus financing, gradual assumption of industrial responsibility for the Airbus program was introduced in the Federal Republic of Germany. In the other partner countries, subsidies are likewise gradually being reduced.

IV. The German Aerospace Industry in the International Market

IV.1 Commercial Airplanes

In the five years from 1983 through 1988, the growth rate of passenger kilometers flown in civilian aviation was between 6.2 and 9.4 percent. The annual average growth rate was 7.4 percent. If this trend continues, it will be necessary to contend with a doubling of air traffic within nine to 10 years. Airlines and the aviation industry are anticipating this growth. The German industry has assured its share in this development through its significant participation in the Airbus program (37.9 percent).

In the largest civilian market segment, commercial turboprops, 513 aircraft were delivered in the West in 1988. The manufacturer distribution was as follows:

Table 15
Jet Deliveries (1988)

	U.S.		Europe			Total
	Boeing	MDC	Airbus	BAe	Fokker	
Units	290	129	61	22	11	513
Share (%)	57	25	12	4	2	100
Total units	419		94			
Share (%)	82		18			

Source: EC 1

Whereas according to the above table the market share for European manufacturers was still only 18 percent in 1988, already in 1989 the European market offensive was successful. In the year of the largest increase to date in the market for commercial aircraft, the European manufacturers obtained a market share of 31 percent (in terms of numbers of units). The following table shows the distribution:

Table 16
Jet Orders (1989)

Region	Manufacturer	Units	%	Units/Region	%
U.S.	Boeing	887	50	1226	69
	McDonnell-Douglas	339	19		
Europa	Airbus-Industrie	405	22	563	31
	British Aerospace	39	2		
	Fokker	119	7		
Worldwide	Total			1789	100

Source: EC 1

However, in terms of value the estimated market distribution for the Europeans must be lower, since their share in large planes is still small and with the B747 (jumbo) one American manufacturer still has the market monopoly for large long-range aircraft.

The demand for civilian commercial aircraft is estimated at more than 7,000 units over the next 10 years, based on a market analysis by Airbus Industrie (AI). Its distribution and AI's targeted market share in each category are reported in the following table:

Table 17
Market Prognosis of Commercial Aircraft Demand From 1988 Through 2000

		Short- and Medium-Range		Long-Range
		Narrow Body	Wide Body	Wide Body
Total demand	Units %	3850 55	2032 29	1147 16
Airbus targeted share	Units %	1089 28	715 35	307 27

Source: AI

Boeing arrives at comparable results in its market prognosis. In the period through 2008, the companies value the market volume at approximately \$700 billion. Approximately half of the passenger planes are expected to be wide-body aircraft with more than 300 seats. The number of freight planes, currently approximately 700, should rise proportionally to more than 1600.

IV.2 Commuter Aircraft

Of the total of 5799 commuter aircraft operated worldwide in 1988, approximately 75 percent were in commercial aviation and other civilian use, with approximately 25 percent in official use (governmental and defense tasks, etc.).

However, in the commuter market manufacturing and use conditions are different from those of the jumbo market. Although, here again the U.S. domestic market absorbs by far the most aircraft (approximately 60 percent), the U.S. aviation industry cannot nearly satisfy this demand. Manufacturing is concentrated in Europe with a market share of approximately 62 percent.

The 389 commuter planes delivered in 1988 may be categorized as follows according to seating capacity:

Table 18
Commuter Plane Deliveries by Seating Capacity (1988)

Seats	15 - 19	20 - 70	40 - 70	70 - 110	Total
Units	127	123	91	48	389
Share (%)	33	32	23	12	100

Source: Dornier

However, the shares of the individual European manufacturers in this market reflect both a fragmentation of capacity caused by a multitude of suppliers and the comparatively poor position of the sole German manufacturer:

Table 19
European Manufacturer Shares in Worldwide Production of Commuter Aircraft 1985 - 1988 (in %)

Manufacturer	Number of Seats			
	15 - 19	20 - 39	40 - 70	Total market
ATR	-	-	49	16
BAe	39	-	12	17
CASA	-	7	6	4
Dornier	16	1	-	6
Fokker	-	-	16	5
Saab	-	28	-	9
Shorts	-	12	-	4

Source: Dornier

Despite the great pent-up European demand and the South-east Asian demand, which is experiencing extraordinary growth, North America will remain—because of the geographic and infrastructural conditions there—the largest market for commuter aircraft in the foreseeable future.

Total worldwide demand for commuter aircraft in the period from 1991 through 2000 is estimated by the industry at approximately 4,440 units. The following table reports the anticipated distribution among the individual size categories:

Table 20
Estimated Demand for Commuter Aircraft 1991 - 2000

	Number of Seats				
	15 - 19	20 - 39	40 - 70	71 - 110	Total
Planes (Units)	1080	1370	1140	850	4440
Share (%)	24	31	26	19	100
Value (billion ECU)	3.2	8.1	10.2	14.1	35.6
Share (%)					
Airlines	72	82	87	ca.90	
Other	28	18	13	ca.10	

Source: Dornier

In this estimate, a regional distribution is assumed for the aircraft sold to airlines, where the 15 through 39 seat market segments dominate in North America. In Europe—as is already the case—the 40 through 70 seat category prevails. According to the industry, its share will continue to increase with a trend toward even larger planes (71 through 110 seats). This can be attributed primarily to the air traffic control problems in the vicinity of European airports.

In the corporate aircraft market (fewer than 15 seats), conditions similar to those in the 15 through 19 seat commuter planes are found. The United States has a 73-percent share of the worldwide inventory (Europe = 11 percent). However, the highest growth rates (13 percent in 1988) are found in Asia, where, in particular, the demand for fast jets is increasing rapidly (Source: AVData).

IV.3 Helicopters

In the five-year period between 1983 and 1988, a sharp cutback occurred in the civilian helicopter market with a 25-percent drop in sales. This resulted in the creation of clear surplus capacities. In 1988 a total of 1080 units was delivered worldwide, of which a 41-percent share went to the civilian market.

The worldwide inventory of civilian helicopters stood at 17,838 units in 1988 with a total value of approximately 6,552 MECU. This is regionally distributed as follows:

Table 21
Civilian Helicopter Inventory 1988

	Europe	U.S.	Other	Total
Units	2,964	9,332	5,542	17,838
Share (%)	17	52	31	100
Value (MECU)	1,394.8	2,898.6	2,259.8	6,552.2
Share (%)	21	44	35	100

Source: EC 1

Of the worldwide inventory of civilian helicopters, approximately 40 percent are currently equipped with piston engines and approximately 60 percent with turbine engines, with the share of helicopters with turbine engines slowly increasing. The European manufacturers supply the turbo helicopter market. The 10 largest manufacturers assume the following positions in a worldwide context:

Table 22
Share of Civilian Helicopter Manufacturers in the Worldwide Inventory (1988)

Rank	Company	Units in the worldwide inventory	Share (%)
1	Bell	5949	52
2	Aerospatiale	2120	20
3	McDonnell Douglas	1443	14
4	Sikorsky	534	5
5	MBB	449	4
6	Hiller	150	1.4
7	Agusta	141	1.3
8	Soloy	135	1.3
9	Boeing-Vertol	47	0.4
10	Westland	22	0.2

Source: Dornier

The future demand for the 10-year period between 1988 and 1997 is estimated by the U.S. engine company Allison at a total of 5,300 civilian helicopters.

The German helicopter industry—supported by public R&D funding and developmental loans, which have now been paid back—managed to establish a foothold in the world market with light two-engine helicopters (BO 105 and BK 117). However, because of declining demand surplus capacities have developed worldwide, which also need to be remedied because of the strong fragmentation of the manufacturing scene.

Therefore, the German aerospace coordinator recommended in his report presented in 1989 that the German industry develop on its own a plan for international cooperation in civilian and military helicopters which seems absolutely essential to its long-term competitiveness. MBB thus developed with Aerospatiale a cooperation plan which is now to be implemented gradually. It will merge the two largest European helicopter manufacturers into a common company (Eurocopter) with a coordinated palette of products. The German partner is assuming the lead role for the lower weight class, the French for the heavier. Together, the partners intend to concentrate in the future on market-based sales rather than on competing programs. A memorandum of intent has already been signed with the goal of a definitive agreement before the end of this year.

IV.4 Engines

In the period between 1984 and 1987, jet engines valued at approximately ECU74 billion (approximately \$68 billion) were sold. The civilian share was 44 percent, or ECU32.5 billion. The EC countries obtained a 25-percent share of the total market.

Production and sales for the significant segment "engines for civilian commercial aircraft" were distributed as follows:

	Europe	U.S.	Other
Production (%)	24	75	1
Sales (%)	20	49*	31

*Including Canada and the Caribbean

Source: MTU

Worldwide, the engine market for civilian commercial aircraft is dominated by three large manufacturers: General Electric (GE), Pratt & Whitney (PW), and Rolls Royce (RR). The sole German manufacturer until now (MTU) has only a 1.9-percent share of the market.

The sales projection of the industry for the worldwide engine market in the 10-year period from 1989 to 1998 amounts to ECU177 billion (\$208 billion). The German

share of this could be about 5 percent. This would require that the civilian share of the market increase to 57 percent (approximately ECU101 billion) within the period in question. According to MTU data, the forecast civilian engines sales will be distributed as follows:

Table 24
Sales Forecast for Engines for Civilian Aviation (1989 - 1998)

	Value (billion ECU)	Share (%)
Wide-bodied planes	81.8	81
Commuter planes	5.1	5
Corporate planes/ Helicopters, etc.	14.5	14

Source: MTU

The sales forecast in the market segment "engines for civilian commercial aircraft," which includes wide-body and commuter aircraft, breaks down into the following thrust classes:

Table 25
Sales Forecast for Engines for Civilian Commercial Aircraft (1989 - 1998)

Thrust (lb)	Engines (Units)	Share (%)	Sales (billion ECU)	Share(%)
< 20,000	1,560	10	12.1	15
20 - 30,000	7,150	46	25.7	32
30 - 45,000	2,340	15	10.5	13
> 45,000	4,550	29	32.2	40
Total	15,600	100	80.5	100

Source: MTU

Thus, the thrust class ranges between 20,000 and 30,000 lb and over 45,000 lb assume particular significance. Together they represent 75 percent of the units and 72 percent of the value of the sales forecasts.

Expansion of the market is particularly difficult and risky for the German engine industry in light of the predominant positions of the three worldwide leading manufacturers mentioned.

IV.5 Equipment

The German equipment industry employs approximately 31,000 workers in 64 companies. It thus enjoys a share of approximately 32 percent of the employees in the German aerospace industry. The size of the companies of the individual entrepreneurs varies greatly. However, this sector is composed primarily of medium-sized firms.

The spectrum of offerings of the German equipment industry extends from aircraft interior furnishings, through actuators, sensors, and homing heads, to elements of the cockpit equipment, the flight control

system, and engines for auxiliary power supply. However, complete equipment packages, as offered by the U.S. competitors who dominate the world market, are as yet not produced by German equipment manufacturers.

One of the weaknesses of the German equipment industry is the relatively small series. The lack of national programs in the Federal Republic of Germany compared to the competing countries has the same effect as the export restrictions imposed on the German aerospace industry. In addition, due to the cutbacks in the equipment market, foreign competitors are increasingly penetrating the free German market. Further difficulties result from the fact that German systems companies have from time to time expanded their development and production shares to the disadvantage of the equipment manufacturers. Nevertheless, the German equipment industry has managed to assert itself relatively successfully into international competition by entering into international cooperative projects.

The equipment manufacturers consider themselves as partners of the systems companies and would therefore like to be included with the same rights in national and international projects from the beginning based on their potential technical contribution.

In the military contracts, the problem lies primarily in the relationship of the equipment manufacturers to the systems firms commissioned as general contractors. However, the ideal of early participation of the equipment manufacturers, where the government client would set aside a specific share of the development costs for equipment, is impossible to implement under the pressure for economical budget management—with an increasing share of fixed price contracts. The equipment manufacturers only find out the share of development costs which will fall to them after the general contractor has finished his planning. This makes long-term planning extremely more difficult for the equipment industry.

The German federal government is also promoting the efforts of the equipment industry to obtain a fair share of defense R&D costs through improvement of the awarding guidelines and the establishment of an ombudsman for medium-sized industry in the Federal Office of Military Engineering and Procurement (BWB).

In the Airbus program, it was possible to continually expand the share of German equipment. Thus, it increased from 8 percent with the A300 in 1974 to 17 percent with the A310 in 1980 and 32 percent with the A320 in 1984. With the Airbus A330/340, the share for equipment development cost was specified by a cabinet decision and thus the former priority access of the German general contractor to the funds was removed.

IV.6 Defense Technology

In all industrialized countries, the defense technology markets have previously been largely reserved to domestic industry. The domestic purchaser thus holds the key position.

The politically inspired export restrictions in the Federal Republic of Germany narrow the market for the German arms industry significantly compared to its competitors.

The export shares of the defense sector of the aerospace industries of the competing countries can be represented as follows:

Table 26
Arms Export Share of Total Sales of the Aerospace Industry

Country	D	F	UK	U.S.
Percentage	10	33	25	7

Source: Dornier

The small share in the United States should not overshadow the high absolute arms exports. Japan is showing up in the market with an increasing share—primarily in electronic equipment. Also, developing countries such as Brazil are increasingly significant arms exporters.

The opening of the frontiers for defense procurements to create a European arms market is being worked on by the ministers of defense of the member states of the Independent European Program Group (IEPG). With it the following should be accomplished:

- international competition for development, procurement, and maintenance contracts;
- a so-called "juste retour" [fair return] for foreign contracts;
- maximum possible facilitation of technology transfer between IEPG member countries;
- maximum possible implementation of joint research and technology work.

The systems expenditures corresponding to the increasing technical performance requirements—particularly the increasing share of electronics—is leading to increasingly higher costs and—with current budget appropriations—to increasingly smaller procurable systems production lots. Large defense programs frequently cannot be financed by single national economies and, consequently, have for a long time been increasingly carried out primarily as cooperation programs. Only market expansion—achieved through the union of multiple national markets—yields adequate advantages to permit undertaking production at unit costs which are still bearable.

In the wake of this developmental trend, net profits in the airframe and drive sector are declining. The functional equipment and avionics in fighter plane engineering have already obtained a net profit share of 40 percent (35 percent for airframes, 25 percent for drives).

Table 27
Market Situation for Fighter Planes 1988

		U.S.		EG	
		heavy	light	heavy	light
Number of suppliers		5	3	2	4
Suppliers		McDonnell-Douglas General Dynamics Northrop Grumman Lockheed		Consortium (Panavia, Eurofighter)	AMD - BA Dornier Aeritalia BAe
Buyers		U.S. Armed Forces + Exports		Europ. Armed Forces + Exports	
1988 Market Volume	Units	193	331	57	137
	MECU	5.766	5.301	2.604	1.953

Source: Dornier

The basic capacity utilization of the German aerospace industry through government contracts (defense and astronautics) is approximately 50 percent. Outlays of the BMVg [German Defense Ministry] for military aviation amount annually to DM7 to 8 million. This corresponds to approximately 13 to 15 percent of the defense budget. The distribution of expenditures for research, development, materials maintenance, and procurement is shown in Appendix 4.

All the relatively large programs of the Bundeswehr in the area of defense aviation materials are carried out in international cooperative programs. In this, the principle of "industrial return" still applies, guaranteeing the industries of the partner countries a contractual return proportionate to national financial participation. In the wake of the emerging European arms market within the framework of the EC internal market, this principle will be increasingly pushed aside in favor of the most competitive bid.

Using the example of the product generating the most defense sales, fighter planes, it is possible to illustrate the competitive situation of the German aerospace industry. The enormous costs for development and production of modern fighters make concentration and even greater internationalization imperative in all industrialized countries.

Thus, in the United States there will probably be only one fighter plane program, which five formerly independent manufacturers will have to share. With four partners the European Fighter Aircraft (Jaeger 90) also has a larger following table summarizes information and figures characterizing the market situation:

The table shows that the U.S. industry, including exports, has 2.5 to 2.7 times the market volume of the European suppliers.

Worldwide in 1986, a total of 19,620 helicopters were in use for military purposes, regionally distributed as follows:

Table 28
Inventory of Military Helicopters (1986)

	Units	(%)
Europe	4,750	24
U.S.	7,645	39
Other	7,225	37
Total	19,620	100

Source: EC, Dornier

The worldwide inventory outside the United States (61 percent) is distributed among the manufacturers as follows:

Table 29
Inventory of Military Helicopters Outside the United States (1986)

	Europe		Other		Total	
	Units	(%)	Units	(%)	Units	(%)
Aerospatiale	1,709	36	1,201	17	2,910	24
Agusta	848	18	565	8	1,413	12
MBB	412	9	179	2	591	5
Westland	621	13	165	2	786	7
US manufacturers	855	18	2,747	38	3,602	30
Other	305	6	2,368	33	2,673	22
Total	4,750	100	7,225	100	11,975	100

Source: Dornier

The strong position of Aerospatiale, which holds the largest market share of an individual manufacturer outside the United States (Bell is in second place with 2,476 units), stands out in helicopter construction. The strong shares of Agusta and Westland in the military market are noteworthy—compared to the civilian market. The Western European manufacturers are represented in the worldwide market outside Europe and the United States with a share of approximately 30 percent.

In sales, Aerospatiale is currently (1989) heading the list of manufacturers with 231 units (i.e., 27 percent). Second through fourth place are occupied by the U.S. manufacturers Sikorsky (179 units, 21 percent), Bell (166 units, 19 percent), and McDonnell Helicopter (93 units, 11 percent). MBB (69 units, 8 percent) and Agusta (68 units, 8 percent) follow in fifth and sixth place. In contrast, Westland (15 units, 2 percent) has dropped to eighth place.

The total worldwide inventory of engines in the defense sector in 1987 was 126,537 units. The distribution of the worldwide inventory by manufacturer in the largest segments: turboprops and turbojets, with an approximately 55-percent share of production is shown in the following table:

Table 30
Breakdown of the Worldwide Inventory of Military Engines (Turboprop and Turbojet) by Manufacturer

Manufacturer	Turboprop		Turbojet		Total	
	Units	(%)	Units	(%)	Units	(%)
CFM	1,288	1.8	0	0.0	1,288	1.8
RR	4,054	5.8	4,135	5.9	8,189	11.7
SNECMA	1,373	2.0	2,119	3.0	3,492	5.0
TURBO-Union	1,656	2.4	0	0.0	1,656	2.4
GE	4,988	7.2	15,742	22.6	20,730	29.8
PW	11,989	17.2	6,326	9.1	18,315	26.3
Other	3,376	4.8	12,633	18.2	16,009	23.0
Total	28,724	41.2	40,955	58.8	69,679	100.0

Source: EG 1

Here, the dominance of the U.S. manufacturers is quite obvious. They have a firm grip on almost 60 percent of the market. At the same time, it reveals what its dominant position in the civilian market must ultimately be attributed to.

The amounts for military space expenditures for the most significant comparative countries are the following:

Table 31
Military Space Expenditures 1987

	MECU
U.S.	16,300
Europe	210
China	1,300
Japan	-

Source: Eurospace

The table reveals the great competitive lead of the U.S. space industry. Whereas there are no military space expenditures in the Federal Republic of Germany, the French and British industries also benefit from military space contracts in contrast with the German aerospace industry.

IV.7 Astronautics

In the astronautics sector, the competitive situation of the aerospace industry is basically still determined by the governmental clients. Only approximately 10 percent of the total sales of the German industry are based on non-governmental contracts. In the U.S., which is more advanced in the commercialization of astronautics, the share of commercial clients is already about 20 percent.

Appendix 3 presents an international comparison of the space budgets for 1987.

The government expenditures of the Federal Republic of Germany for astronautics break down further as follows:

Table 32
Astronautics Expenditures in the Federal Republic of Germany (1984 - 1988)

Astronautics	1984	1985	1986	1987	1988
BMP	210*	382*	362*	295*	281*
BFMT	408	416	358	419	464
National total (BMP + BMFT)	618	798	720	714	745
+ ESA	367	414	559	640	644
Total	985	1,212	1,279	1,354	1,389

*Including procurement of TV-Sat and DFS Kopernikus, which will be completed in 1990.

Source: BMWi-Koor LR

In terms of space expenditures relative to the gross national product, the Federal Republic of Germany does not come off at all well in the international comparison:

Table 33
Astronautics Expenditures as a Percentage of the Gross National Product

U.S.	0.56
France	0.12
Italy	0.046
Federal Republic of Germany	0.041
Great Britain	0.032
Europe (ESA)	0.038
Japan	0.039

Source: EUROCONSULT 1987

For the Federal Republic of Germany, the share of the gross national product devoted to astronautics expenditures is less than 0.05 percent. It thus is less than the share in the U.S., France, and even Italy. On the one hand, this can be attributed to the fact that in Germany astronautics, as is also the case with the ESA, are only undertaken for civilian purposes. However, on the other hand, its acceptance by society is also lower than in France, for example.

The worldwide commercial market is estimated by the technical organization Eurospace at more than ECU7 billion. This is based on the following distribution:

Table 34
Commercial Astronautics Market 1987 (in MECU)

Commercial Market	U.S.	Europe
Telecommunications	3,500	620
Earth observation	40	6
Boosters (Launch vehicles)	200	180
Ground segment	2,500	

Source: Eurospace

This table reflects the extremely dominant commercial importance of satellite-supported telecommunications including the ground segment. Currently, 70 percent of all civilian satellites are in telecommunications. The rest are divided at a rate of 15 percent each between scientific and earth observation satellites including meteorology.

The following table compares sales and employees of the competing companies in satellite communications in Europe and the U.S.. The data are based for the most part on estimates because the activities involved are frequently assigned only to individual departments of the participating companies and are not calculated separately in the balance sheets. Therefore, they can only serve as indicators of magnitude. In contrast, for the Japanese situation, not even estimates are available. The Japanese willingness to share information—as in the aerospace industry as a whole, for that matter—is extremely limited.

Table 35
Sales and Employees in the Telecommunications Satellite Industry (1988)

		Sales (MDM)	Employees
D	MBB	850	1,700
	ANT	140	700
F	Alcatel/Aerospatiale	900	2,200
	Matra	800	1,620
UK	British Aerospace	360	1,900
	GEC/Marconi Space Systems	780	1,100
I	Selenia Spazio/Aerital	350	1,400
U.S.	Hughes Aircraft	2,000	8,500
	Ford Aerospace	510	1,600
	GE-Astro	850	4,900
	TRW	2,500	5,500

Source: ANT

The German astronautics industry is thus positioned far behind the United States and is only in third place in Europe, behind France and Great Britain. France and Italy, in particular, are investing nationally in the technological pacesetter role of these technologies. In addition to their intense participation in ESA telecommunications programs, the two countries are purposefully conducting national application and technology projects. To be sure, in Great Britain, the support through the government's civilian budget is clearly weaker; however, the British industry is able to support its telecommunications activities through the military budget.

The German astronautics industry has consistently prepared itself for satellite supported telecommunications. For this it has used considerable funds of its own along with the funding provided by the ESA and the BMFT. Within the ESA technology projects, it has concentrated during the last three years on a few future-oriented themes, such as SILEX (the next generation of optical

data transmission) and SAT 2 (communications repeater definition)—with a view to the data relay satellite system (DRS) planned by ESA.

National funding through the BMFT for future communications satellites was terminated with TV-SAT 1. Contributions with a 50-percent support rate were granted through 1989, to research specific device technologies and key components for modern communications payloads (annual BMFT funding including research institutes and universities on the annual average from 1975 through 1988: approximately DM26 million; Source: A.D. Little 2).

At present, only a small financial participation of the BMFT in the ESA technology program ARTEMIS, being developed in preparation for the data relay satellite system (DRS), is being considered. It is doubtful whether German participation in the DRS will be possible. If there is no participation, the past governmental and private expenditures for SILEX and other technologies (such as the ion engine developed by MBB) are jeopardized for the German industry. It would be disadvantaged in the future in a growth-oriented, competition-intensive market compared to the competition in the other ESA member countries participating in the program.

The satellite industry is currently undergoing radical changes. In France, the companies Alcatel and Aerospaiale are planning to merge their satellite activities. This would create the largest European satellite supplier. Matra (F) has joined with GEC/MARCONI (UK). Selenia Spazio's merger with Aeritalia is about to take effect. In the U.S., Ford Aerospace is for sale; however, no buyer has been found yet.

The German satellite industry must consider what cooperation strategies it intends to pursue in this market in order to be able to survive in the competition. The worldwide market leadership of GE and Hughes can be considered undisputed. Because of deregulation, both companies were also able to establish exploitation companies in the U.S., which provided them access to telecommunications fee revenues, reserved for the postal administrations in Europe. Hughes independently owns a fleet of seven operational satellites; GE-Astro exploits six satellites of its own. In Europe, BAe is preparing for entry into the international fee market with its participation in Orion Satellite Corporation, for which it will position two satellites above the Atlantic along with GE-Astro in 1992.

The development of the satellite-supported telecommunications market during the period from 1978 through 1988 is shown in the following table. One indicator is the number of transponders installed on the satellites available or in use. A comparison between Europe and the United States reveals the rapid growth in demand for transponders. For the U.S., an estimate is also presented for future demand through 1996. In the Ku-band, it assumes a tripling.

Table 36
Number of Transponders in the United States and Europe

Transponders		1978	1988	1996
U.S.	C-Band	180	536	636
	Ku-Band	0	268	850
Europe		0	110	

Source: Frost & Sullivan Inc.

Despite the competition of satellites with the submarine cable, which has been revitalized by the appearance of glass fiber technology and the multiplication of performance possible with it, the rapidly growing telecommunications market promises significant growth for both transmission media.

Another large market segment for the German and European aerospace industry is space transportation. Here, it has a competitive product in the European rocket Ariane.

Of four conceivable market niches for the space transporter:

- Satellite transportation,
- Transportation of experiments (primarily for micro-gravity),
- Transportation of space station modules and structures,
- Manned and unmanned transportation for supply and repair of the future space station(s),

only satellite transportation is economically significant at present. It is handled commercially. However, all launch rockets used for it have been developed under government contracts.

In the Western world, the U.S. manufacturers McDonnell-Douglas (Delta 2), General Dynamics (Atlas Centaur I and II), and Martin Marietta (Titan III) are currently competing with the European company Arianespace (Ariane 4), a merger of the European booster industry (German share: approximately 20 percent; French: approximately 60 percent). Eastern competitors are also penetrating the Western market: the USSR with Proton, Zenith, and Energija; the PRC with Long March. India and Israel also have launch systems which have already been tested. Japan is on the verge of entering the market with the H-II booster rocket developed there.

The competition for commercial satellite transportation is complicated by governmental contracts, which are supported in the United States and the USSR primarily by military budgets. Between 1980 and 1986 over 80 percent of all rocket launches were made by the USSR; 8 percent were U.S. government contracts.

The commercially accessible transportation market thus involved about 10 percent of all launches. In the market thus described, Arianespace assumed a dominant position with a share of approximately 50 percent. If you add on the U.S. government contracts, which to date have exclusively benefitted the American launch vehicle

industry, to the market potential, Ariane's share drops however to approximately 25 percent.

Different practices in figuring the costs of the use of government-owned launching sites and mission control centers for commercial launches by the government offices in the United States and Europe are such that the competition is further distorted. Consequently, both sides—the U.S. government and the ESA through its member governments—are attempting to draw up an agreement on mutual "rules of the road." Governmental negotiations should begin soon.

In the past, the U.S. trade delegates had initiated legal proceedings under Art. 301 of the U.S. Trade Law with the accusation of unfair preferential treatment by the ESA governments. The suit ended in 1986 with a decision of the American president, according to which comparable conditions were established for commercial satellite launches in Europe and the U.S.. However, the president asked the governments of both sides to coordinate competitive conditions.

New competitive problems are currently emerging with the appearance of the PRC and the USSR on the Western market. Because of the form of their economies they are both in a position to offer satellite transportation for less than the world market price without regard to costs, which in some cases cannot be accurately determined.

Consequently, the U.S. government concluded an agreement last year with the PRC government, in fact permitting the Chinese industry to launch American satellites, but limiting their number to a total of nine launches within a six-year period. Furthermore, the agreement obligates the PRC to base its launch bids on world market prices. The Europeans, who have already been negotiating for a long time with the U.S. government concerning issues of competition in the booster sector, are seeking inclusion in the agreement with the PRC.

The Western governments also are presented with a new, even political dimension relative to the Soviet bid to transport Western satellites on their launchers. Trade policy obstacles of the Cocom [Coordinating Committee on Export Controls] regime and fears of distorted price competition stand in the way of the desire for general improvement of political relations with the Soviet Union. The European governments will also confer in the near future with the U.S. administration about these issues.

C. Conclusions

The coming years will be characterized by further disarmament, resulting in reduced defense budgets and a correspondingly reduced procurement market for aerospace industry products. Worldwide, surplus capacities are being created by the disarmament efforts and industrial efforts are being triggered to compensate partially for them through conversion of production to civilian

aircraft and—to a lesser extent—to astronautics. In light of this development, the German aerospace industry must decisively consolidate its position in the civilian markets.

In the market for large commercial aircraft, the German aerospace industry has accomplished significant consolidation through its substantial participation in the Airbus program in the wake of the expansion of this program into a family concept (the program now covers the entire spectrum of commercial aircraft—from the short- and medium-range jet A320 to the wide-bodied long-range A340). With its assumption of the responsibility for integration of the A321 (stretch version of the A320 with a large market potential), a new basis for systems leadership tasks has been developed.

To assure the market position of the Airbus program, it is now imperative to completely establish the cost-effectiveness of European construction of the wide-bodied aircraft as quickly as possible. For this Airbus Industrie, currently still managed as an interest group under French law (GIE [European Interest Group]), must be transformed into a joint stock company with transparent responsibility for management and results. Proposals for this have been presented to the board of directors and to the Airbus governments. To accomplish this objective, it seems unimportant which national legal form is used as the basis of the joint stock company to be formed. The transformation into the desirable legal form of a European stock company can occur when the legal conditions are created within the EC for this type of company.

However, there should be no mistake about the fact that even after a successful restructuring of Airbus nationally and in Europe, risks exist which go well beyond careful planning. This is particularly true for the development of the dollar exchange rate, but also for the future pricing policy of the major competitor Boeing, whose civilian aircraft production is highly profitable, not in the least because of its enduring monopoly position in the B747 market segment.

In view of these risks, but primarily because of the continued indirect support of the American industry through R&D contracts, primarily from the Department of Defense, government subsidies will also be required for the development of new types of aircraft in the future on the European side.

It will however be possible to significantly reduce their volume compared to the past. A cutback is also advisable in this area because otherwise it will be necessary to contend with trade policy measures from the U.S.. In this regard, in December 1989 the U.S. government demanded GATT action against the above-mentioned exchange rate protection of the Federal Republic of Germany. The Airbus partner governments have been attempting for more than three years to negotiate an agreement with the United States which would settle the disagreement about the removal of the GATT aircraft

codex relative to government assistance to national aircraft industries. This would involve limiting the subsidies to a level which would take the special structure of these markets into consideration and balance them out in a competitively neutral way. It is possible that an agreement might yet be concluded this year concerning additional subsidy discipline and, consequently, ending the conflict which has been going on for years with the United States concerning Airbus subsidies on the one hand and the indirect assistance for U.S. manufacturers on the other. An important objective in this is also the extension of this agreement to include possible future competitors in wide-bodied aircraft construction, e.g., Japan.

Plans are currently being developed by various national manufacturers in the U.S., France, and Great Britain for an economical supersonic transport plane (successor to the Concorde). Primary requirements are new engine and materials technologies. The German aerospace industry is endeavoring to participate in overcoming the technical and, above all, the environmentally significant problems for the development of a supersonic commercial aircraft in worldwide international cooperation. Even the Japanese industry could be included in this cooperation.

In the commuter plane sector, three findings are crucial to the future objectives of the German aerospace industry:

1. In 19- through 110-seat commuters, six European manufacturers are active. Thus, the supplier side seems overcrowded.
2. Because it is not anticipated that any of the present manufacturers will voluntarily surrender his segment of the market, cooperation strategies must be developed and implemented to guarantee the market of the German aerospace industry.
3. Because of the air space situation, the development of the market for small commercial aircraft is giving planes in the class between 70 and 110 seats new opportunities.

The German aerospace industry must examine its market chances. In this process, it must decide whether it is financially and technologically capable of assuming systems leadership in a new relatively large cooperative program in the 70- through 110-seat class.

The extremely shrunken helicopter market is too small to provide a secure long-term outlook for all suppliers. In light of the dominant market position of the U.S. manufacturers, a concentration of European capacities seems to be the appropriate solution. Therefore, it is a welcome development that Deutsche Aerospace AG (DASA) has decided, in cooperation with the French Aerospatiale (AS) to take a first step in this direction. The two companies are planning to combine their helicopter activities into a common company Eurocopter. In it, the

German partner is assuming leadership in the lighter class, the French in the heavier class.

This shared enterprise could become an example for other European helicopter manufacturers if it succeeds in providing a coordinated shared palette of products for complete coverage of the market. Together the partners could concentrate in the future on market-oriented sales rather than competing programs.

In light of the importance of government R&D budgets for astronautics, securing the financing for the German participation in the ESA long-term plan and for the domestic space program adopted in 1987 within the orientation framework of the federal government for German space policy is a priority political task. More than two-thirds of the German astronautics budget is dedicated to participation in international programs—primarily within the framework of the ESA. A unilateral German pullout from the ESA programs approved in the ESA ministerial council's conference in the fall of 1987 would not only weaken the technological position of the German aerospace industry but would, above all, also cast doubt on the entire concept of political cooperativeness.

The domestic astronautics program, which promotes first and foremost the utilization of investments made in astronautics, consolidates and supports scientific development in the direction of strong commercialization of space as well. Observation satellites are assuming increasing importance in the verification of arms control agreements and in environmental protection. The coordinator for German aerospace favors consideration of these tasks in the national astronautics plan.

To guarantee the competitiveness of the German aerospace industry, in addition to government support for the development and utilization of space, it is also essential to promote commercial applications of astronautics with equal vigor. This is an area of individual responsibility for the German aerospace industry which it should develop with its rich ideas, but also with the appropriate willingness to take risks. Commercial activities should be expanded beyond the already prospering sector of satellite-supported telecommunications to other fields of activity in earth observation and also increasingly in the use of microgravity. The manufacturing industry and users should increasingly commit themselves in these areas with their own funds.

In the continuing commercialization of satellite-supported telecommunications, the German aerospace industry is also considering participation in the operation and exploitation of the systems—in light of the significant revenues from telecommunications fees. However, for the European market, further deregulation of telecommunications, still reserved primarily for the postal administrations in Europe, is essential.

Government funding should also not be denied to commercialized telecommunications when new communications technologies are being developed in international projects—such as within the framework of the ESA

long-term plan, for example, the current development of optical data transmission through the ESA. Because other ESA governments are participating in this program, the German industry, which has produced significant preliminary work even with its own funds, would be permanently disadvantaged.

In the commercial launcher market, in light of the U.S. competition, all rationalization potentials must be exhausted in Arianespace. To prevent distortions of competition, the full costs for use must be calculated when government-owned launch facilities and mission control centers are used for commercial satellite transportation. It is therefore essential that the ESA member governments and the U.S. government agree soon on common "rules of play" for permitting industrial use of their facilities.

Additionally, competition will be further intensified through the entry of the PRC and the Soviet Union into the market. Pricing policies of the Eastern suppliers, which are unfair because they are not based on cost considerations, must be countered as necessary through appropriate agreements. However, because of the global markets, these agreements should not be concluded in isolation, but rather with close international coordination.

The continued competitiveness of the European launcher industry can only be obtained through drastic reductions in transportation costs. With the model concept Saenger, the German industry is involved as the leader in the technological preparation for such future launch systems which will reduce costs because they will be reusable.

The worldwide engine industry is facing a brilliant outlook for the future because of the rapidly growing market for commercial aircraft, but it also faces new technical challenges. They are defined particularly by environmental protection considerations with regard to low energy consumption, reduced harmful exhausts, and low noise levels.

The short-term goal is the continued enhancement of existing turbofan technologies, primarily in light of increasing environmental consciousness. For the medium term, the improvement of new technologies for advanced ducted-propfan engines as well as the technical preparation of hybrid engines for anticipated supersonic transport planes will have to be continued.

The German engine industry, which has managed to secure a small but relatively undisputed market niche based primarily on military contracts, is taking on the challenges of the civilian market. Recognizing that a strengthening of the market position cannot be accomplished single-handedly, it is pursuing a welcome cooperation strategy jointly with the large engine manufacturers. This already includes European and transatlantic associations. The entry of BMW into the market lends this process a special dynamic.

It is also welcome that potentials for cooperation with the USSR are currently being investigated.

In defense technology, the German aerospace industry must work from a decreasing procurement market. For the German aerospace industry this will depend on being able to economically and technically satisfy the demands for air mobility, reconnaissance, and modern guidance systems as well as "intelligent weapons" determined by defense policy. In particular, new solutions for air- and space-supported earth observation, reconnaissance, and verification must be developed.

The continuation of the development of the European Fighter Aircraft (Jaeger 90) gives the German aerospace industry the capability of connecting with international technical development. The decision about the purchase of the Jaeger 90 will not be made before 1992. The question of whether the Jaeger 90 is to be acquired for the armed forces depends, among other things, on the new defense policy situation. From the standpoint of industrial and technological policy, this program will enable the German aerospace industry to maintain its systems leadership and international cooperation capabilities in fighter plane construction and to strengthen its position in the civilian sector as well. Comparable development projects are also being undertaken in the United States (Advanced Tactical Fighter, ATF), in France (Rafale), and in Sweden (Gripen).

The German equipment industry has good chances to participate in the development of markets for new aerospace systems. Its participation is secured on the one hand through the international cooperation it is pursuing; on the other hand, the federal government is continuing its efforts in the government procurement and aid programs supported by it to guarantee the share of the German equipment manufacturers corresponding to German participation in the programs.

Summary

1. The outstanding characteristics of the aerospace industry compared to other branches of the economy are the intensity of R&D and the high capital requirement along with exceptionally long capital commitment (currently, the development of a new commercial aircraft must be estimated at costs of approximately \$5 billion; it lasts approximately five years; the production program runs for a period of approximately 20 years with sales projections of 600 to 1,000 planes). Capital requirements and capital commitments with low production quantities of aerospace industry products entail extraordinary risks.

2. The secondary role of the German aerospace industry in the worldwide context is discernible not only in the absolute quantitative comparison, but also in its continued minor role in the overall economy—in comparison with the other large industrialized countries.

The significant domestic net product of the aerospace industry in the competing countries is primarily attributable to their well-developed defense activities—with a high export component.

In terms of the number of employees and sales, compared to the other Western industrialized nations, the German aerospace industry is currently in 4th place behind the U.S., Great Britain, and France. The largest German aerospace firm, Deutsche Aerospace AG (DASA), resulting from the merger of Daimler-Benz and MBB, is in 7th place worldwide in the comparison of companies. In Europe, DASA occupies 2nd place behind British Aerospace.

However, in terms of the individual sectors of the aerospace industry—airframes, engines, equipment, and space—because of its greater diversification DASA ranks—even among European companies—far behind the current sector leaders in Great Britain and in France. For example, the French and British companies are two to three times larger in terms of the building of commuter aircraft, helicopters, engines, and satellites.

3. Compared with the leading competitors, the German aerospace industry has a deficit in systems management experience, since the number of relatively large domestic aerospace projects is comparatively small in the Federal Republic of Germany. Systems leadership in engine construction has so far remained completely out of reach. Thus, the German aerospace industry is currently primarily a partner in international cooperative programs (e.g., Airbus, Jaeger 90, PAH 2, Ariane, and Hermes). Only in a few programs has it succeeded in assuming overall systems leadership (e.g., in Columbus). The aerospace industry considers joint systems leadership the most demanding but also the most lucrative form of economic activity. Therefore, competition between national aerospace industries will increasingly become first and foremost competition for system management.

4. In all Western industrialized countries the aerospace industry encounters comparable framework conditions for competition (fully-developed infrastructure, qualified work force, government support of research and development). Special fiscal disadvantages of the German aerospace industry are not discernible. In wages and salaries, but also in productivity, German aerospace industry employees are currently on the top.

5. Distortions of competitiveness are caused primarily by the granting of direct and indirect subsidies. The U.S. aerospace industry has been able, for example, in the development of jumbo aircraft, to always support itself through military development contracts (most recently the MD 11 based on the C 17 troop transport). This is also true for space projects (the space budget of the Department of Defense is twice as large as that of NASA).

With the decision for the Airbus program, the European governments and industrial partners were aware that

long-term chances for the success of the product could only be achieved with the help of direct government funds. Shoring up the Airbus with military jumbo engineering was impossible due to the lack in Europe of the need for troop transport planes.

Since competitiveness of the German aerospace industry was virtually nonexistent in commuter aircraft, there was a need for almost complete assumption of risks by the government for the German share of the Airbus program.

With the help of this backing and considerable subsidies in France, Great Britain, and Spain as well, it was possible to establish the Airbus on the market. The German aerospace industry was in the meantime able to strengthen its competitive position in comparison to the partners, which was finally recognized in the decision for final assembly of the A321 in Hamburg.

Therefore, the opportunity now offers itself to reduce subsidies and to increasingly transfer the remaining risks to the industry itself. With the so-called "new regulation concept" of Airbus financing in the wake of privatization and the takeover of MBB by Daimler-Benz, the gradual transfer of the Airbus program to industrial responsibility has been introduced. In the other partner countries, subsidies are likewise gradually being reduced.

6. In the aerospace industry markets, the cutbacks in defense budgets in the industrialized countries are triggering a new adjustment process. Released capacities are impacting the civilian markets in aviation and to a certain extent in space as well. The German aerospace industry must complete this process unless it wants to jeopardize the competitive position it has achieved. Single-handed national ventures will thus be ruled out in the future because of the costs and risks involved.

In the adjustment process the worldwide development of the market for civilian commercial aviation is working to the benefit of the German aerospace industry. In the continuing emergence of passenger and freight business, a doubling of air traffic must be reckoned with by the year 2000.

6.1. Airbus Industrie, which in the boom year 1989 already obtained a 22-percent share in the orders of commercial aircraft, intends to raise this share to one-third of the world market.

6.2 At present the various national manufacturers in France and Great Britain, but also in the U.S., are drawing up plans for a new supersonic transport plane (successor to the Concorde). The German industry has decided to contribute its skills to the project. Cooperation with Japanese industry is desirable.

6.3 In the commuter aircraft market (up to 100 seats), Fokker (NL) has managed to position itself as a leader. Deutsche Airbus GmbH (formerly MBB) is participating at a rate of 25 percent in the successful F100 aircraft.

The German aerospace industry is currently investigating its market prospects in this segment of the market (75 through 100 seats) and the cooperative strategies necessary for that.

6.4 The sharply curtailed market for helicopters is too small to permit all its suppliers to survive. In light of the predominant market position of the U.S. manufacturers, concentration of European capacities seems to be the appropriate solution. Therefore, it must be considered encouraging that DASA is planning to merge its helicopter activities in a joint company Eurocopter. The objective is to provide a coordinated palette of products for a complete market offering. The German partner is assuming the lead role for the lower weight class, the French for the heavier. Together, the partners will be able in the future to concentrate on market-based sales rather than on competing programs. This cooperation should be open to additional European partners.

6.5 The German engine industry, which has managed to secure a small but relatively undisputed market niche based primarily on military contracts, must increasingly adapt to the challenges of the civilian market. Recognizing that a strengthening of the market position cannot be accomplished single-handedly, it is pursuing welcome cooperations jointly with the large engine manufacturers.

The engine industry on the whole is facing a brilliant outlook due to the rapid growth of commercial air travel; however, it is also facing new challenges. They are defined particularly by environmental protection considerations with regard to low energy consumption, reduced harmful exhausts, and low noise levels.

6.6 In defense technology, the German aerospace industry must work from a decreasing procurement market. For the German aerospace industry this will depend on being able to economically and technically satisfy the demands for air mobility, reconnaissance, and modern guidance systems as well as "intelligent weapons" determined by a new defense policy.

The continuation of the development of the Jaeger 90 gives the German aerospace industry the capability of connecting with international technical development. The question of whether the Jaeger 90 is to be acquired for the armed forces must be decided on the basis of the new defense policy. From the standpoint of industrial and technological policy, this fighter plane program will enable the German aerospace industry to reduce deficits of systems leadership capabilities in all sectors—airframes, engines, equipment—and will provide new developmental potentials for future civilian applications. Comparable development projects are also being undertaken in the United States (ATF), France (Rafale), and Sweden (Gripen).

6.7 In light of the paramount importance of government R&D budgets for astronautics, securing the financing for the German participation in the ESA long-term plan and for the domestic space program adopted in 1987 within

the orientation framework of the federal government for German space policy is a priority political task. A unilateral German pullout from the ESA programs approved in the ESA ministerial council's conference in the fall of 1987 would not only weaken the technological position of the German aerospace industry but would, above all, also cast doubt on the entire concept of German political cooperativeness.

Observation satellites are assuming increasing importance in the verification of arms control agreements, for crisis management, and in environmental protection. The coordinator for German aerospace favors consideration of these tasks in the domestic astronautics plan—as already set forth in his report presented in 1989.

The commercial applications of astronautics must be promoted. This is an area of individual responsibility for the German aerospace industry which it should develop with its rich ideas, but also with the appropriate willingness to take risks. The German aerospace industry is prepared—in light of the lucrative revenues from telecommunications fees—to establish itself as an exploiter of satellite systems. However, it can only do this in the European market if greater deregulation is implemented.

6.8 The German equipment industry has good chances to further improve its market position. It is accomplishing this by itself on the one hand through the international cooperative programs which it has entered. On the other hand, the federal government is continuing its efforts in the government procurement and aid programs supported by it to guarantee the share of the German equipment manufacturers corresponding to German participation in the programs.

List of Abbreviations and Sources

ADL 1	-	Arthur D. Little International: "The Influence of American Expenditures for Defense and Astronautics on Technical and Economic Development" (Report to the BMWi), Wiesbaden 1987
ADL 2	-	Arthur D. Little International: "Analysis of the Market Position and the Development Outlook of German in the Area of Communications Satellite Technology" (Report to the BMWi), Wiesbaden 1990
AI	-	Airbus Industrie
AIA	-	Aerospace Industries Association of America Inc., Washington
ANT	-	ANT Nachrichtentechnik GmbH (Bosch Telekom)
AS	-	Aerospatiale
ATF	-	Advanced Tactical Fighter
AVData	-	Aviation Data, East Murdock, Kansas
BAe	-	British Aerospace
BDLI	-	Federal Association of the German Aviation, Astronautics, and Equipment Industry e.V.

BIP	-	Grossdomesticproduct	GE	-	General Electric, Inc.
BMFT	-	Ministry for Research and Technology	GIE	-	European Interest Group
BMVg	-	Ministry of Defense	IEPG	-	Independent European Program Group
BMWi	-	Ministry for Economics	INTA	-	National Institute of Aerospace Technology [Spain]
BSP P	-	Gross national product (GNP)	ISN	-	International Social-Political Information
BWB	-	Federal Office for Military Engineering and Procurement	KoorLR	-	Working group of the Coordinator for German Aerospace in the Federal Ministry for Economics
CASA	-	Construcciones Aeronauticas S.A., Madrid	LRI	-	Aerospace Industry
CIRA	-	Italian Aerospace Research Center	MBB	-	Messerschmitt-Boelkow-Blohm GmbH
CNES	-	National Center for Space Studies [France]	MDC	-	McDonnell Douglas Corp.
DA	-	Deutsche Airbus GmbH	MECU	-	Million European currency units
DASA	-	Deutsche Aerospace AG	MTU	-	Motoren- und Turbinen-Union GmbH
DIW	-	German Institute for Economic Research, Berlin: "The German Aerospace Industry: Status and Outlook," Kurt Hornschild, et al. Frankfurt/New York 1988	NASA	-	National Aeronautics and Space Administration
DLR	-	German Aerospace Research Facility e.V.	NASDA	-	National Space Development Agency, Japan
DOD	-	Department of Defense	NASP	-	National Aerospace Plane
ECU	-	European currency unit	NLR	-	National Aviation and Astronautics Laboratory, the Netherlands
EFA	-	European Fighter Aircraft (Jaeger 90)	ONERA	-	National Office for Aerospace Studies and Research, France
EG 1	-	Commission of the European Communities: "The European Aerospace Industry—Trading Position and Figures," Brussels, 1990	PW	-	Pratt & Whitney
EG 2	-	Commission of the European Communities: "First Report on the Status of Science and Technology in Europe," Brussels, 1989	RAE	-	Royal Aeronautical Establishment
ESA	-	European Space Agency	RR	-	Rolls Royce
EUROCON-SULT	-	European Economic Research and Consulting Group on High Tech Industries	SAAB	-	Svenska Aeroplan AB
EUROSPACE	-	European Industrial Space Study Group	SNECMA	-	National Aircraft Engine Research and Manufacturing Company
EUROSTAT	-	Statistical Office of the European Communities	TRW	-	Thompson Ramowoldrige Inc.
FuE	-	Research and Development	TST	-	Telefunken Systemtechnik GmbH
GATT	-	General Agreement on Tariffs and Trade	UIMM	-	Union of the Metal and Mining Industries
			VDO	-	VDO Luftgeraetewerk—Adolf Schindling GmbH
			WEM	-	Western European Metal Trades Employers' Organization

Appendix 1
European Companies Compared to Each Other 1988

	Federal Republic of Germany	France	Great Britain	Italy	The Netherlands	Sales (MECU)	Employees	Productivity (MECU/Empl.)
1.			BaE			6,117	84,900	0.075
2.		Aerospatiale				3,979	32,626	0.122
3.		Thomson-CSF				3,964		
4.	MBB (DASA)					3,429	39,886	0.086
5.			Rolls-Royce			2,960	40,900	0.072
6.		Dassault				2,511	13,818	0.182
7.		SNECMA				1,459	13,482	0.108
8.				Aeritalia		1,079	14,177	0.076

Appendix 1
European Companies Compared to Each Other 1988 (Continued)

	Federal Republic of Germany	France	Great Britain	Italy	FThe Netherlands	Sales (MECU)	Employees	Productivity (MECU/Empl.)
9.	TST (DASA)					1,012	11,180	0.091
10.		Matra				966	4,747	0.203
11.					Fokker	879	11,610	0.076
12.	Dornier (DASA)					755	9,178	0.082
13.	MTU (DASA)					707	7,787	0.091
14.				Agusta		668	9,888	0.068
15.			Westland			530	9,231	0.057
16.		SEP				518	6,144	0.125
17.				Selenia		478	6,716	0.071
18.				Fiat Aviazione		370	4,755	0.078

Source: EC 1; DASA

Appendix 2
European Companies Compared Worldwide 1988

	Federal Republic of Germany	France	Great Britain	U.S.	Japan	Sales (MECU)	Employees	Productivity (MECU/Empl.)
1.				Boeing-Group		14,429	126,000	0.115
2.				MDC		11,326	109,400	0.104
3.				GE		10,863		
4.				UTC		9,329	46,000	0.138
5.				Lockheed		9,008	86,000	0.105
6.			BAe			6,117	84,900	0
7.	DASA					5,903 ¹	68,031 ¹	0.087 ¹
8.				GM-Hughes		5,967 ²		
9.				Northrop		4,931	(46,000) *	(0.107) *
10.				General-Dyn		4,545		
11.		Aerospatiale				3,979	32,626	0.122
12.		Thomson CSF				3,946 ²		
13.				Raytheon		3,912 ²		
14.	(MBB = 3,429 MECU)			Martin Marietta		3,847	(33,084)	0.116
15.	(MBB = 3,429 MECU)			Rockwell Int		3,378	32,574	0.104
16.			Rolls Royce			2,960	40,900	0.072
17.		Dassault				2,511	13,818	0.182
18.				Grumman		2,248	32,000	0.070
19.					Mitsubishi HI	2,061	(6,300) *	(0,327) *

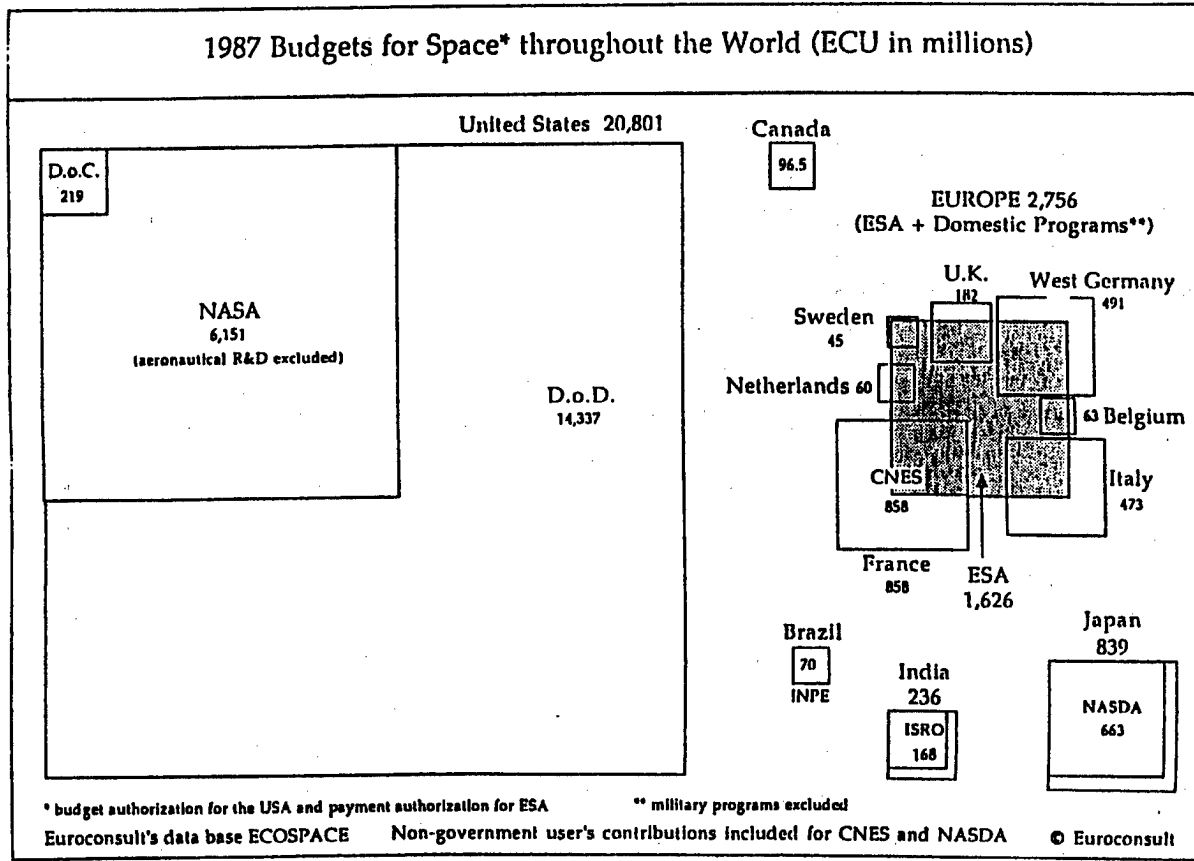
1 Addition of company data for MBB, Dornier, MTU, and TST (DASA was not founded until 1989)

2 Thomson CSF

*EC Estimate

Source: EC 1; Thomson CSF; DASA

Appendix 3



Appendix 4

German Federal Expenditures for Aviation and Astronautics (in DM millions)

	1984	1985	1986	1987	1988	1989
1. Civilian Aviation Projects	485	569	530	535	559	721
Aviation Research & Technology (BMFT)	176	165	166	182	170	204
Development (BMW)	252	363	345	338	375	504
Financing of Sales	57	41	19	15	14	13
2. Defense Materials Aviation	7,313*	7,013*	7,329*	7,839*	7,872*	7,560*
Research & Technology	163	203	255	307	288	244
Development	665	1,032	981	1,267	1,156	1,328
Procurement	5,287	4,538	4,723	4,765	4,778	4,238
Materials Maintenance	1,198	1,240	1,370	1,500	1,650	1,750
3. Astronautics (BMFT, BMP, BMV)	985	1,212	1,279	1,354	1,389	1,466
ESA	367	414	559	640	644	713
Domestic Projects including DLR	618	798	720	714	745	753
Totals 1 -3	8,783	8,794	9,138	9,728	9,820	9,747

*Projected figures

Source: BMWi-KoorLR

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