

DOCUMENTED BRIEFING

RAND

From National Champions to European Heavyweights

*The Development of European
Defense Industrial Capabilities
Across Market Segments*

Katia Vlachos-Dengler

National Defense Research Institute

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Katia Vlachos-Dengler

*Prepared for
the Office of the Secretary of Defense*

DB-358-OSD

National Defense Research Institute

The research described in this briefing was sponsored by the Office of the Secretary of Defense (OSD). The research was conducted in RAND's National Defense Research Institute, a federally funded research and development center supported by the OSD, the Joint Staff, the unified commands, and the defense agencies under Contract DASW01-01-C-0004.

ISBN: 0-8330-3175-9

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Published 2002 by RAND
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
201 North Craig Street, Suite 202, Pittsburgh, PA 15213-1516
RAND URL: <http://www.rand.org/>

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PREFACE

As in many other industrial sectors, current trends in the world's aerospace and defense industries are pointing toward increased globalization. Defense firms on both sides of the Atlantic are looking to increase access to each other's markets through collaborative ventures, teaming arrangements, or outright acquisitions, among other activities. Their moves are driven primarily by dramatically reduced defense budgets and spiraling weapons systems costs. At the same time, governments are responding to these industrial developments with initiatives to reform their administrative and regulatory mechanisms (such as their controls on exports and foreign investment and their technology transfer regulations) in order to facilitate transatlantic collaboration, while also addressing concerns and challenges related to security, competition and innovation, technology sharing, reciprocal market access, and other issues.

Enhancing competition among and interoperability with coalition partners is one of the stated policy objectives of the sponsor of this study, the Office of the Deputy Under Secretary of Defense, Industrial Policy (DUSD/IP) (www.acq.osd.mil/ip/ip.html). This objective can be achieved through transatlantic industrial collaboration with reliable industrial firms in countries that have policies congruent with those of the United States. In the context of this policy objective, the structure of and current and projected developments in the European defense and aerospace industry are of particular importance. The transformation of the European defense industry can affect the potential for industrial linkages among firms on both sides of the Atlantic that seek to compete effectively in both European and U.S. markets and that may wish to share technology that is subject to security safeguards.

This documented briefing summarizes RAND's research conducted for the DUSD/IP on the current structure of the European defense market. The analysis focuses on key segments (platforms and major subsystems) of this market, identifying major industrial players in each segment as well as significant market trends. This briefing is part of a continuing research project by RAND on assessing the European defense market and related transatlantic issues. It should be relevant to policymakers and analysts interested in understanding current developments in the

European defense industry and their potential implications for transatlantic collaboration.

This study was conducted for the Office of the Deputy Under Secretary of Defense, Industrial Policy within the Forces and Resources Center of RAND's National Defense Research Institute (NDRI). NDRI is a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the unified commands, and the defense agencies.

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SUMMARY

Current trends in the world's aerospace and defense industries are pointing toward increased globalization. Defense firms on both sides of the Atlantic are looking to increase access to each other's markets through collaborative ventures, teaming arrangements, acquisitions, and other activities.

For the initial stage of RAND's analysis of the European defense market, this briefing focuses on the five countries that host the largest defense industries in Europe: the United Kingdom (UK), France, Germany, Italy, and Spain. Additional important European players, including Sweden, Norway, and the Netherlands, are being examined by RAND in a follow-on phase, documentation of which is scheduled for late 2002.

THE TREND TOWARD CONSOLIDATION

Consolidation in the European defense market has led to the emergence of three dominant industrial players—BAE Systems, EADS (European Aeronautic Defence and Space Company), and THALES (formerly Thomson-CSF)—who participate in most market segments. This is a general trend, although some segments are more consolidated than are others. For example, the aerospace and missile segments are much more consolidated than the land systems and naval shipbuilding segments.

Consolidation in the European defense industry has followed three distinct models, which are represented by different firms' growth strategies:

1. Consolidation by government acquiescence to the creation of a national "champion," such as the merger of British Aerospace and GEC Marconi that gave rise to the all-British giant BAE Systems.
2. Consolidation at the European level, such as in the case of EADS, created by the merger of the German firm DaimlerChrysler Aerospace (DASA), the French firm Aérospatiale Matra, and the Spanish firm CASA.
3. Expansion of an individual firm through acquisition and integration of smaller businesses while maintaining the core "vehicle" (i.e., the parent company). This model best describes THALES' growth

strategy. The only exception to the French company's strategy so far is its acquisition of Racal Electronics, a relatively large company compared with THALES' other acquisitions.

European firms have become more visibly competitive in the world defense market. BAE Systems is among the leading defense contractors globally, in terms of defense revenues, following its acquisition of Lockheed Martin Aerospace Electronics Systems in 2000. Other European companies are also well positioned in the global market, with EADS and THALES ranked seventh and eighth in defense revenues. Nevertheless, European companies lag American ones in terms of overall size, at least in the top tiers. The three largest European defense players represent a combined turnover of \$22 billion, while the top three U.S. players represent more than double that amount, \$49 billion. European companies may be smaller, but they are quite solid financially, with good debt net cash positions, satisfactory profitability compared with U.S. firms, and relatively good capital market performances. However, in a rough comparison of market shares, U.S. firms seem to dominate in sales in all market segments except land systems.

Key challenges currently facing the European defense market include the future of intra-European and transatlantic consolidation, the ability of European players to achieve successful rationalization and integration of their acquisitions, and the strength of government demand and budgeting for defense goods.

The future of consolidation in the European defense market is also affected by the progress of efforts to build a common European security and defense policy (ESDP) and the defense capability to support it. The future of ESDP will be a critical determinant of the structure of the European defense industry, potentially affecting the viability of European defense firms and their progress toward consolidation and integration.

MARKET SEGMENT ANALYSIS

The market segments examined in this documented briefing include the following: under platforms—fixed-wing military aircraft, helicopters, unmanned aerial vehicles (UAVs), missiles, land systems, shipbuilding, and space; under subsystems—propulsion, defense electronics (with particular emphasis on radar/sonar and electronic warfare), and landing systems. After performing a market-segment analysis, the following general observations emerge:

- In the European defense industry today there are a handful of global players whose interrelated programs represent a highly interdependent matrix of design, manufacturing, and distribution activities and capabilities (as seen from the matrix in Appendix A). Specifically:
 - Structural relationships among players are extremely complex, justifying their being characterized as “the European spaghetti bowl.” There is a multitude of cross-shareholding relationships, joint ventures, and consortia, often formed around specific programs but occasionally evolving into more permanent structures.
 - Despite this apparently complex structure, the same industrial players are active in most market segments and are present in many different forms: either as single corporate entities or, through their stakes in other players or through mergers, structural or program-specific alliances, joint ventures, or other types of linkages. Exceptions to this phenomenon are the land systems and shipbuilding segments, which remain very fragmented and are characterized by a sharing of the market among a number of important players (without a clear market leader) and several smaller or niche players.
- The aerospace sector, which includes the market segments of fixed-wing military aircraft, helicopters, and space, is the most concentrated among European defense market segments, whereas the land systems and naval shipbuilding segments are the most fragmented. Missiles and defense electronics fall somewhere in between those segments. Although some segments have more potential, and need, for consolidation than others, consolidation may not always follow market rules for a number of political and industrial reasons. Those factors include the desire to preserve a national industrial base, national security interests, and domestic employment concerns. These considerations are part of the reason why the land systems and shipbuilding segments have remained fragmented to this day.

In addition, some segment-specific observations can be made:

- The military aircraft segment is dominated by BAE Systems, which takes part in almost all European product offerings (except for the French Mirage and Rafale combat aircraft). BAE is also the most active in terms of transatlantic business activities: 31 percent of its revenues

in 2000 were linked to the U.S. market following a series of acquisitions of U.S. companies and participation in several transatlantic programs.

- European firms captured 30 percent of the global military aircraft market in 1998 (compared with 55 percent for U.S. firms), although these relative figures are projected to change as new European programs (Eurofighter, Gripen, and Rafale) come into production. Specifically, industry analysts project a European fighter market "renaissance" over the next decade as European producers become more-significant players in the global market. Decisions with respect to major U.S. programs will inevitably affect these projections.
- The helicopter segment is concentrated around two dominant firms—Eurocopter and Agusta Westland—and is likely to remain that way. The market outlook over the next ten years is generally positive, but growth will be slow.
- UAVs are a potential growth market, reflecting a desire to improve Europe's gaps in military surveillance and reconnaissance capability, made more apparent during the Kosovo air campaign in 1999.
- Missiles are another high-growth market segment. There is a clear European leader, MBDA,¹ which is also the second biggest player globally behind Raytheon. MBDA is challenged by THALES, the second-largest European company in this segment. Consolidation in the missile segment is ongoing, with a number of small players currently in the process of integrating themselves into one of the larger structures.
- The land systems segment is characterized by fragmentation and overcapacity, although there are indications that further consolidation may be on its way. One of the key challenges for this segment is the changing market: the move toward lighter, more mobile vehicles, which are not part of the major European manufacturers' core skills. As a result, European manufacturers find themselves in an unfavorable financial situation and are under pressure to adapt quickly to the changing demands of the market if they want to survive. Additional pressure on European land systems manufacturers is

¹MBDA—formerly called Matra BAe Dynamics—combines the missile businesses of Aérospatiale Matra (now part of EADS) and BAE Systems, and it will soon integrate Alenia Marconi Systems (a company jointly owned by BAE and Finmeccanica).

created by the increasing involvement of American firms in the European land systems market segment. These U.S. firms are very interested in penetrating the European market and exploiting the efficiency and productivity gains to be made through acquiring or linking up with these European firms.

- Shipbuilding is also very fragmented and organized around national markets, which are dominated by national champions heavily dependent on domestic demand. Notable exceptions are a few efficient niche producers that manage to dominate their respective subsegments, such as the German submarine manufacturer HDW. A noticeable trend in the shipbuilding segment is the importance of systems integration and prime contractor capabilities in delivering competitiveness. Governments progressively expect complete systems to be provided to them by systems integrators, who are able to control key subcontracts and assume the entire risk of the program.
- The big three European players are also present in the space market through the two leading companies in that segment: Astrium (75 percent owned by EADS and 25 percent owned by BAE Systems) and Alcatel Space (49 percent owned by THALES). European manufacturers are particularly active and gaining market share against their American counterparts in the commercial satellite segment, largely due to constraints from export regulations on the U.S. side.
- Rolls-Royce is the market leader and SNECMA the major market player in the European propulsion segment, while a number of smaller players will likely be integrated eventually with one of the two big players. The segment is quite competitive, growing (driven mostly by its commercial side), and characterized by a strong transatlantic element.
- In defense electronics, BAE Systems is the leader (in sales), with THALES a close second player in many areas, particularly radar and sonar. The creation of structural alliances, such as the joint venture between THALES and Raytheon, is seen by many in the European defense industry as a potential model for the future of transatlantic collaboration.

EUROPEAN DEFENSE MARKET DRIVERS

Several driving forces shape the structure of the European defense market. These drivers refer to both the demand side and the supply side of the industry and include the following:

1. Current and projected demand, distinguishing between
 - trends in budgets and spending, for equipment procurement and research and development (R&D), and
 - trends in demand for particular types of platforms and subsystems.

There is a significant gap between Europe and the United States in spending on equipment procurement and R&D. The U.S. procurement budget is about 2.5 times larger than the European one, while the corresponding relationship is four-to-one in the case of R&D budgets. Unless European governments decide to increase their budgets and target their spending more efficiently, this gap could increase the risk both for Europe's current capabilities (funded by equipment budgets) and for its future capabilities (funded by R&D budgets).

2. Company strategic orientation and business models.

This factor refers to defense firms' strategies with respect to product choice, their role in the industry (for example, systems integrator or niche producer), targeted markets, and other issues.

Systems integration is an important trend affecting European defense producers. As defense customers (governments) increasingly expect defense contractors to provide them with complete systems, systems capability becomes a key resource necessary to integrate the many diverse materials and technologies that constitute modern platforms and defense systems in general.

In terms of business models, each of the three big European defense companies has followed a different development path. BAE Systems has focused on becoming a systems integrator, while emphasizing transatlantic links and access to the U.S. market. EADS on the other hand, has been more of a "European company" with a complex management structure and a still unclear degree of defense (versus civil) orientation. Finally, THALES has followed a "multi-domestic strategy" by acquiring small and medium-sized companies abroad and producing locally with them, building up a domestic identity for itself

in the process. THALES has a big presence in Europe but is also very interested in the U.S. market, the most notable example of that interest being the recent creation of a structural alliance (joint venture) with Raytheon.

3. Technological trends and projected focus of future investment for both European governments and industry.

Europeans claim to have a technological or developmental edge in certain areas (for example, stand-off weapons, missiles, next-generation fighter aircraft), but they are often put at a disadvantage versus their U.S. competitors due to small production runs and limited government R&D funding.

4. Capabilities in the civil market, which could have extensive impact on military industry developments.

Airbus is often cited as exemplifying the potential for synergies between the civil and military markets, but the uncertain budget, timing, and specifications of the A400M military transport aircraft program leave such synergies unrealized at present.

5. Developments in the U.S. market, particularly with respect to the funding of future military programs such as the Joint Strike Fighter (JSF) combat aircraft or changes in the regulatory environment.

THE IMPACT OF SEPTEMBER 11

Defense establishments on both sides of the Atlantic are likely to be affected by the terrorist attacks of September 11, 2001. Unlike the situation with the airline industry, the September 11 events did not have an immediate impact on the aerospace and defense industry. Nevertheless, the effects experienced by the commercial aerospace firms gradually are cascading into the aerospace and defense sector. According to some analysts, this sector could be significantly affected by the terrorist attacks in the next two to five years.²

The impact of the September 11 events can be felt by both the demand side and the supply side of the market and in both the short term and the long term.

²Heath, Bill, "Security Measures Take Center Stage in Aerospace and Defense Industry," EDS Manufacturing Global Industry Group, www.eds.com/about_eds/homepage/home_page_911_heath_assess.shtml (last accessed April 3, 2002).

On the demand side in the short term, a change in threat perceptions has had a significant impact on defense spending:³ The United States is leading the trend, of course, but European governments are likely to follow by potentially increasing spending, particularly on counter-terrorism and security.⁴ These spending increases, however, are likely to be limited geographically (for example, only in specific countries such as Britain, France, and Germany) and in scope (increased spending only for particular types of capabilities, rather than across the board).

On the demand side in the medium and long term, in the aftermath of the attacks and learning from the experience of the war in Afghanistan, Western militaries are expected to increase purchases of certain types of weapons systems and military equipment. These include, among others, missiles and ammunition, particularly precision-guided bombs; defensive electronics and other equipment (such as countermeasures systems) to improve the survival chances of helicopters and transports; radars and sensors; UAVs and unmanned aerial combat vehicles (UCAVs), particularly high-altitude UAVs and UCAVs; rotary-wing aircraft to offer rapid reaction mobility; and communications and command and control equipment.

This new situation could also fundamentally change the supply side of the market—defense production and the structure of the industry—on both sides of the Atlantic. As defense budgets rise after September 11 and demand for certain types of systems increases, the contractors that produce such systems are likely to increase their revenues and profits.⁵ European companies that are expected to benefit from a buildup include small niche players, particularly UK-based but also other continental firms, specializing in areas such as data analysis, electronic warfare and detection equipment, and countermeasures against biological and

³According to Loren Thompson, defense analyst with the Lexington Institute, "The whole mind set of military spending changed on Sept. 11. The most fundamental thing about defense spending is that threats drive defense spending. It's now going to be easier to fund almost anything." (Berrigan, Frida, "The War Profiteers: How Are Weapons Manufacturers Faring in the War?" World Policy Institute, December 17, 2001, www.worldpolicy.org/projects/arms/updates/profiteers121701.html (last accessed April 23, 2002).

⁴Pfanner, Eric, "Europe Assesses Collateral Damage," *International Herald Tribune*, September 21, 2001.

⁵These trends will be more pronounced in the United States, and their impact on Europe will vary among European countries depending on the extent of their participation in U.S. operations.

chemical warfare. Furthermore, given the trends in the market, some companies with a diversified business base (both civil and defense) may experience greater incentives to focus more closely on their defense business.

Finally, a broad coalition against terrorism might deepen industrial links across the Atlantic, based on existing collaborative structures between American and European defense companies. At the same time, however, collaboration may be impeded by potentially tighter American security and export controls out of fear that American technologies may leak through European countries to "grey countries."⁶

FOLLOW-ON RESEARCH

The research findings from this phase of the RAND study of the European defense market will build a base for potential follow-on research and analysis, which may concentrate on the following tasks:

- Extending the analysis to include players from other European countries, such as Sweden, Norway, and the Netherlands.
- Performing a more in-depth analysis of the main industrial players and their capabilities.
- Projecting the structure of the European defense market over the next three to five years by examining both demand-side and supply-side factors.

Key issues that could be addressed in such a follow-on phase include the progress of European defense consolidation; the relationship among consolidation, rationalization, and integration; the balance between trends toward specialization versus diversification; and the sources of innovation in the defense market.

⁶"The Defence Industry's New Look," *The Economist*, October 8, 2001.

ACKNOWLEDGMENTS

This document has benefited from the insights and contributions of many. Over the course of this research, I spoke with several people whose comments and suggestions have strengthened the final product considerably. In particular, I would like to thank the following people: from the defense industry, Bernard Rétat, Brian Phillipson, Patrick Guerin, Pierre Bayle, Michael J. Bell, and Philippe Humbert; from the research and analysis community, Keith Hayward, Burkard Schmitt, Guillaume Parmentier, Yves Boyer, Trevor Taylor, John Dowdy, Byron Callan, Andrew Clifton, Heinz Schulte, Philippe Gossard, Francis Tusa, Christina Mackenzie, and Giovanni de Briganti; and finally, from the French Délégation Générale de l'Armement (DGA), Philippe Coq. I would also like to thank Adrian P. Kendry and Greg Hildebrandt for their very thoughtful reviews of an earlier version of the manuscript. Despite these contributions, the responsibility for any omissions or errors rests solely with the author.

Overview
• Research objectives and scope • Industry overview • Analysis by market segment — Platforms — Selected subsystems • Market drivers and projected trends • Directions for follow-on research
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OVERVIEW

This documented briefing analyzes the European defense market by focusing on distinct market segments, which comprise major platforms and selected subsystems.

This document is divided into four parts:

- After establishing the broad objectives of RAND research on the European defense market as well as the specific goals and scope of this particular project, the first part of the briefing provides an overview of the European defense industry, its key characteristics, and a broad comparison with the U.S. defense industry.
- The second part of this briefing presents an analysis by industry segment, concentrating on major platforms and selected subsystems. Each market segment is characterized by some firms that act as market leaders, others that are less dominant but still major market players, and minor or niche players. The structural relationships and linkages among industrial players can be quite complicated, and may differ by

segment. Furthermore, each market segment is characterized by varying degrees of concentration and by distinct trends.

- The third part of this document sets the stage for projecting the structure of the European defense market in the near term. This projection is accomplished through the identification of the key driving forces behind the structure and performance of the European defense market today.
- The concluding part of this briefing offers suggestions for related follow-on research on the European defense market.

Broad objectives of RAND research on the European defense market
• Establish and analyze the current structure of the European defense market: players, capabilities, and innovative potential • Project the structure of the European defense market in the next three to five years • Identify implications of developments in the European defense market for transatlantic collaboration and enhanced equipment interoperability
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RESEARCH OBJECTIVES AND SCOPE OF THIS BRIEFING

BROAD OBJECTIVES OF RAND RESEARCH ON THE EUROPEAN DEFENSE MARKET

One of the primary objectives of RAND's research on the European defense market is to assess its current structure; that is, to identify the key players and to evaluate their capabilities, potential for innovation, competitiveness, and ability to build the next-generation weapon systems.

In addition to the examination of current conditions in the European defense industry, RAND is also interested in making projections for the near term (the next three to five years) of that industry by establishing the main drivers behind the current structure of the European defense market and by estimating the likely evolution of these driving factors and their potential impact on the existing defense market structure.

Finally, an important part of this research and of RAND's general interest in the European defense market is linked to the impact of European

developments on transatlantic cooperation and interoperability. Specifically, it is of interest to study and evaluate the potential effects of different European industrial scenarios on transatlantic developments and the impact of different types of transatlantic linkages on interoperability.¹

¹In addition to documentation from public sources, other documentation for this briefing includes reports and data from industry analysts, financial services firms, and consulting firms specializing in the field of defense and aerospace. Among these sources are Merrill Lynch, Credit Lyonnais, Deutsche Bank, Lehman Brothers, the Teal Group, and Forecast International. Because a significant part of the material supplied by these sources consists of estimates and projections regarding the structure of the defense and aerospace industry or the performance of its participants, a note about the reliability of such sources is necessary. Most of these organizations have been in existence for a number of years, are widely recognized in their field as reliable sources of analysis, and receive high fees for the high quality of their services. Many of these firms, and the financial services firms in particular, are also active (and well-respected) sources of analysis in fields other than defense and aerospace.

Objectives and scope of this briefing

Objectives

- Analyze the European defense market by market segment:
 - Rank European players by segment
 - Clarify structural relationships among them and identify transatlantic links
 - Provide insights into current and future developments and trends by segment
- Identify broad market drivers and major trends
- Lay out potential directions for future research

Scope

- Countries of interest: United Kingdom, France, Germany, Italy, Spain

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OBJECTIVES AND SCOPE OF THIS BRIEFING

The primary objective of this documented briefing is to present an analysis of the European defense market by segment. The research presented in this briefing also identifies some broad driving factors that characterize the European defense market as a whole and that could be used to make projections about its structure over the next three to five years. Finally, this briefing suggests some directions for follow-on research on the European defense industry within the framework of this project, which is sponsored by the Office of the Deputy Under Secretary of Defense, Industrial Policy. Key countries examined in this initial stage of RAND's analysis of the European defense market are the five biggest European producers—the United Kingdom, France, Germany, Italy, and Spain. RAND will examine additional significant players, including Sweden, Norway, and the Netherlands, in a follow-on phase of the research scheduled for later in 2002.

Industry overview: A complex structure with three shapers
Characteristics • Three big players as a result of consolidation — BAE Systems — EADS — THALES • A complex ownership structure: the “European spaghetti bowl” • Different paths to consolidation
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PART I INDUSTRY OVERVIEW: A COMPLEX STRUCTURE WITH THREE SHAPERS

Consolidation in the European defense market over the past decade has led to an industry structure with three dominant players overall and some smaller niche players in particular segments. The “big three” are BAE Systems, EADS (European Aeronautic Defence and Space Company) and THALES (formerly Thomson-CSF). Some of the smaller players are GKN and Rolls-Royce of the United Kingdom (UK), Saab of Sweden, and Finmeccanica of Italy.

The current state of the defense market in Europe could be described as a “European spaghetti bowl.” This description refers to the post-consolidation ownership structure of the European armaments industry, which is very complex, with innumerable cross-shareholdings, segment- and program-specific joint ventures, consortia, and other legal arrangements. Despite this complex picture, the three big players just

mentioned constitute the poles around which most European defense activity revolves because they are involved—either as individual companies or through joint ventures, consortia, or other alliances—in almost all major segments of the European defense market.

Different European players have followed diverse paths to consolidation and growth. Currently, one can distinguish three such approaches or models:

1. Consolidation by state consent to the creation of a national “champion,” such as the merger between British Aerospace and GEC Marconi, giving rise to the all-British giant BAE Systems.
2. Consolidation at the European level, such as in the case of EADS, created by the merger of the German firm DaimlerChrysler Aerospace (DASA), the French firm Aérospatiale Matra, and the Spanish firm CASA.
3. Expansion of an individual firm through acquisitions of smaller businesses, while maintaining the core “vehicle” (i.e., the parent company). This model represents the strategy followed by THALES so far with the exception of its acquisition of Racal Electronics, which is a relatively large company compared with THALES’ other acquisitions.

General observations on the European defense industry
• Systems integration is a trend—BAE Systems leads the way; THALES and EADS follow • BAE becomes the largest defense company in the world following its acquisition of Lockheed Martin Aerospace Electronics Systems • Of the top 100 defense companies in the world: — The United States has 50 companies, with a 63% share of world defense revenues — The UK has 10 companies, with a 14% share — France has 7 companies, with a 8.6% share — Germany has 3 companies, with a 1.4% share
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GENERAL OBSERVATIONS ON THE EUROPEAN DEFENSE INDUSTRY

Systems integration is a trend that first became apparent in the American defense industry and now is reaching Europe. BAE Systems is currently the leading European contractor capable of the full range of defense platform development and systems integration activities. It is at the same time the most vertically integrated among European prime contractors and has the most expansive activities and expertise in different capabilities and domains. Among other big European defense companies, THALES also is positioning itself gradually as a systems integrator, while EADS also shows signs of moving in that direction.

Up to the end of 2000, BAE was the world's third-largest defense contractor behind Lockheed Martin and Boeing in terms of defense revenues. According to some sources, after BAE's purchase of Lockheed Martin Aerospace Electronic Systems (LMAES),¹ the British prime

¹LMAES includes the Sanders Electronic Warfare, reconnaissance, surveillance, and intelligence systems unit.

contractor moved to the number-one position globally. By 2001, however, BAE fell to the fourth position, overtaken by Raytheon.²

In a comparison of global defense industrial capabilities and market shares, of the top 100 defense companies in the world for the year 2000,

- 50 of the companies are American and have a 63 percent share of world defense revenues³
- 10 are British, with a 14 percent share
- 7 are French,⁴ with an 8.6 percent share
- 3 are German, with a 1.4 percent share.

A similar comparison from the year before⁵ reveals that the shares of the major players have not changed significantly since 1999:

- The United States had 43 of the top 100 firms, with 63 percent of world defense revenues.⁶
- The United Kingdom had 9 the top 100 firms, with a 14 percent share.
- France had 7 the top 100 firms,⁷ with a 9 percent share.
- Germany had 3 the top 100 firms, with a 1.5 percent share.

²The rankings are based on the *2001 Defense News Top 100*, www.defensenews.com/current/top100/2001chart1.html (last accessed April 4, 2002).

³This figure uses the top 100 defense companies as representative of "world defense revenues" (*2001 Defense News Top 100*).

⁴EADS is counted as a French company in the *2001 Defense News Top 100*.

⁵The top 100 for 2000 are based on 1999 defense revenues.

⁶The top 100 defense companies are used as representative of "world defense revenues." Figures are based on the *2001 Defense News Top 100*.

⁷Again, EADS is counted as a French company.

Global defense industry ranking, 2000

Rank	Company	Country	2000 defense revenues (\$bn)
1	Lockheed Martin	US	18.0
2	Boeing	US	17.0
3	Raytheon	US	14.0
4	BAE Systems*	UK	13.2
5	General Dynamics	US	6.5
6	Northrop Grumman	US	5.6
7	EADS	FR/G/Sp	4.6
8	THALES	FR	4.3

* Includes recent Lockheed Martin purchases
Source: 2001 Defense News Top 100

NOTE: European companies are shown in boldface.

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GLOBAL DEFENSE INDUSTRY RANKING, 2000

The table above presents the leading firms in the global defense market in the year 2000, ranked in terms of their defense sales.

By including the recent acquisition of LMAES in BAE Systems' sales figures, BAE ranks fourth in the world (compared with ranking third the previous year). Other European companies positioned among the top players are EADS (ranked seventh), with only one-third of BAE's defense revenues, and THALES (ranked eighth) with even lower, comparatively, defense turnover.⁸

⁸The terms "sales," "revenues," and "turnover" are used interchangeably here and in the following illustrations.

European defense industry ranking, 2000

Rank	Company	Country	2000 defense revenues (\$bn)
1	BAE Systems	UK	13.2
2	EADS	FR/G/Sp	4.6
3	THALES	FR	4.3
4	Rolls-Royce	UK	2.2
5	Smiths Industries	UK	1.7
6	GKN Group	UK	1.4
7	DCN Group	FR	1.2
8	Finmeccanica	IT	1.2

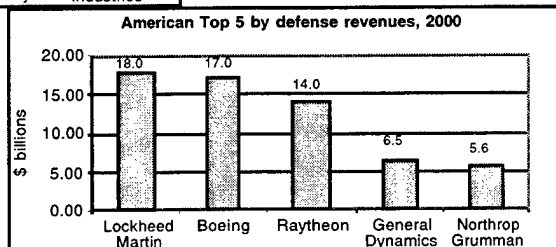
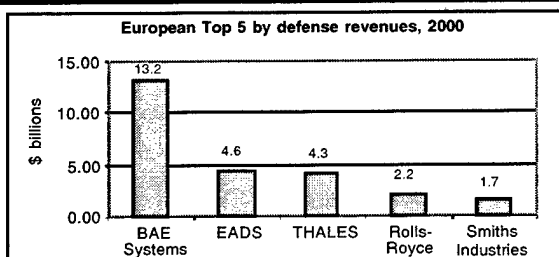
Source: 2001 Defense News Top 100

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EUROPEAN DEFENSE INDUSTRY RANKING, 2000

The table above shows the ranking of defense players within Europe, as measured by their defense revenues in the year 2000. BAE Systems is the European leader. The three major European players—BAE Systems, EADS, and THALES—are involved in almost all major segments of the European market.

Europe lags the United States in size



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EUROPE LAGS THE UNITED STATES IN SIZE

In terms of overall size, as measured by defense sales, European companies lag American ones, at least in the top tiers (manufacture of platforms and major systems). However, as discussed later in this documented briefing, the relative picture varies by market segment. Of the top European and U.S. companies, the three largest European defense players represent a combined turnover of \$22 billion, whereas the top three U.S. players represent more than double that amount, \$49 billion (see the following table).⁹

	Revenue of Top Three Firms (2000 revenues, \$bn)	Revenue of Top Five Firms (2000 revenues, \$bn)
Europe	22.07	25.95
United States	49.03	61.18

⁹Data are from the 2001 *Defense News Top 100*.

Solid financially but room to improve in value creation

Overall, European companies have

- Good debt net cash positions
- Satisfactory profit margins, compared with U.S. firms
 - Average EBIT margin in Europe 7–8% versus 15% in the United States (but difference is largely due to self-financed R&D)

European capital market performance has been satisfactory

- The performance of European defense and aerospace stocks experienced a 5% increase between January and November 2000, although the sector still underperforms its U.S. peers by 5%

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SOLID FINANCIALLY BUT ROOM TO IMPROVE IN VALUE CREATION

Before attempting a comparison of European and American firms with respect to their financial viability and profitability, one should note that such comparisons are often difficult to make because of the fact that several European firms are either wholly or partially state owned (or controlled), in contrast with U.S. firms, most of which are privately held. In addition, drawing solid conclusions from the revenue patterns among the major defense and aerospace prime contractors is difficult because of continuing portfolio adjustments following the most recent consolidation phase. In other words, rapid changes in the size, ownership, and structure of both European and American firms as a result of continuing mergers and acquisitions make comparisons over time—transatlantic and also within the same industry—a challenging task.

Overall, European companies are financially solid; they generate cash and have good long-term potential financial viability. This is partly due to the following facts:

1. European defense firms have lower average debt-leverage levels and are more "cash rich"—in terms of cash as a proportion of assets—than their American counterparts. The debt net cash positions¹⁰ of European companies are very good compared with those of U.S. firms, largely due to the fact that European companies adopt a different strategy than do their U.S. peers with respect to acquisitions. Specifically, U.S. firms have shown increasing debt leverage over the past decade due to the recent merger and acquisition boom in U.S. industry combined with the American companies' method of financing such transactions through debt. In contrast, European firms finance their acquisitions with debt as well as with equity, with the objective of maintaining their financial firepower to be able to make further acquisitions in the future.
2. European defense firms are quite profitable compared with their U.S. counterparts. The high average European profit margins can be attributed to the inclusion in the profit calculations of smaller, second-tier suppliers in high-margin niches. Examples of such companies include Meggitt (a producer of avionics and defense electronics systems and components), Cobham (specializing in avionics and aircraft in-flight refueling equipment), Racal (a manufacturer of electronic warfare, radar and navigation systems, now incorporated within THALES), and Alvis (a producer of specialty land vehicles).
3. According to a European defense industry analyst, the average EBIT (Earnings Before Interest and Taxes) margin in Europe is around 7 to 8 percent,¹¹ compared with about 15 percent in the United States, but a

¹⁰Debt net cash positions can be an indicator of the degree of leverage of a business—that is, the degree to which it is utilizing borrowed money. A certain degree of leverage (neither zero nor excessive) is desirable for almost any company in order for it to be able to operate.

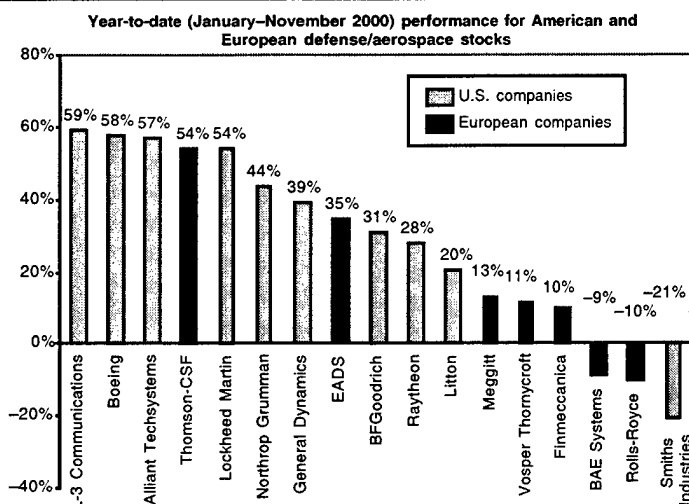
¹¹EBIT, or operating income/operating profit, is one of several different measures used to evaluate the financial performance and profitability of a company. EBIT measures a company's earning power from ongoing operations and is equal to earnings before deduction of interest payments and income taxes. Other measures of performance include EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) and ROIC (Return on Invested Capital). EBITDA is a measure of cash flow or cash profitability, which helps evaluate the amount of money a company brings in (cash flow is a measure of a company's financial health and equals cash receipts minus cash payments over a given period of time). EBITDA is calculated as revenues (earnings) less expenses before deduction of interest, taxes, depreciation, and amortization. ROIC indicates how much cash can be produced by each dollar of cash that is invested in a company. According to some analysts, oftentimes free cash flow, or ROIC, minus a

large part of that difference could be attributed to the fact that Europeans spend around 7 to 8 percent of their sales on research and development (R&D), a significant portion of which is funded by the Department of Defense (DoD) in the case of U.S. firms.

4. In terms of capital market performance, the performance of the European defense and aerospace sector was quite resilient, while U.S. stocks have performed exceptionally well, as can be seen in the next figure. In absolute terms, the performance of European defense and aerospace stocks rose by 5 percent between January and November 2000, although this still represents a 5 percent underperformance versus the stocks of U.S. peers. Companies such as THALES and EADS have been doing quite well, although long-term financial performance will be heavily influenced by the ability of the larger players to manage and integrate their acquisitions and to generate value for their shareholders.

charge for the use of that capital produces a much better view of the economics and value of a company than just looking at earnings growth. A deeper insight into the advantages and disadvantages of using each measure is beyond the scope of this documented briefing.

European stocks tend to lag U.S. stocks



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EUROPEAN STOCKS TEND TO LAG U.S. STOCKS

The graph on this page shows the performance of the Merrill Lynch universe of global aerospace and defense stocks between January and November 2000. A clear message emerging from this graph is that, overall, European stocks have tended to lag U.S. stocks even though some have performed quite strongly—for example THALES (still Thomson-CSF at the time) with a 54 percent return or EADS with a 35 percent return.

Overall, the consolidation that started in the European industry in the mid-1990s has been a key driver of stock performance. The benefits and synergies from acquisitions have paid off, at least initially, but certainly there are integration issues to be dealt with that create considerable uncertainty in the European sector. For example:

- EADS has been doing very well since its stock market introduction at the end of June 2000. Possible reasons for that performance include the success of Airbus and some positive initial results of the company's post-merger integration. The successful reception of the A380 will most likely have a major positive impact on the overall performance of EADS. The prospects for the A380 are now diminished by the crisis in

the airline industry provoked by the September 11 attacks. The balance between civil and military revenues will remain a crucial aspect of EADS' structure.

- BAE Systems and Rolls-Royce did not fare very well in the year 2000, mainly because of earnings warnings from both companies, but also because of the market belief that BAE overpaid for its acquisition of Marconi. Recently, BAE has managed to emerge from its downward spiral because of (1) its presence in the U.S. market—the only defense market growing significantly—which in 2000 represented 31 percent of BAE sales (that percentage is projected to grow further) and (2) renewed confidence in BAE's continuing plan to integrate Marconi without major delay. Rolls-Royce's performance is partly due to the market belief that some of its businesses offer little synergy and partly due to a fall in profits driven by a decline in the demand for maintenance and spare parts for aircraft engines (due to increased engine reliability).¹² However, Rolls-Royce is still expected to play an active role in both the European-wide and transatlantic consolidation of the engine industry.
- THALES has been performing considerably well since 2000, partly due to its new more internationalist strategy (a welcome change, after years of suffering from a growing perception of being isolated within Europe), promising civil-military synergies, and recent moves to forge transatlantic relationships, particularly its latest joint venture with Raytheon. In addition, the takeover of Racal Electronics of the UK has boosted THALES' stock price.

Following the September 11 attacks, stock performance has varied among European defense and aerospace companies. The share price of EADS, which owns 80 percent of the commercial aircraft manufacturer Airbus and relies on Airbus for a large part of its profits, went down about 40 percent in the week following the attack as part of a general trend of investors bailing out of commercial aviation business stocks.

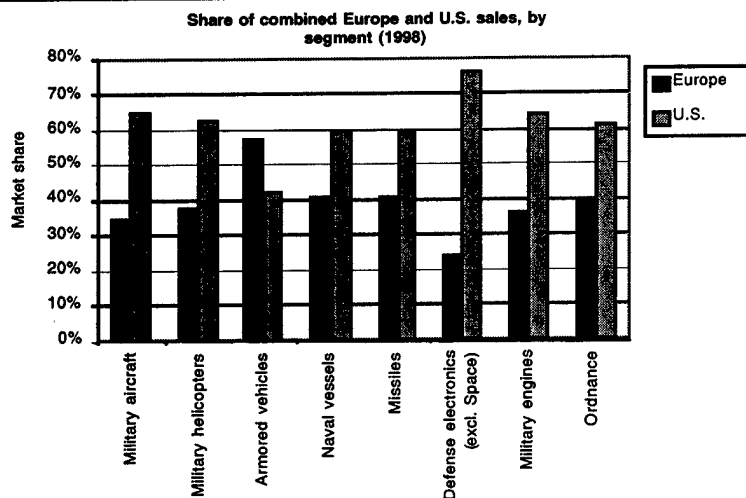
In contrast, BAE Systems, a big Pentagon supplier, has outperformed a generally declining global market since September 11. BAE shares made gains of 12 percent during the week following the attacks.¹³

¹²Gossard, Philippe, *Aerospace/Airlines—European Sector Review: Clear Outlook for Growth*, Credit Lyonnais Securities Europe, Paris, November 28, 2000, p. 86.

¹³Odell, Mark, "Investors Turn to Defense Stocks," *Defence Systems Daily*, March 1, 2001.

THALES also did well in the markets compared with other defense companies. This has been partly attributed to the fact that this French company is a specialist in information warfare systems—such as detection and communications gear, computer integration, and the like—and specialists, such as THALES, should expect to get a boost from the campaign that the United States and Great Britain are waging against Afghanistan. THALES is also a major contractor to the British Ministry of Defence, whose equipment spending is expected to rise.

United States dominates sales in all segments except for land systems



Source: Lehman Brothers estimates and company annual reports

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UNITED STATES DOMINATES SALES IN ALL SEGMENTS EXCEPT FOR LAND SYSTEMS

The calculation of market share in the above chart is based on 1998 sales by segment (in millions of dollars). The total market used to calculate the shares consists of the combined sales of U.S. and European firms.

The chart shows that the relative importance of U.S. versus European suppliers varies by segment: For example, in 1998, Europeans had a larger market share in armored vehicles—57 percent versus 43 percent for American companies. However, one should take into account that traditional European capabilities in land systems are more focused on heavy armored vehicles, a market that is currently in decline.

The substantially more important size of American suppliers is evident in military aerospace—fixed-wing aircraft and helicopters—and defense electronics. In missiles and naval vessels, the difference is less significant. As shown in the illustrations that follow, relative market shares in some segments are projected to change over the next decade when new programs enter into production.

Finally, the future of consolidation in the European defense market is also affected by how well efforts to build the common European security and defense policy (ESDP), and a defense capability to support it, are progressing. The future of the ESDP will be a critical determinant of the structure of the European defense industry. Efforts to build a European defense capability have intensified because of strong political momentum over the past few years. If these efforts progress successfully, they will reinforce existing tendencies of European governments to organize procurement at the European level and potentially to engage in European preference¹⁴ in procurement and protection of key technologies. These developments would strengthen the European defense industry while precluding American contractors' access to key European programs.

A failure to meet the Headline Goal,¹⁵ combined with a military operational failure somewhere on the globe, could suppress the European ambition for obtaining an autonomous defense capability and a credible military presence. For the European defense industry, this would imply that European governments will never provide European defense contractors with enough business to ensure their corporate survival (hence, the continuing efforts by companies such as BAE Systems and EADS to penetrate the growing U.S. defense market). Such a situation could have a serious impact on the viability of European defense firms and their progress toward consolidation and integration.

¹⁴The term "European preference" in this briefing refers to the tendency of European governments to (indirectly) favor European producers and programs when awarding important procurement contracts.

¹⁵At the Helsinki summit in December 1999, European Union (EU) nations committed to a "Headline Goal" for a rapid reaction force, whereby the EU member states would, by 2003, be able to deploy within 60 days 60,000 troops capable of carrying out the full range of Petersberg tasks ("humanitarian and rescue tasks, peacekeeping tasks, and tasks of combat forces in crisis management, including peacemaking"), including the most demanding tasks, that would be sustainable for at least a year of operations in the field.

Analysis by market segment

- Ranking of European players:
 - Market leaders
 - Major market presence
 - Minor market presence
- Structural player relationships and transatlantic links
- Market insights, current and future trends

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PART II ANALYSIS BY MARKET SEGMENT

This part of the briefing analyzes the European defense industry at the market segment level—platforms and major subsystems. Platforms comprise fixed-wing military aircraft (mainly fighter and transport aircraft), helicopters (civil and military), unmanned aerial vehicles (UAVs), missile systems, land and naval systems, and space systems (commercial and military). The subsystems comprise propulsion (aero-engines, missiles, and land, naval, and space propulsion), defense electronics including subsegments of these such as radar/sonar and electronic warfare, and finally, landing systems.

Within each segment, the analysis is structured around the following objectives or tasks:

- The first task is to identify key European players and distinguish among market leaders, firms that are major players, and firms with a minor market presence. Such a clear-cut distinction is not always feasible in each market segment because there are cases in which

market leadership is shared between two or more players (such as in civil and military helicopters). In other cases, the market segment is so fragmented that there are several players with a major market presence but no single dominant firm.

- The second task is to map the structural relationships among European players (such as those players' subsidiaries, cross-shareholdings, joint ventures, consortia, and other structural arrangements) and their links to U.S. companies (either through direct ownership, joint ventures, participation in joint programs, or other relationships).
- The third task is to identify key trends and to derive insights about the current situation and potential outlook in each market segment, resulting in observations about the current pace of consolidation, potential linkups (both intra-European and transatlantic), demand (budgets), and technological trends.

European market players: Platforms

<i>MILITARY AIRCRAFT</i>	<i>UAV</i>	<i>LAND SYSTEMS</i>	<i>SPACE</i>
BAE Systems (BAE)	Aérospatiale Matra and CAC Systèmes JV	GIAT, GKN / Alvis, Krauss Maffei Wegmann, Vickers	Astrium
EADS, Dassault Aviation	BAE	Rheinmetall, Alenia Difesa	Alcatel Space
Finmeccanica, Saab	EADS (Dornier)		Alenia Spazio
<i>HELICOPTERS</i>	<i>MISSILES</i>	<i>SHIPBUILDING</i>	
Eurocopter (EADS)	New Matra BAe Dynamics	BAE (VSEL, Yarrow), DCN, Vosper Thornycroft	
Agusta Westland	THALES	HDW, Bazan, Thyssen	
	LFK (EADS), Saab, BGT		

NOTE: In this table and other similar tables that follow in this report, European market leaders are indicated in larger boldface type, European major players are in larger regular type, and European minor players are shown in smaller type.

NOTE: JV=joint venture; DCN=Direction des Constructions Navales; HDW=Howaldtswerke Deutsche Werft; LFK=Lenkflugkoerpersystems; BGT=Bodensee Geraetetechnik.

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A. EUROPEAN MARKET PLAYERS: PLATFORMS

The table above gives an overview of the main market segments with respect to defense systems or platforms and the positioning of European industrial players within each segment. Several of these segments have undergone a quite extensive consolidation process, which has led to the emergence of the "big three" players positioned as leaders in most segments in their various "incarnations" (i.e., through their subsidiaries, joint ventures, and other structural arrangements). Exceptions to the consolidation trend are the land systems and shipbuilding segments, where the industry remains very fragmented, and the market is not dominated by a single player but is shared among several larger and smaller firms.

MARKET SEGMENT	NUMBER OF PLAYERS
Fixed-wing military aircraft	6 ^a
Helicopters	2-plus ^b
Unmanned aerial vehicles	9
Missiles	12 ^c
Land systems	14
Shipbuilding	7
Space	4

^aThese players are interrelated by a complex network of collaborative ventures, cross-shareholdings, and joint companies.

^bIncludes two main players (Agusta Westland and Eurocopter) and a number of consortia and joint ventures (NH Industries, EH Industries, and others).

^cPlayers include "traditional" companies such as MBDA and consortia such as Euromissile, Eurosam, and others.

The table on this page illustrates the fragmented nature of the European defense market in many industry segments by showing the number of players (both the major and less important ones) in each segment. The military aerospace sector exhibits a higher degree of consolidation compared with other segments. This characteristic applies mostly to the fixed-wing aircraft and helicopter components of the sector, whereas the engine and avionics/defense electronics components are less consolidated in comparison, as discussed later in this briefing.

Within the European defense industry, there is now a handful of global players whose interrelated programs represent a highly interdependent matrix of design, manufacturing, and distribution activities and capabilities (see the table in Appendix A).

Military aircraft: Global industry structure

Company	Products	1998 Revenues (\$bn)
Boeing	F-15, F/A-18, F-22	9.8
BAE Systems	Eurofighter, Gripen, Harrier, Hawk, Tornado	7.9
Lockheed Martin	F-16, F-22	6.0
Northrop Grumman	F/A-18	5.2
EADS	Eurofighter, Mirage, Rafale, Tornado	1.9
Dassault	Mirage, Rafale	1.8

Source: Merrill Lynch estimates, February 2000.

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MILITARY AIRCRAFT: GLOBAL INDUSTRY STRUCTURE

The table above presents a comparative picture of the major industrial players in the global military aircraft market segment ranked by their revenues in that segment. The estimates in this table include revenues derived from platforms, avionics, and support activities for all companies.

BAE Systems is the second-biggest global player after Boeing. Other European players are farther down on the list; for example, EADS and Dassault Aviation are ranked fifth and sixth, respectively.

Military aircraft: European industry structure

Company	Country	Products	Estimated 1999 Revenues (Euro bn)
BAE Systems	UK	Eurofighter, Gripen, Hawk, Harrier, Jaguar, Tornad o GR4, A400M, Nimrod MRA4, JSF, avionics	9.3
EADS	FR/G/SP	Eurofighter, Mirage, Rafale, Tornado, A400M, CASA C-101, C-212-400, CN-235M, Breguet 1150	1.5*
Dassault Aviation	FR	Rafale, F-4F Phantom II, Mirage 2000-5 Mk2, Super Etendard/ Etendard, Jaguar	0.9
Finmeccanica	IT	Eurofighter, AMX, Tornado, avionics	0.8
Saab	S	Gripen, avionics	0.6

* Includes 46% of Dassault (not consolidated)

Source: Company data and Merrill Lynch estimates, September 2000.

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MILITARY AIRCRAFT: EUROPEAN INDUSTRY STRUCTURE

The table above lists the major industrial players in the European military aircraft market segment ranked by their revenues. The estimates in this table include revenues derived from platforms, avionics, and support activities for all companies. The European military aircraft landscape is dominated by BAE Systems, in part due to the revenues the company derives from its Saudi Arabian contracts, specifically the Al Yamamah contract¹ estimated to be worth around 2.5 billion Euro.

In terms of positioning, with 80 percent of its revenues in military aircraft, BAE is the clear European leader in that segment. Also, BAE is the second-biggest player in the global military aircraft market, behind Boeing, with a

¹Al Yamamah, the United Kingdom's largest export contract, signed in 1985 by the UK and Saudi Arabian governments, involves the provision of a complete defense package for Saudi Arabia in return for oil for the UK. BAE Systems was established as the prime contractor with overall responsibility for delivering the entire contract, which includes aircraft and associated hardware, radar, communications, support, construction, and manpower for the Royal Saudi Air Force, and the supply and support of minehunters for the Royal Saudi Naval Forces. In 1999, the program moved from equipment provision and construction to customer support and maintenance.

21 percent market share (in 1998 defense revenues) compared with Boeing's 28.7 percent share.

BAE takes part in all of the European offerings in this segment, except for the French Mirage and Rafale combat aircraft. The group offers a comprehensive portfolio of military aircraft:

- The Eurofighter Typhoon in the medium/heavy category—BAE has a 37.5 percent share versus EADS' 43 percent share and Alenia's 19.5 percent share.
- The Gripen in the medium/light aircraft category—BAE has a 35 percent stake in Saab and a joint venture agreement to market, adapt, manufacture, and support export variants.
- The Hawk as a light attack/trainer aircraft.
- The Nimrod 2000 upgrade (21 maritime reconnaissance platforms)—here BAE is the prime and systems integrator.
- The Harrier series.
- The Tornado GR4—the Royal Air Force's (RAF's) mid-life update of the GR1 multi-role combat aircraft.
- The A400M transport aircraft, through BAE's stake in the Airbus Military Company.

BAE Systems: A Market Leader with International and Transatlantic Links

BAE's Al Yamamah contract with Saudi Arabia represents a significant source of revenue for the company—estimated at 20 percent of its turnover in the year 2000. According to the company's chairman, Sir Richard Evans, BAE has planned to invest in building up aircraft overhaul and repair facilities in Saudi Arabia, probably in a joint venture with a Saudi partner.

In terms of its transatlantic activities, BAE's U.S. sales represented 31 percent of total revenues in 2000, not taking into account the acquisition of LMAES, which means that this figure is set to grow further after the integration of that purchase. This is very positive for growth because the U.S. defense market has the most positive growth outlook among global markets and BAE is the European player that is best positioned to tap that market. Still, a drawback of BAE's business model is that it is extremely complex: The group aims at being at the same time a prime contractor, a

systems integrator, and a producer of individual systems in different segments, which might disadvantage its growth prospects. More analysis on this and other business and integration issues will be included in a follow-on study by RAND scheduled for fall 2002. EADS and Dassault Aviation both have a major market presence in the European military aircraft segment.

EADS and Dassault: Major Market Players

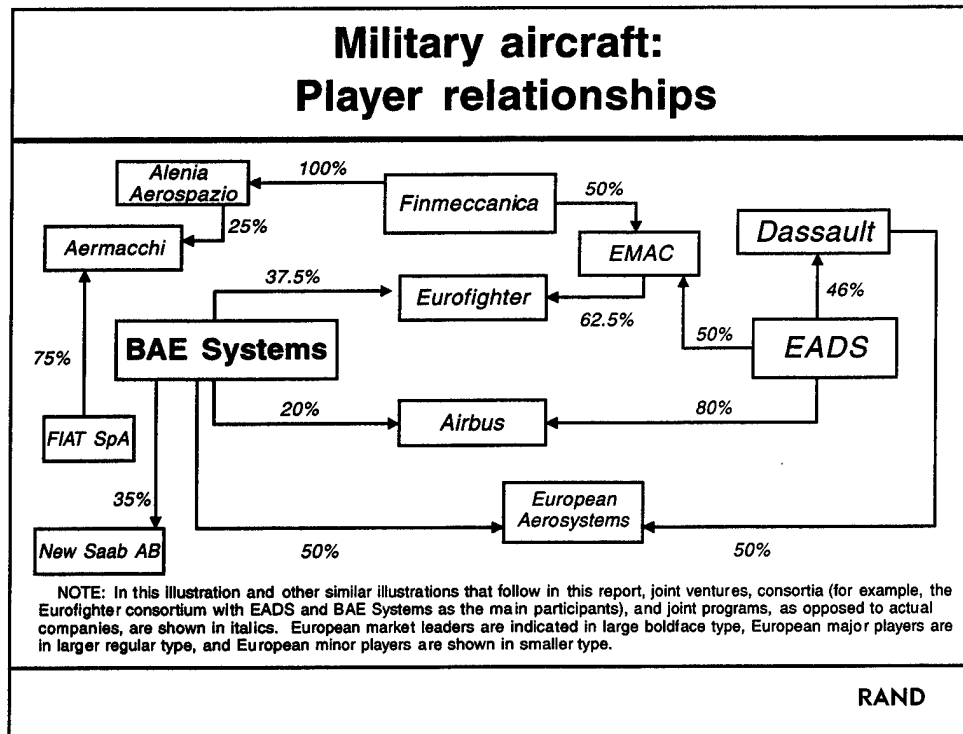
EADS is mainly a civil company because the largest part of its revenues (about 80 percent) comes from its civil side, namely Airbus. Military aircraft activities represent only 6 percent of EADS' total sales, and the company had a 5.7 percent global market share in 1998 (as shown later), including its Dassault stake—EADS has a 46.5 percent stake in Dassault Aviation but Dassault seems determined to continue functioning as an independent company.

In terms of transatlantic links, EADS is developing a relationship with Northrop Grumman in different segments, although not in the field of military aircraft. Recent agreements with Northrop Grumman, for example, include cooperation in the AN/APN-241 weather and navigation radar project that will be offered for the A400M military transport aircraft and joint development of a high-altitude long-endurance unmanned aerial vehicle system (a Memorandum of Understanding [MoU] was signed in July 2000). Furthermore, in October 2000 the two companies formed a joint venture to pursue the maintenance, repair, and overhaul (MRO) of large commercial aircraft.² Dassault has two major combat aircraft programs, the Mirage and Rafale series. According to industry analysts, the company has the required capability to build the next-generation systems and it can probably count on the support of the French government, assuming that the government's current goal of preserving national defense capabilities remains among its top priorities.³ The big question is whether Dassault will remain independent or whether it will link up with one of the other players in the military aircraft segment. So far it has been playing a waiting game, partly due to a

²The importance of MRO operations is to be emphasized, particularly in the light of budgeting injections to improve U.S. readiness following September 11.

³Recently, however, there have been signs that the French government is balancing the goal of preserving national defense capabilities with the goal of encouraging solid, well-managed, and shareholder-value-driven companies that can play a major role in the consolidation of the European defense industry.

potential management transition period it is going through and partly due to uncertainty surrounding the French government's Rafale orders.



MILITARY AIRCRAFT: PLAYER RELATIONSHIPS

The chart above presents the complicated structure of the European military aircraft industry—one illustration of the so-called “European spaghetti bowl”—characterized by an intricate web of cross-shareholdings, joint ventures, subsidiaries, and other structures. The chart shows relationships among European contractors in the European military aircraft segment: major joint ventures, consortia, and joint programs. An example is the European Military Aircraft Company (EMAC), a 50-50 joint venture between EADS and Alenia, to be completed by 2002. EMAC⁴ will combine Alenia’s civil and military aircraft products with EADS’ military products (excluding CASA’s transport aircraft). Another European venture is European Aerosystems, between BAE Systems and Dassault Aviation, which is the first practical step in Europe toward exploring future enabling technologies that could be added to existing aircraft, such as the Eurofighter and Rafale, and future military aircraft.

⁴EMAC should be distinguished from the Airbus Military Company, the military part of Airbus, which will produce the A400M military transport aircraft.

Military aircraft: Market outlook and market shares

Company	Market share (%)
BAE Systems	21.4
EADS	5.7
Finmeccanica	1.2
Saab	1.2
Celsius	0.4
Total share, European majors	29.9
Boeing	28.7
Lockheed Martin	16.7
Northrop Grumman	7.0
Other significant U.S. companies	2.8
Total share, U.S. majors	55.2

Source: Lehman Brothers estimates, February 2000, SBAC estimates.

NOTE: The remaining 15% market share consists of smaller companies in various countries other than the United States and countries in Europe.

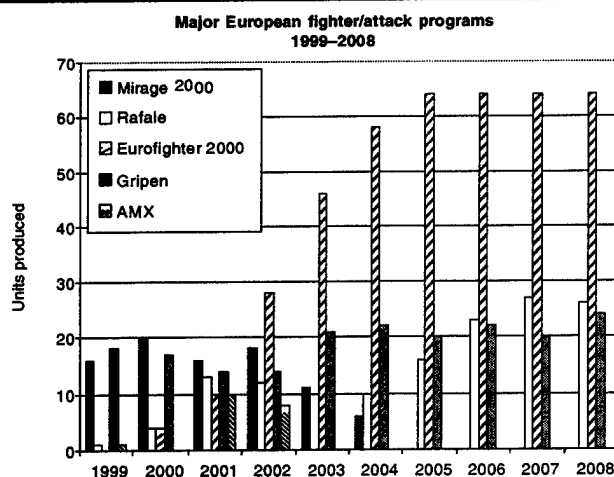
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MILITARY AIRCRAFT: MARKET OUTLOOK AND MARKET SHARES

According to the Society of British Aerospace Companies (SBAC), the estimated annual market size, in terms of global output, of the military aircraft segment was around \$36 billion in 1998. Furthermore, an analysis by investment bank Lehman Brothers estimates the annual market size for *new* aircraft for the same period at about \$17 billion. Based on that analysis, the bank estimates market shares for major European and U.S. defense contractors in the military aircraft segment. These estimates are based on 1998 segment sales revenue provided by Lehman's estimates and company annual reports. Sales figures include all after-market sales—upgrades, MROs, and logistics. The SBAC estimate of the size of the total military aircraft market is used to calculate market shares.

As seen from the table, in 1998, major European contractors had a 30 percent share of the global military aircraft market, compared with a 55 percent share for their U.S. counterparts. Among the Europeans, BAE had the largest share—21 percent—while other players such as EADS and Saab followed with a significant lag. On the U.S. side, Boeing dominated with a 28.7 percent share and Lockheed and Northrop Grumman followed with 16.7 percent and 7 percent shares, respectively.

European fighter/attack aircraft production



Source: Teal Group estimates.

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EUROPEAN FIGHTER/ATTACK AIRCRAFT PRODUCTION

Another approach for assessing capability in the military aircraft segment is to look at projected demand or production for different aircraft programs over a specific time period. The chart above shows the evolution of production in combat/attack aircraft units between 1999 and 2008 for the main European programs—Mirage 2000, Rafale, Eurofighter 2000, Gripen, and AMX. This forecast, prepared by the Teal Group intelligence service, a defense and aerospace consultancy firm, in its *1999 World Military and Civil Aircraft Briefing*, covers all combat aircraft with a maximum take-off weight over 20,000 pounds.

While the market for military aerospace products is likely to remain stable or expand slowly, the demand for fighter/attack aircraft alone over the next decade could still be in the region of 2,732 aircraft, with an estimated value of \$130 billion (in 1999 dollars). Of these, 31 percent are European programs (such as the Mirage 2000, Eurofighter 2000, Rafale, and Gripen), 46 percent are American ones (F-16, F-22, F/A-18, and others),⁵ and 23

⁵These figures take into consideration the Joint Strike Fighter prototypes, which are built within the specified time frame (a total of ten aircraft).

percent are programs from the rest of the world (MiG-29, Su-27, and others).

Currently, the fighter market is at its lowest point since the jet age began, with a mere 153 fighters worth \$6.7 billion that were to be delivered in 2001. Although the future of this market is clouded by doubt and uncertainty, analysts from the Teal Group predict a fairly robust recovery as procurement holidays end in the United States and Europe. Specifically, the annual value of fighter production is projected to double by 2006. Also, because Europe's procurement holiday was longer than the U.S. holiday, Europe's market share could increase dramatically as production of the European fighter series begins. The major European contractors in the military aircraft segment are well placed to capture a large share of this business: Their share (in terms of units produced) evolves from 13 percent (versus a 69 percent U.S. share) to 36 percent (versus a 43 percent U.S. share) between 1999 and 2008. Over the whole decade, Europeans capture 31 percent of the market, with Eurofighter 2000 taking 14.7 percent and the Rafale and Gripen obtaining 8.4 percent and 7 percent, respectively.

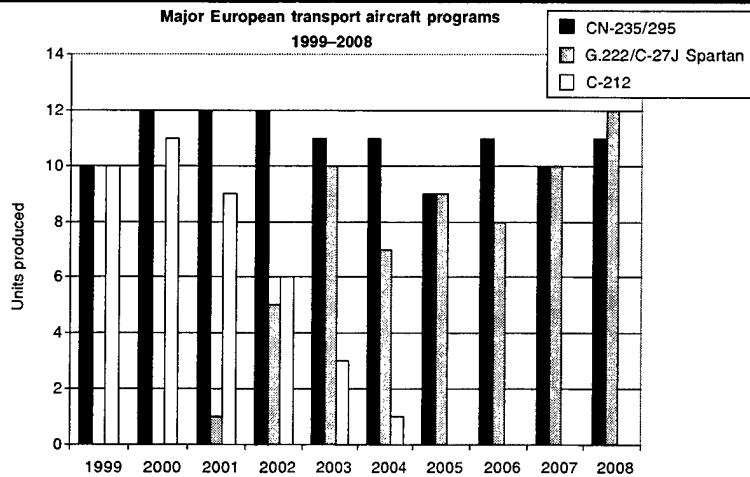
U.S. contractors get 46 percent of the fighter/attack market over the next decade: Lockheed Martin is the winner with 27.4 percent of the market; Boeing retreats from 31 percent in 1999 to a more modest 13 percent in 2008 and an 18.5 percent share over the decade, probably driven by the end of its McDonnell Douglas legacy programs (F-15, F/A-18 C/D, and AV-8Bs), with the only major remaining programs being the F/A-18 E/F and possibly the Joint Strike Fighter (JSF).

Among programs, the Eurofighter 2000 dominates the market over the decade, with a stable share of more than 20 percent between 2004 and 2008 and a projected production of 64 units per year between 2005 and 2008 (402 units total). Other European programs have lower production levels: The Gripen is forecast at 192 units and the Rafale at 142 units between 2000 and 2008. The equivalent figures for U.S. programs show the most significant production coming from the F-16 (390 units over the decade), the F/A-18 E/F (347 units), and the F-16-60 and F-22 (around 155 units each).

The market share estimates (for Eurofighter 2000, Boeing, and the rest) use as a base the unit production forecast for all major programs in Europe, the United States, and the rest of the world.⁶

⁶The forecast includes programs such as the MiG-29 and Su-27 in Russia, the Japanese/American F-2, and others.

European transport aircraft production



Source: Teal Group estimates.

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EUROPEAN TRANSPORT AIRCRAFT PRODUCTION

The chart above is based on Teal Group projections of production rates in major European transport aircraft programs over the decade 1999–2008. It seems that Lockheed Martin's C-130 and Boeing's C-17 will dominate the transport aircraft subsegment. Over the period 1999 to 2008, the two programs are projected to deliver 402 aircraft valued at \$33.5 billion (in 1999 dollars), which represents a 92.6 percent share of the worldwide market over that period.

On the European side, the main players are Alenia, with its G.222 and C-27J Spartan, and CASA, with its C-212 and its CN-235/295 joint venture with Industri Pesawat Terbang Nusantara (IPTN), Indonesia's sole aircraft manufacturing company. European production of transport aircraft is projected at 211 units between 1999 and 2008, but valued at a mere \$2.7 billion, which represents only a 7.4 percent market share over the decade. In terms of units, the European and the American shares have an approximately 3-to-1 relationship each year, but in terms of value, the American share clearly dominates at over 90 percent for most years.

Airbus has unveiled plans for a new large military transport aircraft, the Airbus A400M. This military airlifter is seen as a crucial element in the

European Union's plans to set up an autonomous rapid reaction force because the aircraft is intended to provide Europe with an indigenous medium- to heavy-lift military transport aircraft. The A400M will compete with Lockheed Martin's C-130 and Boeing's C-17, and it will be built by Airbus Military Company (AMC), whose consortium partners are BAE Systems, EADS, TUSA Aerospace Industries (Turkey), OGA (Portugal), and the Flabel consortium (Belgium). The A400M could be well positioned to capture a significant portion of the military airlift market; the A400M is sized between the C-130 and the C-17, it is priced competitively (in contrast to the expensive C-17), and combined with the "European preference" noted in Part I, the A400M could secure a large portion of the global market for airlifters, which it will share with the C-130J.

Eight countries—Belgium, Great Britain, France, Germany, Luxembourg, Portugal, Spain, and Turkey—plan to procure the A400M. The eight nations intend to order a total of 196 aircraft, and the program will be managed by OCCAR, Europe's new four-nation procurement agency. The aircraft is planned to take its first flight in 2006, with delivery to begin in 2008. However, all this assumes that the European program will actually be realized. Even though there is a consensus among European governments to improve their collective airlift capability, getting the joint program under way has been arduous. One of the main challenges has been getting all participants to maintain their procurement commitments. For example, Italy recently announced withdrawal from the program, and Germany, the aircraft's largest buyer with 73 orders, has been hesitating to confirm its order due to internal political and funding problems. Uncertainties and disagreements cause delays, which not only increase program costs⁷ but also endanger participation.⁸ In addition, the A400M program is facing the dual challenges of market size and cost. It is a very expensive program, which includes an all-new airframe and engine, and companies involved in its development are unwilling to commit full

⁷AMC needs at least 180 orders for the project to go ahead at a price of about \$80 million per aircraft (Regmann, Gerhard, "Italy to Quit European Aircraft Programme," *Financial Times*, October 20, 2001).

⁸For example, the British Ministry of Defence originally sought to replace the RAF's C-130K fleet by around 2005, but the A400M will not be available to meet that date; therefore, the British have resorted to leasing Boeing C-17s as an interim measure (Barrie, Douglas, and John Brosky, "Europeans Labor to Finalize Agreements on New Aircraft," *Defense News*, March 26, 2001).

funding without guarantees of member country procurement and additional launch aid.

Military aircraft: Market insights and trends

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| <ul style="list-style-type: none"> • Potential shift toward Europe in fighter market • Future of European players <ul style="list-style-type: none"> — Dassault Aviation: independent or part of EADS? — Alenia: what will happen to the joint venture with EADS? — Will BAE increase its stake in Saab? • Europe will no longer afford three fighter programs • Significant replacement demand over the next 20 years • JSF progress critical for Europeans |
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MILITARY AIRCRAFT: MARKET INSIGHTS AND TRENDS

A major subsegment of the military aircraft market segment is the fighter or combat aircraft market, which is analyzed in this section. The remainder of this section examines the major players and the most important programs in the military aircraft market segment.

Fighter Market

As seen in the table in the previous section, which shows projected fighter/attack aircraft production, BAE Systems and Lockheed Martin will most likely dominate the fighter market in the next decade. Moreover, there seems to be a potential shift in the balance of power toward Europe—something that some analysts have called a “European fighter market renaissance.” Over the next decade, European producers will become more-significant players in the global market, with a strong mix of new programs and aggressive export activity. European nations remain committed to procurement of European-made aircraft (Eurofighter, Rafale, A400M, and the rest), reducing U.S. opportunities for foreign military sales to NATO allies, although budgetary pressures on European states (intensified by any upcoming recession) may lead to cuts and/or cancellations in such programs.

Examples of the tendency of European fighter aircraft producers to become more-significant players in the global market have included, until recently, the Eurofighter orders from Greece and other countries, the South African and Hungarian orders for the Gripen, and the Mirage 2000 orders from Taiwan, Qatar, and the United Arab Emirates. Some important caveats to the successful market expansion of European firms include the dependence of several European countries on national orders—good examples of which are the Rafale and the Gripen—and the imminent competitive pressures from the fifth-generation American fighters (JSF), although much will depend on the results of U.S. Defense Secretary Donald Rumsfeld's defense review and its impact on the fate of major American military aircraft programs.

Europeans have quite a strong offering right now, but in the next decade the U.S. portfolio could be strengthened considerably by the F-22 and the JSF. Because of its expected size and scope, the JSF program is perceived as a threat to sales of Europe's flagship plane, the Eurofighter. BAE Systems has an advantage, being a significant participant in the JSF. The company had hedged its bets to profit no matter what program decision the U.S. government makes by partnering with both Lockheed Martin and Boeing.⁹ Lockheed Martin's victory over Boeing in the JSF contract award has tightened BAE's grip on the fighter market as a result of the financial and technological benefits the British company is expected to derive from its participation in the program.

The Eurofighter will be the most valuable program for Europe—its total production is valued at \$26.9 billion (402 units) between 2000 and 2008¹⁰

⁹The "old" BAE (pre-Marconi acquisition) teamed with Lockheed Martin and Northrop Grumman, taking responsibility for areas such as the aft-fuselage, the horizontal and vertical stabilizers, the wing tips on the naval variant, and UK customer-specific issues. The former Marconi business was closely aligned with Boeing, principally in four areas: pilot vehicle interfaces (displays, voice recognition, head-up display systems [HUDS], and others); vehicle management systems (flight controls, utility management, and others); mission systems software; and command, navigation, and information systems and electronic warfare (EW). BAE's role in Boeing's bid was much smaller and did not give BAE the technology-generating responsibilities of a joint prime contractor, which in effect is its position with Lockheed. Because of undertakings that were demanded for the Marconi purchase to be allowed, the JSF activities of the "old" BAE and Marconi are kept separate from each other.

¹⁰These figures are based on a Teal Group forecast (in 1999 dollars) which covers production of all combat aircraft with a maximum take-off weight of over 20,000 pounds (all supersonic planes plus the AV-8B Harrier). An alternative estimate by Forecast

and, so far, with a solid procurement outlook due to aggressive export initiatives. This could help drive European producers' combined share of the combat aircraft market to almost equal that of the United States in 2006 (a European share of 37.5 percent versus a U.S. share of 38.1 percent). One potential disadvantage for the Eurofighter is its price tag. The UK government has said it is paying \$63 million per unit (in 1999 dollars) whereas the JSF is expected to go for \$35–\$40 million.¹¹

A lot will depend on what happens with the JSF. The JSF program is set to dominate the fighter segment after 2015, both in terms of domestic and export sales. If the JSF moves according to schedule and has a reasonable price tag, it will be the only option available to most countries after Eurofighter, Rafale, Gripen, Su-35, and Mitsubishi F-2 production has ended. With European contractors (up to now) serving largely secondary roles in the design and manufacture of the JSF, many questions arise with respect to the long-term competitive implications for Europe. In order to avoid being pushed out of the fighter market, European fighter makers will have to join forces, either with each other or with U.S. partners.

Industrial Players

Consolidation in the military aircraft segment has been intense, giving rise to some key issues regarding potential future developments:

First, the future status of Dassault is interesting to follow—Will it maintain its claim to independence or will it eventually fold into EADS? EADS (Aérospatiale Matra) has a 46.5 percent stake in Dassault and 46 percent of the Rafale program. Despite EADS' stake, Dassault has continued to run its business as though it were entirely independent, although the company's owner, Serge Dassault, has signed a shareholder pact giving Aérospatiale Matra veto powers over his company's strategic decisions. Recently, there has been a strong industry that Dassault may sell its military aircraft business to EADS in return for a stake in EADS.

A second player to follow is Alenia Aerospazio (part of Finmeccanica). It is negotiating with EADS to form a joint venture in the military aircraft

International predicts the Eurofighter will sell 324 aircraft between 2000 and 2009—before the JSF enters the market.

¹¹Erwin, Sandra I. "U.S. 'Paper Aircraft' Spawning Trade Wars," *National Defense*, September 2000, www.nationaldefensemagazine.org/article.cfm?Id=246 (last accessed April 23, 2002).

and aeronautics sector, JVCO, which the companies hope to complete by January 2002. This joint venture will open the way for the Italian group to take a 5 percent stake in the Airbus civil aircraft consortium. The military part of the joint venture will be a 50-50 joint company, EMAC, whose activities comprise military aircraft programs and related services, aerostructures, and maintenance and conversion of large aircraft.

EMAC will be the third-largest fighter aircraft producer in Europe after BAE Systems and Dassault Aviation.¹² The joint company will have significant stakes in most major European aerospace programs, including a 62.5 percent stake in the Eurofighter and 71 percent stake in the A400M. Finmeccanica's talks with EADS have been held back because of disagreements over the value of each other's assets, differences over work-share, and an overlap of military transport programs. As a result, the launching of the company was delayed from March 2001 to June 2001 and then delayed indefinitely.¹³ Waning enthusiasm for EMAC in the Italian government formed after the May 2001 elections, as well as increased commitments to purchase U.S. equipment—such as Lockheed Martin's C-130J transport aircraft and Boeing's 767 airborne tanker—may be helping EMAC's demise. In addition, Italy's potential withdrawal from the Airbus A400M military airlifter program, currently under development, could be a severe setback for the creation of EMAC.

The implications for Finmeccanica if EMAC fails could be that it would try to build and strengthen ties with U.S. companies. The company already cooperates with Lockheed Martin on developing the C-27J Spartan military transport aircraft. However, if Alenia remains with EADS, BAE will have to reflect on its future relationship with Finmeccanica (Alenia's parent company), in particular BAE's stake in Alenia Marconi Systems (AMS). So far it is unclear what will happen with AMS.

A third, less controversial, issue to follow concerns the future status of Swedish manufacturer Saab, which is tied to BAE. Analyst expectations seem to be uniformly in agreement in that BAE may increase its 35 percent stake and try to fold Saab into its structure or at least form a strong alliance with the Swedish contractor.

¹²The Eurofighter program will represent 25 percent of the joint company's activity; the other activities will include aerostructures (28 percent), other combat aircraft (23 percent), special mission and transport (16 percent), and trainer/light combat aircraft (8 percent).

¹³Barrie, Douglas, and Martin Agüera, "Alliance Plan Fades: EADS, Finmeccanica Likely to Court Other Companies," *Defense News*, November 5-11, 2001, p.1.

Fighter Aircraft Programs

Currently, there are three fighter aircraft programs in Europe: the multinational Eurofighter, the French Rafale, and the Swedish Gripen. There is general agreement within the European industry that, in the future, Europe will be able to afford only one program per requirement. This implies that there may be even more consolidation at the level of European aerospace prime contractors (for example, Saab and BAE).

Moreover, replacement demand should be significant over the next 20 years.¹⁴ Some analysts speculate that if there is a material (on the order of five years) schedule slippage in the introduction of the JSF, and given that export deliveries are likely to commence after domestic ones have started, this could represent a window of opportunity to then existing competing European products. Such products would, of course, have to satisfy the criterion of substitutability for a delayed JSF.

Current European products do not offer viable alternatives to the JSF. For example, the JSF will be a carrier-based fighter bomber (for the U.S. and British navies) or a vertical take-off and landing platform (for the U.S. Marine Corps), whereas the Eurofighter is a multirole air superiority fighter that would be comparable to the American F-15.¹⁵ Furthermore, the JSF program is likely to benefit from a renewed emphasis on carrier-based aircraft. Currently, six European nations (the United Kingdom, France, Germany, Italy, Spain, and Sweden) have agreed to collaborate on advanced technologies that will develop European capabilities for future combat air systems. The European Technology Acquisition Plan (ETAP), as this initiative is called, aims at developing several kinds of technology applicable to the next generation of air warfare platforms, which are expected to enter service in Western militaries around 2020. The progress of these European efforts, in combination with developments in the JSF, will have a significant impact on the future of carrier-based aircraft procurement in Europe.

¹⁴According to Merrill Lynch estimates in September 2000.

¹⁵Erwin, Sandra L., "U.S. 'Paper Aircraft' Spawning Trade Wars," *National Defense*, September 2000, www.nationaldefensemagazine.org/article.cfm?Id=246 (last accessed April 23, 2002).

Helicopters: Ranking of European players

Company	Country	Products
Eurocopter (EADS)	FR/G	Civil: EC120, EC135, EC155, AS332 Super Puma, AS350 Ecureuil Military: Tiger, NH90, AS532 Cougar/ Mk.2, EC635, AS555 Fennek, AS352 Gazelle
GKN Westland	UK	Military: Sea King, Lynx/Super Lynx, AH Mk1 Apache Longbow
Agusta (Finmeccanica)	IT	Civil: EH101, A119 Koala, BA609 Military: Agusta A129 INT, A109, EH101, NH90, AB139/412 (with Textron Bell)

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HELICOPTERS: RANKING OF EUROPEAN PLAYERS

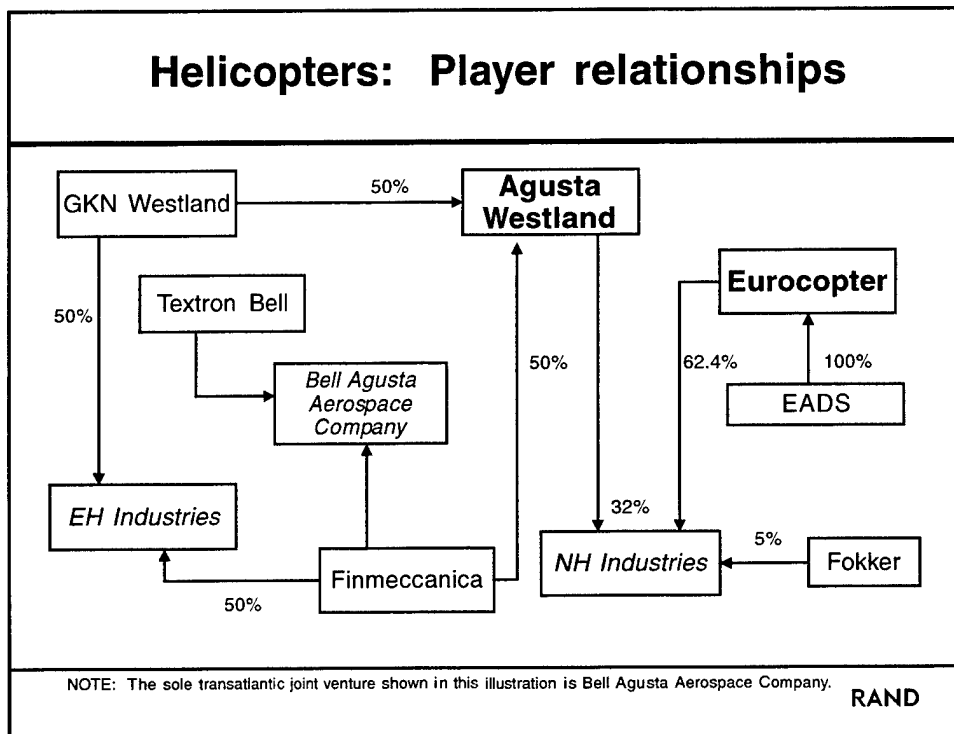
Eurocopter and Agusta Westland are the main industrial players in the helicopter segment. Agusta Westland is a new company formed by the merger of British GKN Westland and Italian Agusta in February 2001. Each company owns 50 percent of the new business. In addition, the two market leaders are also participating in the market through consortia and joint ventures with other companies. Examples of such structures include NH Industries (Agusta, Eurocopter, and Fokker) and EH Industries (Agusta and GKN Westland), each responsible for specific European helicopter programs, such as the NH90 and the EH101.

In spite of their much smaller domestic market—the U.S. military helicopter fleet has more than 6,400 machines compared with 880 in France and 750 in Germany, 660 in the UK, and 600 in Italy—European companies are quite competitive, offering a broad variety of different types of products. Some of them, like Eurocopter, have a strong political and industrial position.

In terms of Europe's products in this segment, Agusta produces the Agusta A129 INT, an international multirole helicopter. Naval helicopters include, in the "small" category, GKN's Lynx for the Royal Navy; in the "medium" category, the NH90 NFH (NATO Frigate Helicopter); in the

"heavy" category, the EH101, developed jointly by Agusta and GKN Westland, and Eurocopter's Cougar Mk2 (ASW / Anti-Submarine Warfare). In military transport helicopters, NH Industries produces the NH90 TTH (Tactical Transport Helicopter), and Agusta, in collaboration with U.S. manufacturer Bell, produces the AB412. Attack helicopters include Eurocopter's Tiger and the Cougar Mk2 family, which also has a version for combat search and rescue (CSAR). The Tiger is the only real competitor to the Apache. It has very advanced features, and even though it has been untried so far, at 427 units it has a stable domestic market. Agusta Westland builds the AH Mk1 British Army version of the AH-64D Longbow Apache under license from Boeing.

In civil helicopters, Europeans produce Eurocopter's twin-engine lightweight EC135, the single-engine EC120, and the larger EC155 Dauphin, as well as the best-selling AS350 Ecureuil and AS332 Super Puma (with good export orders). Agusta (with GKN) produces the commercial version of the EH101, the A119 Koala, and the twin-engine lightweight Agusta A109, while still under development is the AB139 in collaboration with Bell. The two companies are also working together on the tilt-rotor BA609.

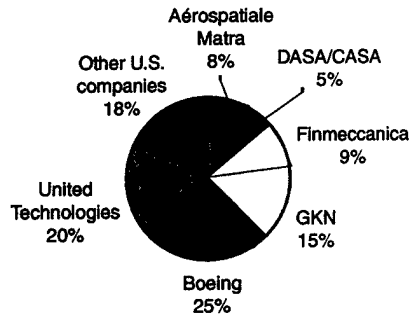


HELICOPTERS: PLAYER RELATIONSHIPS

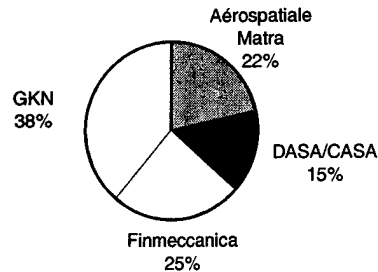
As can be seen from the diagram above, the helicopter segment in Europe is structured around the two industrial leaders and their different intra-European—and some transatlantic—linkups and collaboration arrangements.

Helicopters: Sales and market shares

**Global military helicopter
market shares, 1998**



**European military helicopter
market shares, 1998**



Source: Company reports and Lehman Brothers estimates.

NOTE: The charts show market shares for the "parents" of the joint companies. For example, DASA and Aérospatiale Matra are the parent companies for Eurocopter, and Finmeccanica and GKN are the parent companies for Agusta Westland (not yet formed as of the time of this writing).

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HELICOPTERS: SALES AND MARKET SHARES

Agusta Westland is slightly ahead of Eurocopter in the European helicopter market, with an estimated turnover level of approximately \$2.4 billion versus Eurocopter's \$1.8 billion turnover. This makes Agusta Westland the second most important player worldwide behind Boeing, which has an estimated turnover of \$2.8 billion. According to company sources, the Agusta Westland group had an estimated 18 percent share of the world helicopter market in 2000.

In the civil market, Eurocopter is the world's largest (civil) helicopter manufacturer. In 1999, the Franco-German company cornered 65 percent of the European civil market—a market environment that is still strong and stable. In the U.S. market, the group expanded its share to 48 percent, becoming the leader in the region, while in Asia it maintained its share at 35 percent. Eurocopter's share of the overall global civil market is 45 percent by number of helicopters produced.¹⁶ Eurocopter is set to benefit from the production phases of the Tiger and the NH90.

¹⁶This information is based on company estimates.

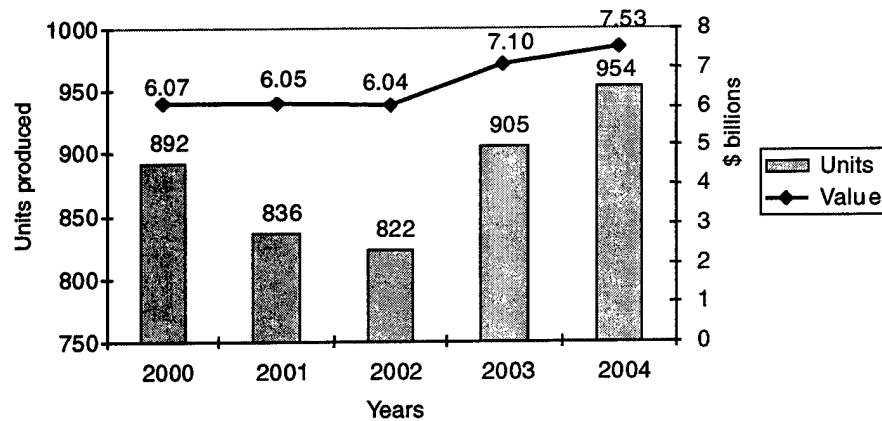
Agusta Westland is a less significant player in the civil market. GKN Westland is mainly a military company, and therefore the merged company's presence in the civil sector is based on Agusta's small percentage of turnover in the civil market. Specifically, Agusta's light civil helicopter range—A109, A119, and AB412/139—should provide the backbone for future civil growth.

In the European military helicopter market, both Agusta Westland and Eurocopter have a major market presence. Eurocopter estimates that it has achieved a 40 percent share of the global military market in 1999 and a 55 percent share of the European one (in unit terms), with 382 helicopter orders in 1999. However, in terms of 1998 sales, Eurocopter seems to have only a 13 percent share of the global military helicopter market (Aérospatiale Matra's 8 percent plus DASA/CASA's 5 percent) versus GKN's 24 percent share (Finmeccanica's 9 percent plus GKN's 15 percent), and it has a 37 percent share of the European market (Aérospatiale Matra's 22 percent plus DASA/CASA's 15 percent) versus GKN's 63 percent share (Finmeccanica's 25 percent plus GKN's 38 percent) as shown in the chart at the top of this section. The inconsistency of the different estimates illustrates the difficulty of determining market shares in the civil versus the military market because companies do not usually release detailed data on the breakdown of their civil and military revenues.

The market share calculations shown in the two charts above are based on the companies' annual reports and on Lehman Brothers' estimates of military helicopter sales for each company in 1998. The basis for comparison is the combined sales of European and U.S. contractors. As seen in the chart on the left, in 1998, European companies had a 37 percent share of the global helicopter market compared with a 63 percent share for their U.S. counterparts. Within Europe, the combined shares of GKN Westland and Agusta were much higher than Eurocopter's.

Helicopters: Market forecast

World 5-year helicopter market forecast



Sources: Teal Group, Aerospace Sourcebook 2000 (value in billions of 2000 dollars).

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HELICOPTERS: MARKET FORECAST

Growth in the global helicopter business has been relatively flat and was expected to remain that way in 2001 as operators struggle to achieve marginal improvements in profitability and aircraft utilization. Fleet replacement or expansion of demand for rotary-wing aircraft is focused chiefly on single-engine models, but operation of twin-engine, turbine-powered helicopters is rising slightly in the wake of sales to corporate and offshore oil operators in the United States, Europe, and to a lesser degree, Asia and the Pacific Rim. Hovering over the entire segment (as well as the aerospace and defense industry in general) is a growing concern about the impact of a recession in not only the United States but also at a global level.

Such concerns could be balanced by a potential boost to the helicopter segment in the aftermath of the September 11 attacks. The transatlantic helicopter market exhibits considerable excess capacity. The potential reorientation of military programs, post-September 11, may bring an upsurge in demand for rotary-wing aircraft and rapid reaction capability

or for stealthy helicopters, which may become a pivotal element in force projection.¹⁷

According to Teal Group estimates for both civil and military helicopter markets worldwide (seen in the above chart), between 2000 and 2004 the total helicopter market will show a modest overall growth of 7.53 percent in unit terms and 24 percent in value terms—with an initial negative growth in production units in 2001 to 2002 and stronger growth thereafter. Overall, the military helicopter market is about three times larger than the civilian market.

The market outlook over the next ten years is generally positive: According to Teal Group assessments, the global helicopter market will continue to grow, albeit at an uncertain and slow pace, compared with previous years. There should be growth overall in deliveries of new helicopters, but this growth is unlikely to exceed around 2 to 3 percent annually, in the combined civil and military helicopter subsegments. This projection is consistent with estimates from several other sources.

Growth—albeit slow—is mainly the result of three factors: first, a rise in corporate demand fueled by a strong economy, particularly in Europe and the United States,¹⁸ which together account for seven out of ten new helicopters purchased; second, an upsurge in law enforcement demand for helicopters; and third, the availability of new models with increased performance, efficiency, and comfort, which acts as a market stimulus, while the advent of the tilt-rotor will further expand the envelope of rotary applications but will also impinge on some traditional helicopter markets and sales.

The market for new civil helicopters will remain flat for the foreseeable future¹⁹ and is unlikely to exceed 800 turbine units a year, with a 60/40 split in favor of commercial models. Estimates by Forecast International, a specialized consulting firm, are consistent with that assessment, projecting an 11 percent growth, in terms of deliveries, between 2000 and 2006, and an average annual growth rate of 2 percent.

¹⁷That said, the continued viability of two European helicopter producers might be in doubt.

¹⁸This trend could be reversed as the economies slow down on both sides of the Atlantic.

¹⁹According to estimates from Jane's Information Group, *Market Review: Helicopter Markets and Systems 1999–2000*, n.d.

The global military helicopter market is also quite uncertain, although projections by Forecast International estimates a growth rate of the order of 77 percent in units and 87 percent in value over that decade.²⁰ That market is projected to peak in 2006. Currently, the market is recovering from a recent low, with deliveries of new helicopters increasing over the next two years, before settling back at a lower annual average. Transport and attack helicopters will lead the market, followed by utility helicopters.

²⁰Estimates are from Forecast International Aerospace Group (1999).

Helicopters: Market insights and trends

Consolidation

- Almost complete in Europe—now transatlantic moves?

Civil market trends

- Relatively stable market—2–3% annual growth
- Europe's share continues to climb

Military market trends

- First half of 2001: Six European countries expected to decide on their helicopter requirements for 71 airframes—military sales in Europe expected to soar to about \$1 billion
- September 2001: Both NH90 and EH101 chosen to fulfill Scandinavian helicopter needs

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HELICOPTERS: MARKET INSIGHTS AND TRENDS

The following sections present the progress of consolidation in the helicopter market segment as well as some key trends in civil and in military helicopter markets.

Consolidation

Most consolidation in the European helicopter segment is complete, leaving two major players: Agusta Westland (a result of the merger between GKN's Westland helicopters and Finmeccanica's Agusta) and Eurocopter (which belongs to EADS). Although some excess capacity still exists, it does not seem that there will be any further intra-European consolidation, at least not among the first-tier manufacturers, mainly for political and industrial base reasons, although we might see some movement at the subtier (supplier) level.

Joint programs will continue to occur, mainly for economic and affordability reasons, but the next set of developments most probably will be transatlantic. For instance, although there are potential problems with the Agusta Westland merger (discussed later), the combination seems to make sense, particularly if followed by an alliance, or merger, with Bell. Agusta and Bell are used to working together and have complementary

product lines—with Agusta's mostly civil line fitting in well with Westland's military product range. Together, the two companies will offer a more credible competitor to Eurocopter,²¹ allowing governments a wider choice and will be better able to invest in R&D to develop future products by broadening their customer base and reducing their dependence on uncertain government contracts. One of the problems to be worked out is how to reconcile the Italian government's stake in the new company with the British penchant of being against any form of state participation in industry.

There are other problems connected with Agusta's long-standing links with Bell (reinforced by last year's agreement between the two companies on the BA609 tilt-rotor and the AB139 utility helicopter) and with Westland's nonparticipation in the four-nation NH90 program. Specifically, it is unclear how Agusta will be able to keep its work with Bell on the AB139 and BA609 on the one hand separate from its work with Eurocopter and Fokker on the NH90 on the other hand, while at the same time tightening its ties with Westland.

A combined Agusta/Bell/Westland entity would have the largest helicopter market share, more than 30 percent, in the coming ten years.²² The companies have few areas of overlap in both civil as well as military products, while market access in the United States and Europe would be significantly improved and the entity would take advantage of Bell's customer support network.

Civil Market Trends

Forecast International projects a 2–3 percent annual growth rate in helicopter deliveries and an overall 11 percent growth rate between 2000 and 2006. Key factors driving the market include the need to replace aging aircraft and the desire for new technology, increased payload, and improved performance compared with older aircraft. Europe's share of the civil helicopter market continues to climb, its main growth drivers being the new and derivative models entering service and the generally favorable economic conditions in Europe. Furthermore, competition in the civil helicopter market will remain fierce, characterized by increasing

²¹Eurocopter's strengths include its wide range of successful new programs (such as the Tiger combat helicopter and the NH90 tactical transport and naval helicopter), which will bring it significant benefits as those programs enter into production.

²²According to Teal Group estimates from *Aviation Week & Space Technology, Aerospace Sourcebook 2000*, McGraw-Hill, Vol. 152, No. 3, January 17, 2000.

demand, but also declining prices—making for a real price war. Finally, there is the continuing potential threat posed to Europe by secondhand U.S. military helicopters appearing on the market, although this threat has not materialized yet.

Military Market Trends

A very significant event in the military helicopter market segment is the outcome of the four-nation Nordic Helicopter Competition, a seven-year effort by four Nordic nations to purchase a common helicopter. This program was aimed at harmonizing the needs of the Danish, Finnish, Norwegian, and Swedish armed forces and considered key to the future of European helicopter manufacturing. The program was marred by difficulties in satisfying the disparate needs and mission requirements of participating countries with a single aircraft.²³ The four countries eventually announced their decision in September 2001: Both the NH90 and the EH101 were chosen (Denmark chose the EH101 while Sweden, Norway, and Finland chose the NH90).²⁴ Other European procurement competitions to follow include Portugal's requirement for SAR helicopters (with the NH90 as the main contender), the Hellenic Air Force's competition (again, the NH90 is prominent), and the replacement of the Belgian Air Force's Sea Kings.

An important technology trend both in the civil and the military helicopter market is tilt-rotor technology, which could have a transforming effect on the segment.²⁵ The transatlantic joint venture between Bell and Agusta would become one of the leading players in that field with its BA609 civil tilt-rotor aircraft, which has already received more than 100 orders. In Europe, Eurocopter is also pursuing tilt-rotor technology with plans for a Eurotilt aircraft in the 19-seat 300-knot range, which rotates only the nacelle with the rotor instead of the entire engine

²³Medium-lift, search-and-rescue, anti-submarine, and anti-surface warfare, are along with shipborne capability, are some of the elements that the four nations juggled as they were trying to choose a single type to meet their disparate needs. For example, the Norwegians had a requirement for a helicopter capable of operating on a frigate, whereas Denmark had a very demanding SAR requirement. Finland and Sweden were very close in terms of requirements for tactical transport and SAR, but the Swedes had an anti-submarine warfare requirement that the Swedes did not.

²⁴Four helicopter types were under consideration: the EH101 by Agusta Westland, the NH90 built by NH Industries, Eurocopter's Cougar, and Sikorsky's (U.S.) S-92 Helibus.

²⁵Industrial College of the Armed Forces, National Defense University, *Report on the Status of the Aircraft Industry*, Fort McNair, Washington, D.C., June 2000.

such as the V-22 Osprey does. Eurocopter feels that this technique would make its product entry lighter and more cost-effective to use.

Unmanned aerial vehicles: Major European players and products

Company	Country	Products
Aérospatiale Matra UAV division and CAC Systèmes JV	FR	C-22, SEAMOS naval drone (Dornier—EADS), FOX AT1/AT2/EW, HELIOT, POINTER
BAE Systems	UK	Phoenix, SkyEye R4E
GIE Eurodrone (Matra BAe Dynamics, STN Atlas Elektronik)	UK/FR/G	Brevel TUCAN version
SAGEM	FR	Crecerelle, UGGLAN, Horus-SD, Sperwer

RAND

UNMANNED AERIAL VEHICLES: MAJOR EUROPEAN PLAYERS AND PRODUCTS

From a historical standpoint, the market leaders in the world UAV market have been large defense contractors, such as Boeing and Lockheed Martin, with years of military investment in the development of UAV systems. That phenomenon is changing with the advanced market position of companies that are independently investing in UAV development. Today there is an increasing mixture between successful larger and smaller players in the market segment, which is partly due to the increasing frequency of strategic alliances.

In Europe, a potential market leader is the joint venture between the UAV division of Aérospatiale Matra and the French UAV manufacturer CAC Systèmes. The joint venture is characterized by Aérospatiale Matra as a "tight marketing, technical, and industrial partnership," but industry analysts call it a "virtual takeover" of CAC by Aérospatiale, the latter having created a new division covering all of the company's UAV and aerial targets businesses.²⁶ CAC Systèmes has annual sales of \$7.1 million

²⁶This division will rank as Europe's leading builder of military UAVs, according to *Jane's Defence Weekly*, May 17, 2000.

and is a market leader for aerial target systems. Other companies with significant presence in the UAV segment include BAE Systems, the French manufacturer SAGEM, and GIE Eurodrone, a consortium consisting of Matra BAe Dynamics and STN Atlas Elektronik.

In terms of products, Europe has a field of well-established tactical UAVs but is only now contemplating endurance UAVs. Key European products include:

- From CAC Systèmes, the FOX-AT1 and AT2, multi-mission close- and average-range UAVs, the FOX-EW version, and POINTER, a very close-range UAV system
- From BAE, the Phoenix Battlefield Surveillance, Acquisition and Targeting System, and SkyEye R4E multi-purpose UAV
- From Eurodrone, the Tucan reconnaissance, surveillance, and target acquisition UAV²⁷
- From SAGEM, the tactical and reconnaissance UAVs Crecerelle, UGGLAN, Horus, and Sperwer.

In terms of new programs, Astrium, a European joint company and subsidiary of EADS, is developing the Synthetic Aperture Radar-Lupe program for Germany, which is designed for both strategic and tactical reconnaissance. German company Dornier (belonging to EADS) is developing an upgraded version of the German Army's CL289 drone for tactical reconnaissance and surveillance. EADS launched its own project in 2000, the Joint Intelligence-Surveillance-Reconnaissance Architecture, the focus of which is to create compatibility among all the reconnaissance and surveillance systems of Germany's armed forces. Many other European countries have active tactical UAV programs under way, such as Spain with its SIVA. Europe's interest in endurance UAVs has been prompted by the U.S. example. France has already looked at the General Atomics Predator, while Britain is also examining its requirements in the field.

Despite the projected growth in the market (as is presented next), competition in the field of UAVs is projected to intensify. The ability of the industry to monitor and meet the demand for higher-quality, more-capable, and interoperable UAV systems at competitive prices will

²⁷Tucan is the German part of the Brevel UAV program that was left after the French pulled out of the program.

determine who will have a lasting presence in this market segment. Given that there are several different unmanned vehicle programs currently in Europe, one should note that there is a danger of duplication of effort, particularly in the design and development of unmanned combat air vehicles (UCAV). The existence of this possible duplication could suggest the potential for further rationalization²⁸ within the European UAV/UCAV industrial base.

²⁸*Rationalization* refers to the restructuring of a market segment (for example, through mergers or disposal of companies) to reduce duplication in product development, production, marketing, and other areas.

Unmanned aerial vehicles: Market insights and trends

- Potential growth market
- European primary contractors making moves to capture new work
- Europe has well-established tactical UAV field and is developing interest in strategic/endurance UAVs
- Small smart weapons, secure data links, and stealth are central to UCAV performance; U.S. leads in low-observables technology
- Duplication of effort, particularly in UCAV design and development, could be problematic

RAND

UNMANNED AERIAL VEHICLES: MARKET INSIGHTS AND TRENDS

UAVs are a potential growth market, with a forecasted compound annual growth rate (CAGR) for the world market of 9.5 percent for the period 1997 to 2004.²⁹ This growth rate—which does not take into account the impact of the war in Afghanistan that has further increased the appeal of UAVs—reflects a trend toward a more rapid influx of both government and private investment.³⁰ In addition, the forecast reflects system sales revenues going into the reconnaissance UAV segment (10 percent CAGR), combined with a cyclical forecast for the aerial target drone market segment (2 percent CAGR).

²⁹Estimates from a 1998 report by the consulting firm Frost and Sullivan.

³⁰To illustrate, U.S. Department of Defense expenditures on UAV programs are significant and growing. The DoD invested more than \$3 billion in UAV development, procurement, and operations between 1996 and 2001; it plans to invest \$2.3 billion more by 2005 and is likely to spend \$4.2 billion by 2010. According to the so-called UAV Roadmap, by 2010, the UAV inventory of all the military services is expected to grow to 290 vehicles (Tiron, Roxana, "Despite Doubts, Airforce Stands by Predator," *National Defense Magazine*, www.nationaldefensemagazine.org/article.cfm?Id=681; last accessed April 8, 2002).

The utility of UAVs in modern conflicts, with their information warfare intensity and low-casualty requirements, was first highlighted during the Kosovo air campaign in 1999. The value of UAVs has been further emphasized recently with the war in Afghanistan, where unmanned vehicles—such as General Atomics' Predator and Northrop Grumman's Global Hawk—have been used extensively.

As interest in unmanned systems accelerates, European prime contractors are making a conscious effort to capture UAV/UCAV work and to offset a developing U.S. lead in that market. European defense companies are counting on the growing gaps in Europe's modern reconnaissance capability to eventually swing procurement decisions in their favor.³¹ The Military Aircraft division of EADS is one of the principal players leading that effort. BAE Systems is also keen on providing a system of UAV systems and is participating in the assessment studies for the British Ministry of Defence (MoD) Watchkeeper UAV reconnaissance project, with 2006 as a probable in-service date. The Watchkeeper will have ISTAR (Intelligence, Surveillance, Target Acquisition, and Reconnaissance) capabilities and is a fast-track acquisition project.

The Kosovo campaign also revealed UAV vulnerability to air defenses and raised the question of whether to include countermeasures in future UAV designs, considering the tradeoffs in terms of weight, cost, and payload. Central to the performance of unmanned systems in the future will be the development of small smart weapons that will increase load-out per mission, internal weapon bays, adequate range capability, and secure data-links. The U.S. campaign in Afghanistan has emphasized the utility of armed versions of UAVs.³² More fundamentally, UCAVs will need to be extremely stealthy to survive dense enemy air defense environments without the guiding influence of an on-board pilot. So far, Europe is floundering in this arena, while the United States has a significant lead in low-observables (LO) technology.

³¹For that to happen, at the same time as increasing their efforts at improving their technologies and product offerings, European companies would also have to benefit from a certain degree of European preference (not evident yet in this segment), given the expectation of intensified competition in the UAV segment.

³²For example, in Afghanistan, the Predator RQ-1 is loaded with Hellfire anti-tank missiles.

At the transatlantic level, EADS and Dornier are developing a high-altitude long-endurance UAV in cooperation with Northrop Grumman.³³ The objective of the agreement among the three industry partners is to jointly define a type of UAV, based on Northrop Grumman's Global Hawk and dubbed EuroHawk, which would use EADS' surveillance sensors. The Eurohawk is slated to be ready for service by 2007 to 2008. The goal of the Eurohawk program is to cover operative reconnaissance and surveillance needs, although no firm program requirements have been released yet.

³³The value of high-altitude, long-endurance UAVs was also highlighted during the war in Afghanistan. Such "weaponized" UAVs could be used as part of a fast-reaction strike system designed to hit targets within minutes of their being detected.

Missiles: Ranking of European players		
Company	Country	Products
MBDA – New Matra BAe Dynamics	UK/FR/G/IT	ASRAAM, MICA, Meteor BVRAAM, Storm Shadow/Scalp EG, ALARM, Sea Skua, Mistral
THALES	FR	Crotale, SHORADS
LFK	G	Kormoran, EURAAM, Taurus
RAND		

MISSILES: RANKING OF EUROPEAN PLAYERS

MBDA³⁴ is the European market leader in the missile segment and the second-largest player globally behind Raytheon. The group combines the missile businesses of Aérospatiale Matra (part of EADS) and BAE Systems, as well as those of Alenia Marconi Systems, a 50-50 joint venture between BAE and Finmeccanica. The new company is 37.5 percent owned by BAE, 37.5 percent owned by EADS, and 25 percent owned by Finmeccanica, Alenia's parent company.

Industry analysts believe that MBDA will be a formidable competitor in the global missile business. The company has a comprehensive product portfolio and is well positioned to exploit what seems to be a strong market outlook. MBDA has about \$2.4 billion in expected annual sales, which should grow to \$3 billion by 2004 or 2005, according to its CEO, Fabrice Brégier. The integration of Aérospatiale's missile activities strengthens MBDA's position in medium-range surface-to-air, anti-tank, and anti-ship products, while the inclusion of DASA (DaimlerChrysler

³⁴Matra BAe Dynamics changed its name to MBDA, where MBD stands for Matra BAe Dynamics, while the A stands for both Alenia Marconi Systems and Aérospatiale Matra.

Aerospace) has brought increased control over programs such as the Roland and the Trigat missiles, as well as some additional core competencies. Alenia Marconi Systems enhances MBDA's missile electronics capabilities.

MBDA's strongest programs and sources of future cash flow and improved margins are the Storm Shadow/Scalp EG standoff weapon, production of which was to begin ramping up near the end of 2001, and the Apache air-to-surface missiles. The Storm Shadow program has a ten-year life, a total size of around 750 or potentially 1,000 units, and will be used on Tornado and Eurofighter aircraft. The Scalp EG missile will be used on the Mirage 2000 and Rafale aircraft.

Other important programs currently undertaken by MBDA include the MICA air-to-air missile, used on the Gripen; the Mirage 2000 and the Rafale; the PAAMS (Principal Anti-Air Missile System) for the next-generation frigate, a problematic contract for which production is scheduled for 2005 to 2012; the Meteor Beyond Visual Range Air-to-Air Missile (BVRAAM) system used on the Eurofighter, a key contract in terms of strategic value for MBDA's competitive position; the UK's Advanced Short-Range Air-to-Air Missile (ASRAAM) program, expected to enter service shortly; and finally some overseas contracts, such as the MICA and Black Shaheen (a derivative of the Scalp cruise missile) for the United Arab Emirates, delivery of which was expected to start in 2001.

Following MBDA's lead, THALES has a major market presence in the missile segment. The French company is likely to remain independent of MBDA. THALES currently holds second place in the European and fifth place in the world missile market behind Lockheed Martin and Boeing.³⁵ THALES produces the Crotale naval air defense system and the Franco-Italian FSAF medium-range missile system and takes part in the PAAMS system for the Horizon frigate.

A more minor player in the European missile market is German company LFK (Lenkflugkoerpersysteme GmbH)—number three in Europe—which already is 30 percent owned by MBDA (there are a lot of questions as to whether it will choose to fold into MBDA or to align with another player). Bodensee Gerätetechnik (BGT, a member of the Diehl Group) is another smaller German company, ranked fifth in Europe and sixth globally. So far, there is little activity in terms of consolidation of smaller players,

³⁵TTU Europe, July 20, 2000.

although there are expectations that the two German companies might eventually be integrated into MBDA.

European companies have various missile products in the different market subsegments. In the air-defense subsegment, with the exception of French interest in developing an anti-missile capability for the Aster system (for the PAAMS naval air defense system), the rest of Europe appears disinterested in the air-defense subsegment of the market. In air-to-surface systems, Europe is lagging behind, having only France's Armement Air-Sol Modulaire (AASM) (American Joint Direct Attack Munition [JDAM])³⁶ program and MBDA's Apache standoff weapon. In cruise missiles, as mentioned previously, France and the UK are developing their own semistrategic conventionally armed cruise missile—the Storm Shadow/Scalp program. In air-to-air, the main programs are the British ASRAAM, the MICA, and the Meteor BVRAAM. There is little happening in anti-ship missiles besides the Exocet, while in anti-tank missiles, requirements have waned (the only significant program is the Trigat MR). Nevertheless, there is interest in light missiles for light infantry, such as the Eryx from Aérospatiale Missiles (EADS).

LFK collaborates with Saab Bofors Dynamics to develop and produce the Taurus—the second major European standoff weapon program (after MBDA's Storm Shadow/Scalp EG). Taurus is moving toward the end of its development phase; meanwhile, negotiations for the series production for the German Luftwaffe have already begun. A total of 600 units worth \$434 million are to be procured for the Tornado and Eurofighter. But just how quickly the German Ministry of Defense can come to a purchase decision and whether the numbers will stay unchanged remain to be seen.

³⁶AASM is France's equivalent to the American JDAM-guided bomb.

Global missile industry structure

Company	Country	Estimated 2000 Revenues (\$bn)
Raytheon	US	4.8
MBDA	UK/FR/G/Sp	2.4
Lockheed Martin	US	1.6
Boeing	US	1.5

Source: Analyst estimates, February 2000.

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GLOBAL MISSILE INDUSTRY STRUCTURE

The table above shows the leading participants in the global missile industry ranked by their estimated revenues in 2000. In addition to being the dominant European manufacturer in the missile segment, MBDA is estimated to be a strong second player globally, behind Raytheon, and ahead of other U.S. participants—the missile businesses of Lockheed Martin and Boeing. MBDA's position will be enhanced by the integration of the missile activities of Alenia Marconi Systems, resulting in a company with expected combined annual sales of about \$2.4 billion, which will allow it to keep its global position.

In terms of transatlantic links, an interesting point is the presence of Boeing in the Meteor missile system consortium, which could open significant export opportunities. Boeing signed on as part of the Meteor consortium in late 1999. Boeing's involvement in the program consists of marketing in the United States and in other countries and integration of the missile on U.S. aircraft to facilitate marketing of the missile in both the United States and in other countries that have U.S. aircraft with that missile in their inventories. Boeing may have seen the agreement as a

means of countering Raytheon's near monopoly on beyond visual range missiles.³⁷

³⁷See Morrocco, John D., "Looming Missile Decision to Shape Transatlantic Ties," *Aviation Week & Space Technology*, February 7, 2000, and Morrocco, John D., "Boeing Signs Agreement with Meteor Missile Team," Boeing news release, October 20, 1999.

European missile industry structure

Company	Country	Estimated 2000 Revenues (Euro bn)
MBD (excl. LFK)	UK/FR/G/Sp	2.8
THALES	FR	0.8
LFK	G	0.5
Saab	S	0.3
BGT (Diehl)	G	0.2

Source: Merrill Lynch estimates, September 2000.

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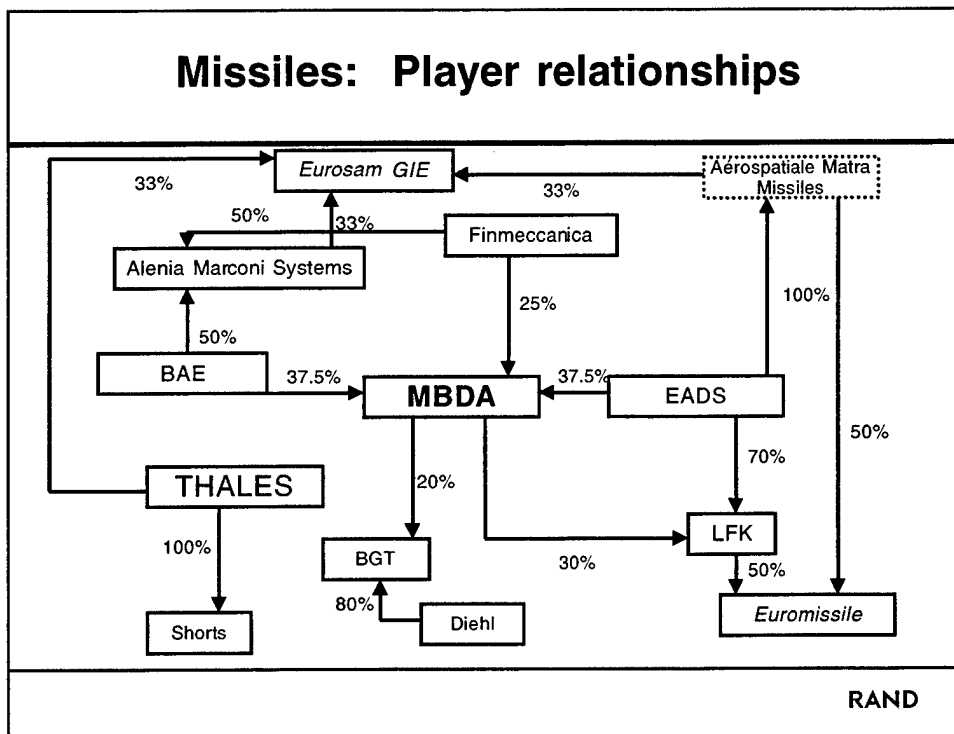
EUROPEAN MISSILE INDUSTRY STRUCTURE

The table above presents the leading participants in the European missile segment, using their estimated revenues for 2000 (the figures for MBD—now MBDA—do not yet take into account the addition of the missile business of Alenia Marconi Systems).³⁸

As mentioned earlier, MBDA is expected to dominate this market segment. If LFK and Saab are eventually integrated into MBDA,³⁹ then the only missile interests remaining outside of this giant group will be BGT and THALES—the French company's subsidiary, Thomson-CSF Detexis, is Europe's largest remaining independent missile-guidance manufacturer.

³⁸The difference in the revenue figures for MBDA (MBD) shown in the table above and the previous table should be attributed to the time of the estimates, the latter estimates being more recent.

³⁹Saab is linked to BAE because of BAE's 35 percent stake in the Swedish company.



MISSILES: PLAYER RELATIONSHIPS

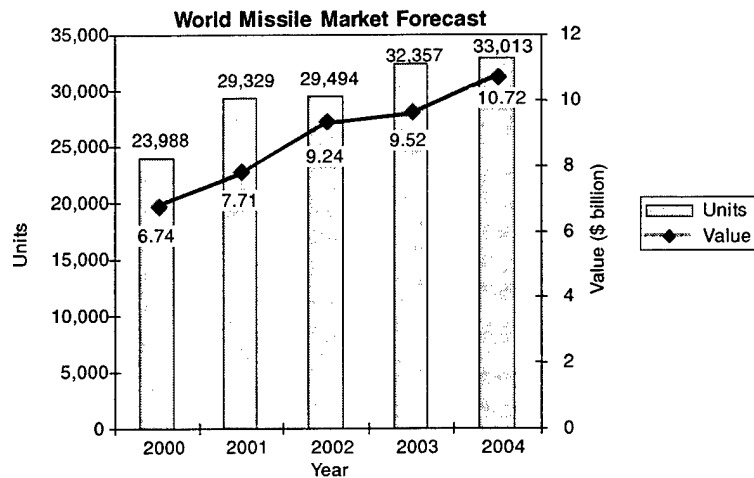
Similar to the military aircraft segment, the missile segment in Europe is characterized by complex cross-shareholding relationships and linkages, as shown in the illustration above. In addition to the formal relationships among companies, there is a wide range of largely program-specific structures or "Euro joint ventures."

In addition to its move to integrate Alenia Marconi Systems, MBDA recently agreed to establish a joint venture with three Spanish companies—IT group Indra, shipbuilder Izar (formerly called Bazan), and EADS' CASA unit. The group, in which MBDA and Indra will hold a 40 percent share each and EADS/CASA and Izar will hold a 10 percent share each, will handle work related to Spain's 10 percent share in the Meteor missile program and other projects.

Separately, MBDA is discussing the creation of an affiliate in Germany with the two German missile makers, LFK and BGT. Between them, EADS and MBDA already have full control of LFK (which is 70 percent owned by EADS and 30 percent owned by MBDA). BGT is 20 percent owned by EADS and 80 percent owned by Diehl, a German family-owned engineering company that specializes in missile electronics and infrared

technology. A possible outcome of these talks would be a joint venture consolidating the German industry.

Missiles: Market forecast



Source: Teal Group, Aerospace Sourcebook 2000.

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MISSILES: MARKET FORECAST

The missile market seems to be one of the most attractive growth segments of the defense industry, mainly due to the increasing importance attached to smart precision-guided weapons, the perceived benefits of potentially reduced casualties, and the technology that can be integrated into missiles. Assuming relatively flat budgets in Europe, one could expect the portion allocated to missiles to grow, particularly after the European deficiencies in such capabilities demonstrated during the Kosovo conflict. Most European governments are expected to spend higher amounts on missiles over the next five years. Among European players, MBDA is in a very strong competitive position to harvest a large percentage of this European opportunity, if and when it materializes.

As seen in the following table, the world missile market seems to be growing, albeit at an uneven rate.⁴⁰

⁴⁰These figures could potentially be revised in the aftermath of the September 11 attacks and the war in Afghanistan.

Years	Growth Rate
2000–2001	+22% in unit terms (14% in value terms)
2001–2002	+1% (20%)
2002–2003	+10% (3%)
2003–2004	+2% (13%)

Missiles: Market insights and trends

- High-growth market segment
- Potential for more consolidation
- Possible developments
 - MBDA integrating smaller players
 - German missile company
- Transatlantic dimension
 - THALES-Raytheon deal promising but may face technology transfer problems
 - MBDA's complex structure may create difficulties in transatlantic linkups

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MISSILES: MARKET INSIGHTS AND TRENDS

The missile market is one of the highest-growth segments in the European defense industry, largely because many European governments are expected to spend more on defense missiles, in particular, over the next five years, reflecting a potential change in spending priorities.

Although recent intra-European consolidation in this segment may have improved Europe's competitiveness, the United States still retains a big lead in many specific areas, particularly in aviation missiles—such as the Advanced Medium Range Air-to-Air Missile (AMRAAM) in the air-to-air segment, JDAM in the air-to-surface segment, and Hellfire in the anti-tank segment.

As mentioned earlier, significant consolidation has already occurred within Europe around two poles (MBDA and THALES), but there are still some smaller players that potentially could be integrated by one of the two big players. For example, MBDA could aim at completing the consolidation process in the missile segment by integrating the two remaining German missile businesses, namely LFK and BGT. Another possible development could be the integration of Saab Missiles into MBDA, given BAE's stake in the Swedish firm. In addition, the creation of

a German missile company to combine EADS' 70 percent share of LFK with BGT could be seen either as an interim step before integration into MBDA or as an independent operation. Integrating BGT into MBDA could prove difficult given that EADS and the Diehl family are engaged in tough negotiations over both the valuation and the future management structure of the operations. Also, although the German government has toyed with the idea of sponsoring the creation of a single German missile house before getting involved in any cross-border consolidation, it does not seem like a very strong possibility today, according to senior German industrialists. MBDA's German move combined with its Spanish joint venture would give the company either control over or a stake in all significant European missile business interests with the exception of those of Saab and THALES. Neither THALES nor Saab has expressed an interest so far in joining the new entity.

In terms of transatlantic links, the THALES-Raytheon deals seem promising but could be mired by technology transfer issues. Furthermore, MBDA's own complex structure and business model—combining a wide range of companies from different countries, cultures, and relationships with the United States—does not facilitate a unified approach, which possibly could create problems in dealing with transatlantic partners.

From the perspective of governments in Europe and the United States, the presence of two large missile companies on both sides of the Atlantic potentially would allow for increased competition. However, the question that remains to be answered is, will governments use purely objective criteria in deciding between American and European firms for missiles linked to major weapon systems? The new MBDA will be a significant force lobbying European governments to choose European rather than American systems. At the same time, in recognition of the need for MBDA to operate in several countries, European governments could be influenced to further ease legal and trade barriers to intra-European technology sharing.

Land systems: Ranking of European players

Company	Country	Products
GIAT	FR	Leclerc, VBCI
GKN/Alvis	UK	Warrior, Stormer; MRAV, Piranha
Vickers Defence Systems	UK	MBT (Challenger 2/2T); MRAV multi-role armored vehicle program
Krauss Maffei Wegmann	G	MBT (Leopard 2, Gepard); scout (Fennek), GTK/MRAV
Rheinmetall Landsysteme	G	WIESEL/WiESEL 2

NOTES: VBCI is a French term for light infantry armored vehicle and GTK (Gepanzertes Transport Kraftfahrzeug) is the German name of the MRAV (Multi-Role Armored Vehicle) program. MBT = main battle tank.

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LAND SYSTEMS: RANKING OF EUROPEAN PLAYERS

The European armored vehicle industry is currently going through a period of uncertainty, particularly since the current decline in spending on ground forces equipment in many NATO countries seems likely to continue. British, French, and German armies have no firm requirements for new main battle tanks (MBTs). After the end of the Cold War, there was a shift in strategic doctrine in Europe with resulting changes in procurement priorities: the abandonment of large and heavily equipped territorial defense forces in favor of smaller, lighter, and more-mobile rapid reaction forces. Such a transformation means that smaller volumes and also different types of equipment are being procured, such as equipment needed for out-of-area crisis management operations (i.e., in the case of land systems, lighter air-portable armored vehicles and only limited numbers of artillery systems and MBTs).

Therefore, changing market needs have diverged from the traditional capabilities and product offerings of the main European players. Despite the existence of a market for MBT replacements and armored vehicle upgrades—MBTs, infantry fighting vehicles (IFVs), and armored personnel carriers (APCs)—demand is increasingly shifting toward lighter, wheeled vehicles to serve rapid reaction forces. This is the case not

only within Europe but also in export markets such as the Middle East. Many countries are moving to more-balanced fleets of both wheeled and tracked APCs, because wheeled APCs are better suited to peacekeeping operations where vehicles have very high utilization rates.

Low demand for heavy armored vehicles within Europe has resulted in fierce competition for a limited number of export contracts in the Middle East and Asia. Competition in these markets is further intensified by the export push from American land armaments companies that are trying to compensate for declining demand in the United States. The German industry has been particularly affected because Germany has a long tradition of and expertise in heavy land systems. European land companies are increasingly finding themselves in a precarious financial situation and with reduced workloads. For example, although the launch of the Multi-Role Armored Vehicle (MRAV) has assured the future of light-vehicle manufacturers, this is not the case for MBT producers. Vickers has a very reduced workload following the delivery of 38 Challenger II tanks to Oman in August 2000, GIAT Industries has little work and accumulated losses of 2.5 billion Euro over the past five years, and Krauss Maffei has difficulty in deciding on a strategy to address the market changes.

In contrast to Europe's primary tier of defense-aerospace companies, where consolidation has effectively played out, the same cannot be said for the land (and naval) systems sectors where many national champions continue to fight turf wars. In this fragmented market, clear market leaders cannot be distinguished. At this point, rather, players can be grouped into two broad categories: the major players and the less significant ones. In the first group are the French state-owned GIAT Industries; the British Alvis Vehicles (recently merged with GKN) and Vickers Defence Systems (owned by Rolls-Royce); and the German Krauss Maffei Wegmann (KMW). The second group consists of smaller players such as the German Rheinmetall Landsysteme, the Italian Alenia Difesa, and others.⁴¹

GIAT Industries is now in an ambiguous position: Its Leclerc MBT production for the French Army lasts until 2005, and its products are technologically very advanced. However, economically, the state-owned entity is supported only by regular injections of government aid. It is

⁴¹The Spanish Santa Barbara Blindados used to belong to that group, but it was acquired by General Dynamics in July 2001, paving the way for transatlantic joint ventures.

reasonable to ask how much longer GIAT will be able to benefit from this arrangement after the Leclerc production ceases. At the moment, GIAT is one of the European land companies trying to adapt to the new market requirements for lighter vehicles—for example, by collaborating with Renault V.I. Defense on the VBCI (Véhicule Blindé de Combat d'Infanterie), a program for the wheeled armored infantry combat vehicle. The VBCI was initially part of the GTK/MRAV program until France decided to pull out and pursue a national program in 1999 after years of bargaining and disagreements over the vehicle's specifications and work share.

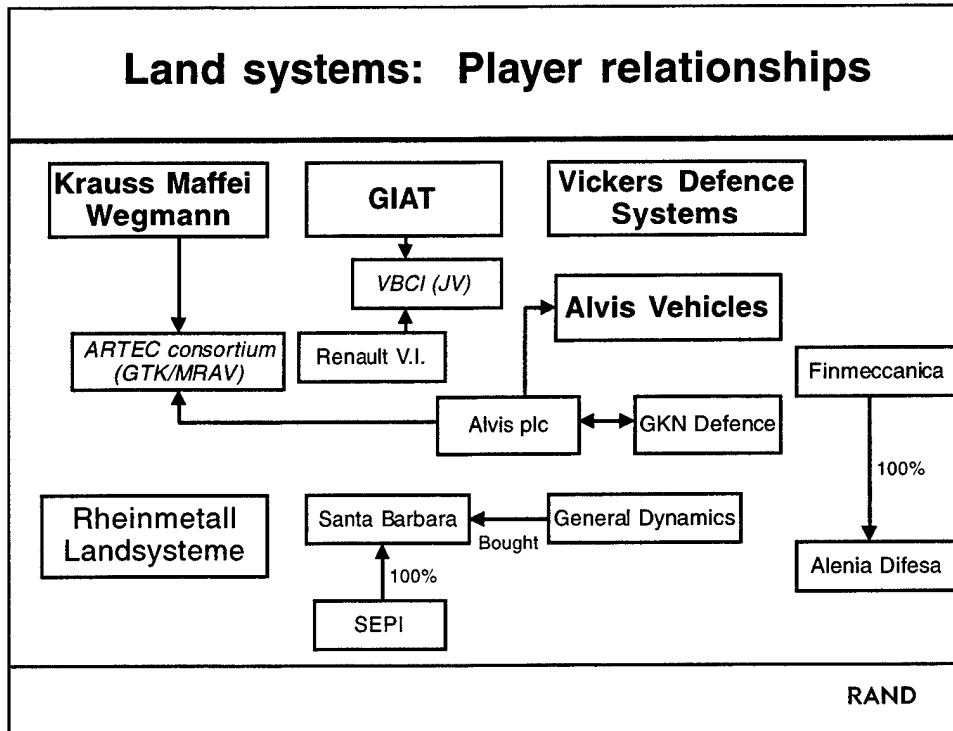
Alvis Vehicles is now a specialist light-vehicle manufacturer, following its merger with British GKN Defence, maker of the Warrior IFV, and the acquisition of Sweden's Hägglunds, maker of the CV90 IFV. Alvis seems to be well positioned to take advantage of the new operational requirements. In addition to the Warrior and the CV90, GKN Alvis produces other tracked vehicles such as the Stormer and Scorpion and wheeled ones such as the MRAV program and the Piranha. There is speculation that Alvis will be a hot contender for purchasing Vickers Defence Systems from Rolls-Royce in order to create a potential giant armored vehicle manufacturer. With Vickers under its wing, Alvis would be able to offer an impressive line of products from MBTs to Warrior and CV90 infantry fighting vehicles made in the UK and Sweden, respectively, to light scout vehicles made by Vickers' new South African subsidiary Reumech.

In 1998, Vickers Defence Systems captured a 24.6 percent market share in armored vehicles. The acquisition of the company by Rolls-Royce created expectations of further concentration in the European military vehicles segment. There is intense speculation that Rolls-Royce will spin off the military vehicle unit in the near future because that unit seems to be out of place with Rolls-Royce's main business lines. One potential buyer for that unit would be Alvis. Another potential buyer would be BAE Systems, which took control of the old armaments division of Vickers Shipbuilding and Engineering (VSEL) when it merged with Marconi Electronic Systems at the end of November 1999. By acquiring Vickers, BAE would round out its capabilities to include armored fighting vehicles. Exactly what Rolls-Royce will do with Vickers' armored vehicle division remains to be seen, particularly because Rolls-Royce officials admitted at the time that their 1999 acquisition had been driven by a desire to acquire Vickers' marine engine business, not the combat vehicle unit which had to be bought along with it. A traditional player in the armored vehicle market is Germany

with two main companies, Krauss Maffei Wegmann and Rheinmetall. Germany has had a big historical ambition and capability in "status quo" land systems. Still, it is far from certain that there is a market for such traditional systems.

KMW produces the Leopard 2A6EX, ranked the world's best tank in January 2001 by Forecast International. Krauss Maffei has already made moves to diversify from tank production by merging with self-propelled artillery manufacturer Wegmann. Its future tank work is likely to be limited to upgrades and coproduction with foreign partners.

A lot of the consolidation in the production of land systems has centered around Rheinmetall, which has made a series of international acquisitions, such as the military activities of Swiss Örlikon Contraves (artillery, small arms, and ordnance) and the German slWKA (Kuka Wehrtechnik and Henschel Wehrtechnik). Rheinmetall has also increased its stake in the Dutch ammunition company Eurometaal.



LAND SYSTEMS: PLAYER RELATIONSHIPS

As seen from the chart above, the European land systems segment is not as consolidated as the other segments examined so far. In fact, it is rather fragmented, consisting of several players without many real linkages among them.

Selected collaborative ventures in this segment are shown on the chart. They include the British-German-Dutch ARTEC (ARmored TEChnology) joint venture company combining Alvis Vehicles, Krauss Maffei Wegmann, Mak, and Stork Defense to develop and produce the 8x8 GTK/MRAV for the German Army and the British Army, respectively,⁴² and the VBCI joint venture between GIAT Industries and Renault V.I. to build the French 8x8 VBCI light-infantry armored vehicle.

⁴²And now the Dutch Army has been added to the initially German-British program.

Land systems: Market insights and trends

Consolidation

- Still overcapacity: too many players, too few programs
- Several obstacles to consolidation exist

Changing market needs

- GTK/MRAV set to continue
- TRACER/FSCS “fading”

Potential role for U.S. companies and/or the commercial sector

RAND

LAND SYSTEMS: MARKET INSIGHTS AND TRENDS

This section presents the progress and current state of consolidation in the land systems market segment, followed by assessments of key segment trends and the potential role of U.S. defense companies and/or U.S. and/or European commercial companies in the European land systems segment.

Consolidation

Although armored vehicle production is a tradition in Europe, particularly in Germany, the large uncertainty characterizing the demand side of the European market for land systems makes more extensive consolidation a necessity. So far, some shaking out has occurred, but there is still overcapacity: too many players and too few programs to sustain an industry of this size.⁴³ Despite the fact that there were not enough

⁴³Overcapacity or productive inefficiency in this context implies a discrepancy between the “desired” or “efficient” (minimum-average-cost) level of output and the actual level of output. A more accurate way of measuring overcapacity would start by estimating the scale of output that would allow a land systems firm to produce at minimum average cost (i.e., the minimum efficient scale [MES] of the land systems market). Assuming such

contracts to support all the existing companies, the West European land armaments industry saw few major restructuring initiatives in the early 1990s. As a result, in the mid-1990s, production overcapacity in military vehicles had become larger than in any other defense industrial sector in Europe.

Currently, there are three major European companies building heavy tanks to increasingly similar specifications—Krauss Maffei Wegmann, Vickers, and GIAT Industries. There are 10 or so prime contractors in the military mechanical sector (as opposed to two in the United States), 4 programs for heavy armored vehicles (versus a single one in the United States), and 16 programs for armored combat vehicles (compared with three in the United States.). Clearly, there is room for rationalization. To date, there are still around 37 major land systems companies in the 17 European NATO countries.

Restructuring of the European land armaments sector along the lines of the aerospace industry will not be an easy task. First, the land sector lacks the decades-long experience of cross-border cooperation and joint projects that preceded the integration of the aerospace industry. Second, the land armaments sector still remains relatively fragmented within national borders, whereas national consolidation would be an important intermediate stage before major cross-border consolidation took place. Finally, the land sector has little contact with the commercial markets and therefore has received little pressure from them to restructure.

Some progress has occurred in the light armored vehicle sector, namely the takeover of small and medium-sized companies by those in a stronger financial position, such as the acquisition of British GKN and Swedish Hägglunds by Alvis of the United Kingdom and the Thyssen Henschel-Kuka operations. But neither the tank sector, with its three dominant actors, nor the artillery sector, where there are 20 companies of all sizes in Europe, nor the munitions sector, with 30 firms of many various sizes, has begun the process of restructuring. On the other hand, land forces equipment is very diverse, and currently only Krauss Maffei's Leopard MBT (which has been bought by 12 armies) can be considered a European standard.

an estimate can be made accurately, a measure of inefficiency could be constructed by comparing actual versus MES output and estimating the shortfall between them.

Completing the process of creating national poles of expertise would be a good first step, allowing some degree of consolidation and rationalization of the land systems market segment. For example, it is most likely that only one German player will remain rather than the current two. Starting in October 2000, political moves in Germany to kick-start consolidation in the land and naval systems sectors indicated the need for further rationalization, mirroring the rest of the defense world. As a result of this initiative, Germany's armaments industry will be forming new strategic alliances in the area of army technology and shipbuilding and looking into the possibility of cross-investments. Specifically, KMW, Rheinmetall, and Diehl are reported to be forming a strategic alliance for army technology, while Babcock Borsig and Thyssen Krupp Industries are forming a strategic alliance in the area of naval shipbuilding. France is also working on rationalizing its land sector, initially focusing more on partnerships and alliances on specific projects.

The logical next phase in land systems would be transnational consolidation, but in order for this to take place, the companies must be on an equal footing. There are several reasons why cross-border consolidation has not greatly affected the land segment:

- Differences in ownership and control of defense companies in European countries—some of these are state owned and heavily subsidized (such as the French companies) while others have commercial links and are privately owned.
- Differences in each country's equipment types and timetable of operational requirements—the slow progress toward harmonization of those requirements is partly responsible for the very small number of collaborative programs in the segment, impeding transnational restructuring.
- The lack of strong competitive pressures on European companies.
- The age of the European land systems industry and a strong state presence (in various forms), which do not easily lend themselves to transnational restructuring.
- The fact that land systems companies are often highly specialized and have widely spread shareholder structures.
- The fact that a large number of land systems companies is relatively small in size and can survive with small contracts in niche markets.

- The reluctance of some governments to encourage industrial restructuring, fearing its social effects in regions historically dependent on land armaments.

The high cost of land systems is forcing countries to consider international collaborative programs, although the experience so far has not given solid reasons for optimism. A good example is the British-American TRACER (Tactical Reconnaissance Armored Combat Equipment Requirement)/FSCS (Future Scout and Cavalry System) program to meet the requirements of the British and U.S. armies for a sensor-driven reconnaissance platform for the 21st century, which was cancelled at the end of 2001. In Europe, Germany, the United Kingdom, and more recently the Netherlands are working together on the GTK/MRAV program. Germany and France signed an MoU in November 1999, and the Dutch joined in February 2001. Each country will procure an initial quantity of 200 vehicles (600 total) with deliveries scheduled to start in 2006. The Munich-based ARTEC consortium—consisting of two German firms, Krauss Maffei Wegmann and Mak Systemgesellschaft, the British Alvis, and the Dutch Stork Defense—is developing the vehicle on behalf of the participating nations. If GTK/MRAV works, it could set the path to greater cooperation within Europe, but it would need to be on a more equal footing, as MRAV is essentially a German-designed vehicle with German subsystems.

Changing Market Needs

Excess supply characterizes the tank and tank-variant market, and forecasted production over the next ten years will exacerbate the problem. The market for medium and light vehicles will decline slightly, but it is still projected to be good for both mature and new systems. Wheeled combat vehicles, in particular, will be important assets for many of the world's military organizations because they have lower unit and lifecycle costs, reduced maintenance, and greater speed and mobility in most terrain than heavy tracked vehicles. Market projections for this class of vehicles remain positive as France, Germany, and the UK position themselves along with other nations to refit or upgrade their inventories.

The trend for increasing demand for lighter multi-role wheeled vehicles originated in the United States. Another trend in that particular segment is the introduction of the "family of vehicles" concept, which is based on the use of a common chassis. Also, although for a long time, most wheeled armored fighting vehicles were of the 4x4 type, over the past few years

there has been a clear trend toward acquiring 6x6 and 8x8 types for their increased payloads and greater cross-country capability.

What will the future bring for this segment? Starting in 2001, the GTK/MRAV program has had a high priority in the UK and Germany. As far as British companies are concerned, the British-American TRACER/FSCS (which was scheduled to start in 2003) has now been cancelled: In February 2000, the U.S. Congress shifted funding from the FSCS to the Future Combat System—an entirely different vehicle family for the U.S. Army—and gave no indication of moving the FSCS project into the engineering, manufacturing, and development phase. Once the United States pulled its funding and planned purchases out of TRACER, the estimated unit costs to the British forces would have soared (because the fixed costs of development and production would have been allotted to far fewer vehicles). In response, the British Ministry of Defence seems to have also shifted its focus from the TRACER to the Future Rapid Effects System (FRES), which would aim at providing the armored element of a medium-weight force and would perform some of the missions once envisioned for TRACER, although at a less sophisticated level. The French GIAT is also trying to move away from “metal bashing” (i.e., manufacturing) to improve its position as a systems integrator while also targeting the U.S. market.

Potential Role for U.S. and/or European Commercial Sector

Industry sources argue that North American land systems companies could play a significant role in the shakeout of this market segment in Europe. American companies seem to be developing a dynamic takeover strategy in Europe. Those companies are primarily interested in market access—getting a foothold in the European market—rather than in obtaining European technological know-how. For example, General Dynamics Land Systems has become the principal shareholder in the Austrian manufacturer Steyr Daimler Puch Fahrzeugtechnik and has also purchased Spanish firm Santa Barbara after a long and controversial takeover process.⁴⁴ Also, GMC Canada has taken control of armored vehicle specialist Mowag of Switzerland, and U.S. land systems giant United Defense has taken over Bofors Weapons Systems of Sweden. Such

⁴⁴Krauss Maffei and Rheinmetall have disputed the takeover. The two German firms were concerned that the know-how in the Leopard 2 tank and the Recovery Vehicle 3, which Santa Barbara builds for the Spanish Army under license, would migrate across the Atlantic.

moves are seen by some observers as another example of U.S. industrial might moving into Europe and could increase pressure on Europe to restructure its land armaments and vehicles sector.

Another potential future development in the land systems segment could be collaboration between traditional military vehicle manufacturers and commercial automobile (car/truck) manufacturers. Furthermore, the same scenario could be observed at a transatlantic level—for example, a joint venture between a German car/truck manufacturer, providing the platform, and an American systems integrator, providing missile and air-defense systems. Such transatlantic alliances would probably be less politically sensitive because they would not be purely defense related.⁴⁵

⁴⁵However, there could be issues of transfer that would be very sensitive, particularly if the German manufacturer insisted on code/access information on the missile systems.

Shipbuilding: Ranking of European players		
Company	Country	Products
BAE Systems (Yarrow, VSEL)	UK	Type 45 destroyer, Type 23 frigates, SSN Astute-class subs
DCN (Direction des Constructions Navales)	FR	La Fayette-class frigates, Charles de Gaulle nuclear carrier, SSBN (4), Agosta 90B and Skorpene-class SSKs
Vosper Thornycroft	UK	Type 45 destroyer
HDW	G/S	Type 124 Sachsen-class frigate, U-212 SSKs
Thyssen Industries (Blohm & Voss, Thyssen Nordseewerke)	G	MEKO frigates and corvettes, Type 123, 124 frigates
Bazan	SP	F100 frigate
RAND		

SHIPBUILDING: RANKING OF EUROPEAN PLAYERS

Shipbuilding is considered a low-value-added industry segment, which explains why the leading primary contractors, with the possible exception of BAE Systems, are not actively interested in investing in this segment (in fact, even BAE is considering contracting out the actual shipbuilding while retaining the systems-integrator role). This contrasts with the situation in the United States, where General Dynamics and Northrop Grumman have acquired all major U.S. shipyards, the latest one being Newport News. The shipyard was the subject of an intense bidding contest between General Dynamics and Northrop in fall 2001, which concluded with Northrop's acquisition of Newport News.

Similar to the situation with land systems, the shipbuilding industry is fragmented and could benefit from further consolidation. The segment is generally structured around national leaders that dominate their domestic markets (BAE Systems in the UK, Fincantieri in Italy, Izar in Spain, DCN in France, and Kockums in Sweden), and smaller shipbuilders specializing in niche markets. At the European level, one can distinguish two "leagues" of players. In the first group belong the British and French players: BAE Systems, DCN (Direction de Constructions Navales), and possibly Vosper Thornycroft. These companies offer a full range of

products from surface combatants to nuclear submarines and from aircraft carriers to patrol boats. In the second group belong smaller players from Germany, Spain, Sweden, the Netherlands, and Italy, such as HDW, Thyssen Industrie (Germany), and Izar (the former Bazan).

The British naval landscape has changed dramatically with the integration of BAE Systems and Marconi Electronic Systems. The latter essentially represents 80 percent of BAE's naval capabilities. BAE Systems, with a turnover of around 2 billion Euro, "inherited" three shipyards from Marconi (Yarrow Shipbuilders, VSEL, and Kvaerner Govan) and is well-positioned in major contracts: It is the prime contractor for the Type 45 destroyer program, produces the Astute-class submarines, and could potentially take part in the future aircraft carrier and future surface combatant programs (the latter being much less certain) and the future attack submarine program (which belongs mainly to the next decade). Therefore, BAE can rely on a significant domestic market for its naval business, which allows it to deploy an aggressive export strategy.

A competitor to BAE, at least in the medium and light categories of vessels, is Vosper Thornycroft, the only other British company with real experience in the manufacture of naval hulls. With its traditional export markets being flat, Vosper has focused on naval construction opportunities in the UK, notably the Type 45 and the projected post-2013 future surface combatant (FSC). Vosper has been specializing quite successfully in certain niche markets, such as maintenance services to the armed forces. In 2001, the shipbuilder managed to secure a significant portion of the design and build work on the Type 45 destroyer program, which is strategically important for the future of the company's shipbuilding business and a challenge to BAE Systems' dominance in naval construction for the British Royal Navy.⁴⁶

State-owned French shipbuilder DCN (and its export unit, DCN International) dominates its domestic market, with a turnover of around 1.6 billion Euro. DCN is the prime contractor for all major national naval programs: In surface combatants, it builds the La Fayette-class frigates and is part of the Horizon frigate program; in nuclear submarines, DCN built the first two in a series of four SSBNs for the French Navy—*Le Triomphant* and *Le Temeraire*. The third, *Le Vigilant*, is under construction, while the fourth is still at the planning stage. In conventional submarines,

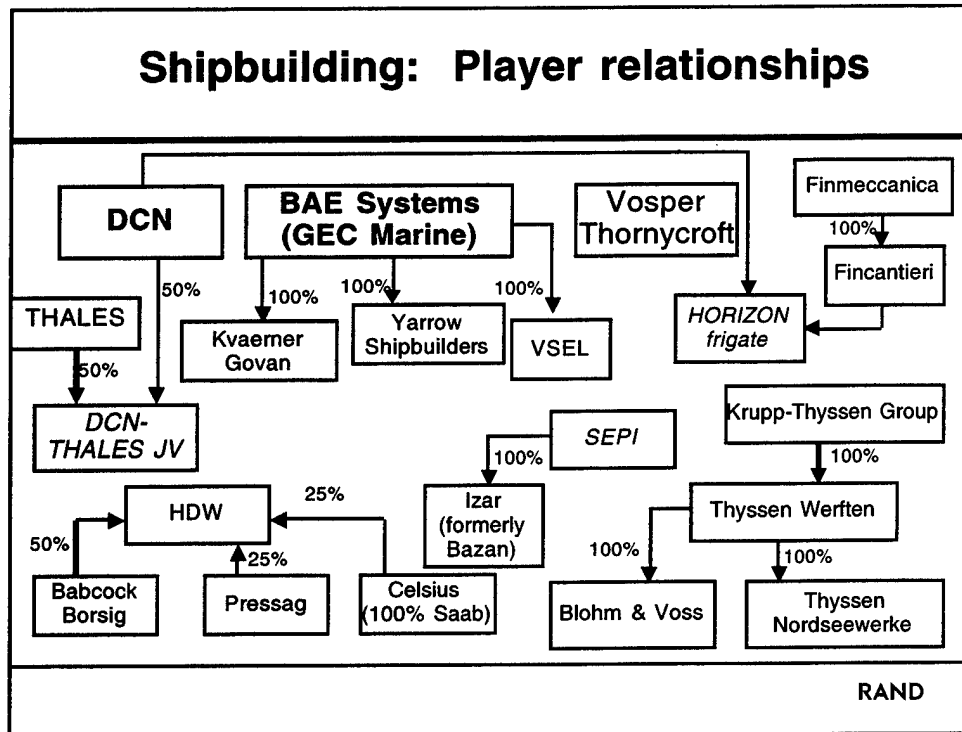
⁴⁶On that program, Vosper had been locked in a battle with BAE Systems, which wanted to build all the destroyers in its Clydeside yards.

DCN builds the Agosta 90B-class and Skorpene-class SSKs. DCN also built the *Charles de Gaulle* nuclear carrier.

Recently, DCN and THALES agreed on a joint venture to develop and produce the combat systems on the SAWARI 2 frigates. The two companies have also established a joint venture company (Société de Systèmes de Défense Navale or SSDN), owned 50-50 by the French state and THALES, in which DCN and THALES will cooperate in the area of naval shipbuilding and combat systems. The new company will combine the prime contracting and naval combat systems expertise of DCN/DCN International and THALES Naval France and will assume responsibility for the French portion of the Franco-Italian Horizon frigate program, in which DCN and THALES have already been cooperating. SSDN could also manage export endeavors like the UK's new-generation aircraft carrier, for which THALES is bidding in cooperation with Raytheon and other companies. German naval companies have smaller turnovers but large profit margins and are very competitive in certain areas. HDW (50 percent owned by Babcock, 25 percent owned by Pressag, and 25 percent owned by Celsius), with a turnover of 0.7 billion Euro, is a market leader in conventional submarines (it produces the Type 209 and U-212 SSKs) and has a strong export performance. HDW also builds surface combatants such as the Type 124 Sachsen-class and Type 23 frigates. Many of its programs are collaborative, for example with Thyssen Nordseewerke (TNSW) and Blohm & Voss. Thyssen, also with a 0.7 billion Euro turnover, owns TNSW and Blohm & Voss, builds among other warships the MEKO frigates series, and participates in the Type 123 Sachsen class frigates program.

In Sweden and Italy, the restructuring of the big state monopolies—Finmeccanica and Bazan—is proceeding slowly and is the object of intense competition among the other big European players. Fincantieri is present in both civil and military shipbuilding, but with a limited market, particularly internationally. Bazan covers the entire spectrum of construction, maintenance, and combat systems. Bazan recently changed its name to Izar after it bought another Spanish naval shipbuilder, Astilleros Españoles, in December 2000. According to announcements from company officials, the new entity will be the ninth largest shipbuilding company globally. Its strategy will be based on cross-border alliances—seeking to build international partnerships on specific programs—rather than pan-European consolidation. According to industry analysts, the company appears to be moving away from European collaboration and toward the transatlantic market. For example,

it is cooperating with Lockheed Martin to put Aegis radar systems on nine new frigates: four for Spain and five for Norway. Furthermore, Izar, Bath Iron Works (part of General Dynamics), and Lockheed Martin have formed the Advanced Frigate Consortium (AFC), an agreement to cooperate on ships weighing between 2,500 and 10,000 tons. However, Izar is still pushing ahead with pan-European programs such as the Skorpene-class submarines for Chile, built with DCN.



SHIPBUILDING: PLAYER RELATIONSHIPS

Even though the shipbuilding segment is organized mainly along national lines, its principal actors have engaged in numerous linkages, both program-specific ones and in a few more permanent ones. In the program-specific category belong the French-Italian Horizon air-defense frigate program (from which the UK has pulled out), a common subsidiary between DCN International and Celsius-Kockums (called ISTC) to design the next-generation conventional submarines following the Skorpene, the collaboration between HDW and Fincantieri for the U-212 submarine, and other collaborations. The figure above shows the ownership relationships and some of the linkages.

Shipbuilding: Market insights and trends

- Europeans dominate their domestic markets
- Potential for consolidation, e.g. in German market, although obstacles remain
- Global warship construction projected to grow by factor of 5, but there may be a drop in naval resources globally
- Prime contractor and systems integration capabilities are critical

RAND

SHIPBUILDING: MARKET INSIGHTS AND TRENDS

Unlike the armored vehicle segment, in shipbuilding there is little intervention in Europe by American companies. The American scene is dominated mainly by two shipbuilders that design very specific products for the U.S. Navy and not really for export markets. Therefore, with limited or no American involvement at all, European manufacturers dominate not only their domestic markets but also the export markets, although they do not have access to the American market.

The European shipbuilding industry remains structured around national markets, with national industries heavily dependent on state orders. Similar to the situation with armored vehicles, there is not enough consolidation. Few collaborative programs have existed until now, and those are mainly of an ad hoc and temporary nature. The only trans-European operation of any size has been the merger between the German HDW and the Swedish Kockums Naval Systems, decided in September 1999.⁴⁷ The merger of HDW with Kockums created a major actor in the

⁴⁷Before that transaction, HDW had been expected to participate in the national consolidation of the German shipbuilding industry by merging with the two shipyards of Thyssen Industrie—Blohm & Voss and Thyssen Nordseewerke.

conventional submarine subsegment, one that ultimately will be linked to BAE Systems through Saab's stake in Celsius (Saab owns 25 percent of HDW).

The German shipbuilding industry is characterized by overcapacity and it seems likely that there will soon be some consolidation there. The Krupp-Thyssen group has announced its intention to get rid of Thyssen Werften (which owns TNSW and Blohm & Voss), and there is still uncertainty about whether HDW will remain in the realm of Pressag. There may also be a merger between HDW and Thyssen.⁴⁸

One of the reasons behind the lack of intra-European consolidation is the fact that demand in this sector is still structured around national markets for two types of navies: blue-water navies that have a complete range of ships (such as France and the UK) and navies with more-modest ambitions (Germany, Italy, the Netherlands, Spain, and Sweden). Moreover, European navies rarely have common requirements. The only significant exceptions are the tripartite minesweeper (Belgium, France, and the Netherlands), the MU90 torpedo (France, Germany, and Italy), and the Horizon frigate (France and Italy, after the UK pulled out).

Even though there is a market for European shipbuilders, the shipyard situation is not ideal. There is a steadily increasing available workload as global construction of major warships (corvettes and above) is projected to increase by a factor of 5, from just 8 units in 2000 to 40 units in 2005. The UK market outlook is particularly positive on the basis of current defense policy guidelines, although there are prospects for intensified competition in the UK domestic marketplace. Nevertheless, shipyards are "going down": for example, the French DCN and Spanish Izar are not doing very well. BAE finds it increasingly difficult to manage its own shipyards (the British company had long been engaged in intense discussions with the British Ministry of Defence, arguing that it could no longer tolerate losing three to four million pounds a month and needed a solid order flow on which to plan and invest).⁴⁹ Only German niche shipbuilders—such as HDW in conventional submarines—are performing relatively well.

⁴⁸This statement refers to the meeting between German Chancellor Gerhard Schröder, Defense Minister Rudolf Scharping, and land and naval systems industrialists in October 2000 at which the Chancellor urged business leaders to move toward consolidation in their respective sectors.

⁴⁹This explains the intense pressure by BAE Systems on the UK Ministry of Defence to award BAE the entire contract for the Type 45 destroyer.

On the demand side, some analyses⁵⁰ suggest that there will be a decline in resources committed to naval forces globally because there has not been a major naval threat to justify current force levels. Specifically, the requirements for combatants that have been articulated for the navies of France, the UK, and the United States through 2018 are unrealistic, given current and projected funding levels. This might imply market changes, such as an increased preference for multipurpose ships, particularly given the increased attention among navies on the need for more sealift and amphibious ships to handle the plethora of small war missions that navies are engaged in today. In addition, the decreased spending will have implications for the structure of the naval market, increasing consolidation and rationalization pressures on the remaining players.

A crucial competitive issue for players in the shipbuilding segment is their ability to provide prime contractor and systems integration capabilities. This area could become more competitive as emphasis is starting to shift toward subcontracting to competent international contractors and integrators. Buyers increasingly expect systems integrators (1) to provide them with complete systems; (2) to control key subcontracts; and (3) to assume the entire risk of a program.

Particularly in military shipbuilding, systems integrators prevail over traditional shipbuilders. An illustration of that trend in shipbuilding is SSDN, the 50-50 joint venture between DCN and THALES aimed at pursuing export and collaborative prime contract management business in warships and naval combat systems. SSDN is intended to combine the systems integration and combat systems skills of THALES Naval Combat Systems with DCN's design and shipbuilding skills. This venture reflects increasing demand in European and other markets for whole warship systems where a single primary contractor delivers a complete combat system, platform, and support package. Another example is BAE in the Type 45 destroyer program, in which the British firm as the prime contractor gives critical importance to addressing integration of all the ship's complex systems at the earliest possible stage of the program and to working with the customer and major suppliers to identify possible risk areas and manage them early on.

The shipbuilding industry in general is characterized by heavy protection of domestic producers, and thus limited export opportunities, and

⁵⁰These analyses include, for example, a report by AMI International, a maritime consulting firm.

governments' desire to maintain a domestic capability. That could change in the near future, however, as budget constraints increase.

An important procurement decision was that by the British MoD regarding the Royal Navy's \$8.7 billion Type 45 anti-air warfare destroyer program. BAE Systems had been pushing very aggressively for building all 12 ships and bypassing competitive bidding, arguing for the need to create a single center of excellence for large naval vessels in view of excess production capacity in the UK's shipbuilding sector. On July 10, 2001, the MoD announced its decision for an initial commitment of six vessels,⁵¹ which will be built by BAE Systems Marine in association with Vosper Thornycroft.⁵² This decision was in many ways a compromise between the interests and demands of the two parties. The larger volume of guaranteed work should allow BAE to make long-term investment decisions,⁵³ while Vosper will play a significant role in the whole program and will benefit from a stable workload that will safeguard jobs in its shipbuilding division well into the current decade. Overall, the UK government decision to go firm on the order, and the resulting certainty for the industry, should have a positive impact on cost reduction and should put the British shipbuilders in as good a position as needed to contemplate how, when, and if there will be a staged rationalization of the European shipbuilding industry.⁵⁴

BAE is also creating tensions with the British government over a competition to oversee construction of two Royal Navy carriers, where again BAE is arguing for curtailing the competitive process. BAE's argument is indicative of the types of pressures the naval segment is experiencing: BAE executives argue that it is unreasonable to expect contestants to invest substantial funds—in this case, the cost of bidding

⁵¹The order doubled compared with the initial commitment contracted in December 2000.

⁵²Under a new agreement with the prime contractor (BAE Systems), Vosper will build sections for all ships in the class, rather than build the second of the first tranche of three.

⁵³However, with the first ship not due until 2007, and work on this contract not due to start in earnest until 2003, the MoD decision has not saved jobs in the short term. BAE Systems has had to announce the cutting of 1,000 jobs in its Clydeside yards in Govan and Scotstoun and 150 jobs in the Yarrow yard.

⁵⁴Tusa, Francis, "2001 The Year in Review," *Defence Analysis*, January 2002, <http://defence-data.com/current/pageda19.htm> (last accessed April 16, 2002).

could total tens of millions of dollars—without reasonable assurance of winning the contract. BAE wants to avoid a loss similar to the 300-million-pound charge it took against the Nimrod maritime patrol aircraft.

Space: Ranking of European players

Company	Country	Products
Astrium	UK/FR/G	Satellites: earth observation, telecommunications, navigation, meteorological, scientific Satellite launchers (Ariane 5) Orbital systems (International Space Station) Military systems (satellite-based reconnaissance, military communications)
Alcatel Space	FR	End-to-end space systems (telecoms, navigation, observation, science, etc.) Platforms (Spacebus, Proteus) Payloads On-board equipment

RAND

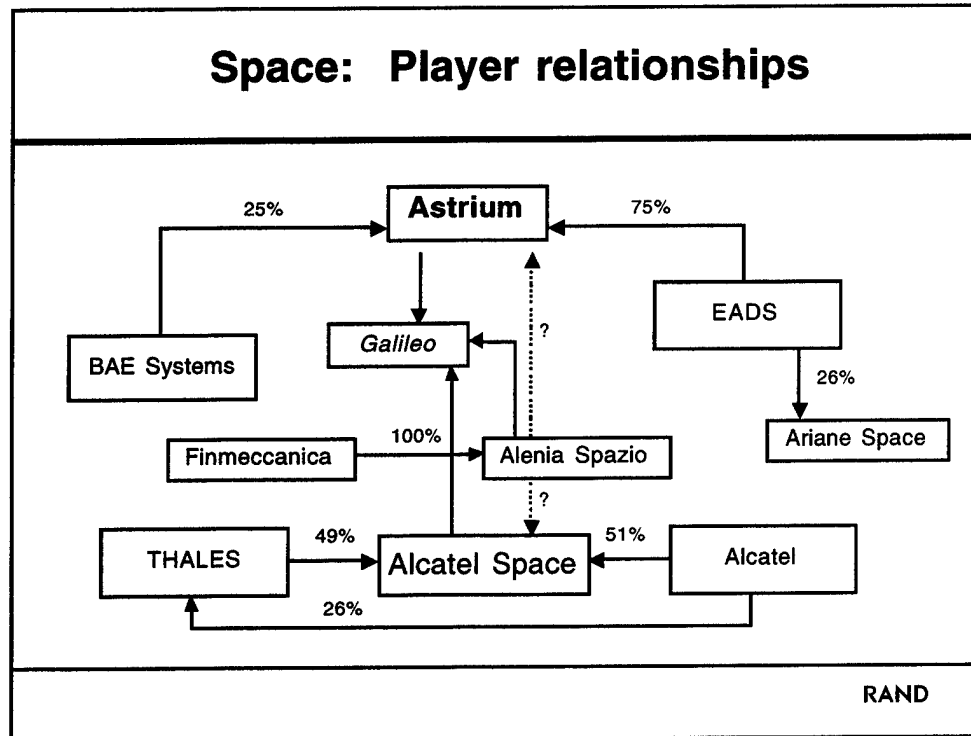
SPACE: RANKING OF EUROPEAN PLAYERS

Within the European space market segment, Astrium and Alcatel Space are the two most significant competitors for American contractors. A much smaller player is Alenia Spazio. Given the crucial role of financing for expensive satellite programs, established companies such as the first two have a competitive position in the market compared with smaller firms that have limited financial resources of their own.

Astrium is the leader in the space market in both the commercial and military segments. Astrium is 75 percent owned by EADS (Matra Marconi Space and DaimlerChrysler Aerospace) and 25 percent owned by BAE Systems. Alenia (Finmeccanica) potentially was planning to join the group, but talks between the two entities have been suspended for the moment. Astrium is Europe's largest space company in terms of sales even without Alenia's participation and is the third largest operator in the global space segment behind Lockheed Martin and Boeing (according to Merrill Lynch estimates in July and September 2000). Sixty percent of Astrium's revenues come from commercial satellites, while its military activities are concentrated in Matra Marconi Space.

A major market presence and close contender to Astrium is Alcatel Space, which is 51 percent owned by Alcatel Alsthom and 49 percent owned by THALES. In 1999 and 2000, Alcatel Space went from an also-ran to a major player in the European space market. Alcatel Space also derives around 60 percent of its revenues from commercial satellites and at the same time is aiming to have a larger presence in the military sector, having had significant progress in France. In the year 2000, Alcatel landed contracts for ten satellites—including France's Syracuse 3, its first award for a large military satellite—representing a 43 percent increase in sales compared with 1999 (2 billion Euros in 2000 versus 1.4 billion Euros in 1999). In contrast, Astrium received six orders, corresponding to a 15 percent increase in sales. Alcatel's sales (2 billion Euros) were about even with Astrium's.

Alenia Spazio is a minor market presence in the space segment. According to its announcement when it suspended talks of integration with Astrium, Alenia Spazio declared its intention to pursue two alternatives: Alcatel Space and a transatlantic alliance. Alenia's decision might reverse competitive positions in the European space segment in the near future.



SPACE: PLAYER RELATIONSHIPS

The chart above shows the intricate web of interrelationships among the players in the space segment. Again, notice that the “big three” (BAE, EADS, and THALES) are present in this segment through their stakes in the main space players.

Although the European space industry has been making moves toward consolidation in France, Germany, and the UK, so far it has failed to bring the Italian space industry into the fold. At the end of 1998, an MoU was signed which would have brought Alenia Spazio’s satellite and international space station activities into Astrium with its parent, Finmeccanica, as the Italian shareholder. The long engagement has recently been broken off, however, with no agreement in sight on valuations and shareholder structure. Alenia is the “wild card” in this process of European consolidation (as the question marks in the figure above illustrate) because its decision on whether to join Astrium, Alcatel, or a transatlantic partner may potentially affect the balance of power and future developments in the segment.

EADS is concentrating on rationalizing its own inherited space activities, which are split between its 75 percent holding in Astrium and its separate

wholly owned EADS Launch Vehicles (EADS-LV) operation.⁵⁵ In fact, EADS and BAE Systems have been in negotiations since January 2001 on restructuring their space businesses. It is understood that BAE has opposed a move that would inject more assets from EADS into Astrium and would require a corresponding injection of capital by BAE to maintain its present 25 percent stake. In January of 2002, BAE and EADS decided to implement a reorganization plan for Astrium's satellite activities.⁵⁶ In addition, a strengthened cooperation between the launcher and orbital infrastructure activities of EADS-LV and Astrium has been agreed upon. This agreement is consistent with the prospect of the integration of EADS launcher and orbital infrastructure activities.

The European space market will probably remain concentrated around the two strong poles of Astrium and Alcatel Space. The latter is most likely to remain independent; Alcatel's joining Astrium probably would not be politically acceptable because it would eliminate competition in both the military and commercial fields. However, according to some analysts and space industry officials, eventually there will be a big restructuring at the global level among the five makers of telecommunications satellites—Alcatel and Astrium in Europe, and Boeing/Hughes, Lockheed Martin, and Loral in the United States. The main reasons are an oversupply of satellite building and launch capacity, falling prices, tight profit margins, and insufficient funding for R&D.

In terms of major European programs, European countries are funding the Galileo project, which is planned as a network of about 30 satellites circling in middle-earth orbit at a height of about 24,000 kilometers. The Galileo project is designed to challenge the U.S. domination of the global satellite navigation services with its global positioning system (GPS) network. The European Commission, European Space Agency (ESA), and private companies have been given the go-ahead, with an initial 100 million Euros of funding, to prepare for a private public partnership (PPP) to develop and deliver Galileo. One billion Euros (from European Commission and ESA funds) will be allocated for the full development

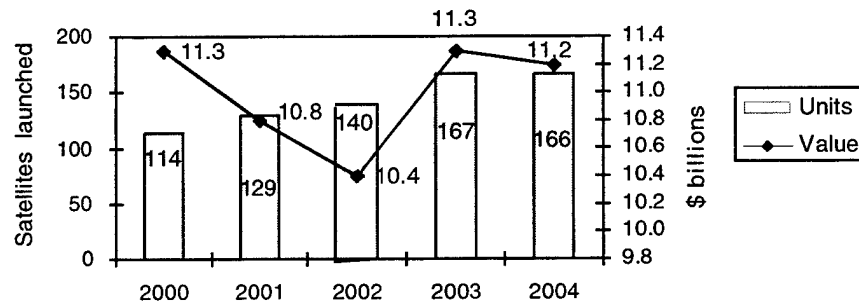
⁵⁵This operation is the renamed former launcher activities of Aérospatiale.

⁵⁶The reorganization plan is aimed at improving the customer focus of the company by better utilizing and coordinating the human and technical resources available in France, Germany, Spain, and the UK; reducing costs through a deeper industrial integration; and streamlining functions in order to improve management efficiency ("EADS and BAE Systems to Strengthen Efficiency of Their Space Activities," www.defense-aerospace.com, January 16, 2002).

phase in December 2001 with the aim of commissioning a fully operating system by 2008. The industrial backers of this project are Astrium, Alcatel Space, and Alenia Spazio. Other important European programs, in military satellites in particular, include the UK's proposed Skynet 5 communications system and France's Helios 2 reconnaissance satellite.

Space: Market forecast

World five-year satellite forecast



Source: Teal Group, Aerospace Sourcebook 2000.

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SPACE: MARKET FORECAST

The graph above presents a five-year forecast of the satellite market by the Teal Group, which predicts a modest growth in units due to the increasing reliance on satellites for a wide range of commercial services, including telecommunications, Internet access, broadcasting and imaging, as well as civil and military applications. However, growth will affect mostly new service applications rather than the construction of new satellites.

There is a limited number of companies, organizations, and governments that will purchase and operate satellite systems, and there is a limit to the number of satellites they will need to deploy. Therefore, the market for new satellite systems is limited in size and the order slowdown is projected to continue. In addition, demand for satellite systems is price inelastic—the number of satellite systems that are required for the projected range of commercial and utility services is inevitably restricted.

Despite the downturn in the number of satellites to be launched into earth orbit during the next few years, this remains a strong market overall. An average of 140 satellites launched each year through 2004 is projected. With the exception of the past three years, the last time anything close to 120 satellites was launched in a year was in 1990, and at that time the

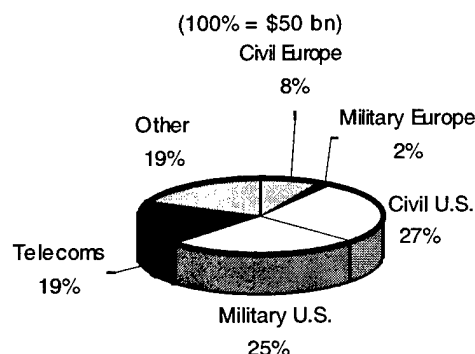
Russians, with their military satellites, occupied a large share of that number.

The commercial market is saturated and the next-generation commercial systems are delayed due to financing difficulties. The ESA budget is tight, particularly after spending so heavily on the launch of the Ariane 5 vehicle and on the Columbus Orbital Facility for the International Space Station. However, there is strong support for ESA's earth observation program, and thus for any satellite whose focus is on earth sciences.

In the military satellite market, the U.S. currently owns and operates more than one-third of the world's military satellites. The Teal Group estimates that around 29 satellites are launched annually, and that number is expected to increase to between 30 and 35 annually by 2004. Of those 29, around 10 or 11 are launched by the U.S. Department of Defense, about 15 are Russian, and the remaining come from Europe, China, Israel, or Japan. Around 305 military satellites are scheduled to be launched worldwide from 1999 to 2008.

Space: Sales by subsegment

Breakdown of the global space market



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SPACE: SALES BY SUBSEGMENT

Even though the global space market generates a turnover of roughly \$50 billion a year, more than half of that market, insofar as it corresponds to the American military and parastatal (nonstate) market, is inaccessible to European companies. American companies hold the lion's share, just over 50 percent of the market, due mainly to their large domestic market, boosted by military contracts. Europe holds a mere 10 percent of the global space market, including both military and civil applications.

However, in the commercial satellite segment, European manufacturers are gaining market share relative to their American counterparts due to stiffer new regulations affecting the latter. A study of worldwide satellite sales trends led by the Satellite Industry Association (SIA) highlighted the switch in export control authority from the U.S. Commerce Department to the Department of State in 1998⁵⁷ as contributing to the lost market share for U.S. firms. The SIA study indicated that since the new stiffer regulations took effect, U.S. companies' share of the commercial satellite

⁵⁷In 1998, Congress passed the Strom Thurmond National Defense Authorization Act (NDAA), transferring export licensing authority for all commercial satellite and related components from the Commerce Department to the State Department.

market dropped from a ten-year average of 75 percent to 47 percent of all worldwide orders by the year 2000.⁵⁸ At the same time, European satellite manufacturers are increasing their orders compared with American firms and are gaining market share. For example, European companies in 2000 for the first time outstripped U.S. companies in geo-satellite orders. According to the SIA study, some companies, including GE Americom, Inmarsat, and Intelsat, that had purchased U.S. spacecraft in the past shifted to Alcatel and Astrium.

⁵⁸This disadvantage may now be eliminated with the return of export licensing authority for commercial communication satellites to the U.S. Department of Commerce through the Satellite Trade and Security Act (STSA) of 2001 (legislation introduced by Representatives Howard Berman, D-Calif., and Dana Rohrabacher, R-Calif.). The STSA is designed to restore and strengthen the competitiveness of the U.S. satellite industry and enhance national security by preventing the unauthorized transfer of sensitive satellite-related technology.

Space: Market insights and trends

Commercial space

European characteristics:

- Record level of activity
- Dominant in civil launch business; tapping navigation satellite market
- Growth opportunities in provision and management of services

Military space

- Growth opportunities may be curtailed due to budgetary pressures

Overall

- Positive prospects for international cooperation

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SPACE: MARKET INSIGHTS AND TRENDS

This section provides a brief overview of key trends in the commercial and military space segment and identifies potential opportunities for international cooperation in that segment.

Commercial and Military Space

In commercial space, European manufacturers have been very dynamic and are experiencing a record level of activity in contrast to the United States. Europeans hold a 10 percent share of the commercial satellite manufacturing market and have a dominant position in the civil launch business with Ariane. According to the SIA report mentioned earlier, the U.S. share of the commercial satellite market plunged in 2000, falling below 50 percent for the first time. According to an analysis by investment bank Merrill Lynch, the satellite manufacturing market has modest growth opportunities, although most of that growth is driven by the commercial space sector. In the military sphere, improved surveillance and observation are among the areas to be prioritized by most military establishments, within the context of continuing pressure on defense budgets. Consequently, growth opportunities might be subdued because of that budgetary pressure. On the commercial side, more growth is

expected in communication satellites than in the civil observation segment. The strongest growth currently is expected in the provision-of-services element. However, one should not neglect the impact of factors such as the high level of financial investment that is required and the significant operational and marketing risks involved in space ventures.

Major areas of European activity in commercial space include (1) government-financed initiatives; (2) launch vehicles; (3) satellite construction; and (4) International Space Station activities. France is leading Europe's space effort by providing 46 percent of the funding for the Ariane launcher programs (in return for primary contractorship), by spearheading together with Germany a series of military satellites and by providing most of the infrastructure for launch facilities and satellite manufacturing. France is at the center of efforts to create a common European space industry.

The Europeans are tapping the navigation satellite market with their government- and industry-backed Galileo satellite network, mentioned earlier. Galileo's backers claim that the system, which will be strictly for civil use and under private-sector control, will end Europe's dependence on U.S. military control of satellite GPS. The argument is that if Europe wants to be technologically competitive and have a common foreign and security policy, it must have the infrastructure—independent navigation and Earth-observation systems—to fulfill these objectives. Moreover, Galileo will allow the development of new industries and services in Europe, creating a potential market of 9 billion Euro annually and generating 140,000 jobs. Currently, the project is mired with difficulties, including schedule slippages, largely due to protracted negotiations over the civil versus the military nature of the project, the role of the private sector in financing, and concerns over potential public-sector liabilities.

Positive Prospects for International Cooperation

At the European level, in an effort led by the ESA, governments and industry have agreed to coordinate space technology R&D in order to end duplication. ESA coordinates most of Europe's government spending on space, although individual nations continue to develop their own space programs, which sometimes duplicate the research and technology (R&T) efforts of other countries. Several areas of overlap currently exist in the European space segment, including electric satellite propulsion, micro- and nanotechnologies for satellites, and large deployable satellite antennas.

European governments also are planning to eventually adopt a single policy in military space and civilian Earth observation managed by the European Commission at the political and strategic level and managed by the ESA at the operational level. More-intense competition in combination with the realization by European countries of the benefits of cooperation have resulted in Great Britain, Italy, France, Germany, and the 14-nation ESA looking for commercial satellite alliances. Most countries prefer to keep military contracts close to home, yet some have allowed U.S. companies to bid as well. This emerging international market could create significant revenue opportunities for U.S. space suppliers, although U.S. military export regulations may constrict this trade in the near term. Key benefits resulting from such international alliances are improved technology and market access.

European market players: Subsystems

PROPULSION	RADAR / SONAR	LANDING SYSTEMS
Rolls-Royce	THALES	Messier Dowty (SNECMA Group)
SNECMA	Alenia Marconi Systems (AMS)	
Motoren und Turbinen Union (MTU)	EADS, BAE, Saab/Ericsson, Thomson Marconi Sonar (TMS), STN Atlas	

DEFENSE ELECTRONICS	ELECTRONIC WARFARE
BAE, THALES	BAE (Sanders, Marconi Electronic Systems)
EADS	EADS, THALES, Celsius
Finmeccanica, Saab	

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B. EUROPEAN MARKET PLAYERS: SUBSYSTEMS

The tables above and below illustrate that the European defense market is as fragmented at the subsystem level as it is at the platform level, if one excludes landing systems, a market segment dominated by one firm—Messier Dowty.

Market Segment	Number of Players
Propulsion	8
Defense Electronics	12
Radar/Sonar	7
Electronic Warfare	5
Landing Systems	1

It is worth noting that the logic of fragmentation may vary according to the circumstances and market segment. In some subsystems, fragmentation may reflect ossification, national protection, and/or inertia, whereas in others it may reflect innovation, competition, and a dynamic

environment generating a multiplicity of companies seeking market share and growth.

Propulsion: Global ranking of players

Company	Country	Aerospace sales (\$ bn), 1999
General Electric	US	10.56
United Technologies (Pratt & Whitney)	US	7.67
Rolls-Royce	UK	6.11
SNECMA	FR	3.96
Honeywell	US	3.87
MTU	G	1.74
Ishikawajima-Harima	J	1.72
Cordant	US	1.31
BMW/Rolls-Royce	G/UK	0.73
Labinal (SNECMA)	FR	0.58

Source: Credit Lyonnais Securities Europe, November 2000.

NOTE: European companies are shown in boldface.

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PROPULSION: GLOBAL RANKING OF PLAYERS

The main subcategories included in the propulsion segment are aero-engines (for fixed-wing aircraft and helicopters), and space (for rockets), missile, naval, and land propulsion.

The table above shows the global ranking of players in the civil and military engines market, according to their aerospace sales in 1999. Four companies dominate the global engine market—General Electric (GE), Pratt & Whitney (owned by United Technologies), Rolls-Royce, and SNECMA (which has recently acquired Labinal, number ten on the list). Nowadays, the majority of these companies' profits come not from the high-thrust, short-duration fighter engines, as was the case in the past, but from the lower-thrust, longer-duration commercial engines. This is a significant market, given that engines make up approximately 25 percent of the flyaway cost of any aircraft.

Robust competition drives all four major engine companies to pursue continuous improvement of product performance, industrial processes, and services. Airlines are tough customers and force manufacturers to cut costs. The worldwide market does not seem adequate for continued growth of all four companies and, therefore, while engine manufacturing

will remain a core competency, firms need to adapt and expand operations in service-related areas to remain viable. In addition, development costs are high, largely driven by environmental concerns and the firms' need to comply with pollution regulations and restrictions, which force companies to spend significant amounts on R&D.

Changes in engine market shares are very slow, particularly in the commercial segment. Airlines keep their engine fleets uniform to reduce maintenance costs, therefore reducing changes in market share. For this reason, gaining market share is a key competitive advantage for engine manufacturers.

Propulsion: Ranking of European players			
Company	Country	Products	1999 Revenues (\$ bn)
Rolls-Royce	UK	Civil: Trent, BR715, AE3007 Military: EJ200, MTR390, TP400; Sprey, WR-21	6.11
SNECMA Group (SNECMA, Turbomeca)	FR	Civil: CFM56 Military: M88, M53, ATAR, MTR390, TP400; Ariane 4 and 5 propulsion	4.54
MTU	G	Military: MTR390, EJ200, RB199, TP400; Ser. 396SE submarine engines; Ser. 870 (Leopard 2)	1.74
FiatAvio Volvo Aero	IT S	RB199, TP400	1.40 1.25
RAND			

PROPULSION: RANKING OF EUROPEAN PLAYERS

The table above provides an overview of the main European players in the engine segment and their product range, ranked by their segment revenues in 1999. To put this information into perspective, one can compare these European companies with their American competitors. GE had a turnover of \$10.6 billion, while Pratt & Whitney, the world's second-largest engine manufacturer, had an \$8.2 billion turnover, and Honeywell/Allied Signal had a \$2.05 billion turnover, ranking fifth globally after SNECMA.

In the commercial part of the market, according to estimates from SNECMA, the market shares based on cumulative firm orders from 1985 to 1999 were as follows: 34 percent for GE, 24 percent each for Pratt & Whitney and SNECMA, 15 percent for Rolls-Royce, and 3 percent for other firms.

Rolls-Royce is Europe's leading manufacturer of propulsion systems and the world's second most important supplier in aircraft engines, after GE. Civil aerospace constitutes 54 percent of the group's sales, while the corresponding shares for military products and marine propulsion are 24 percent and 13 percent, respectively. In civil engines, at the heart of Rolls-

Royce's success is the Trent engine, which is the engine of choice for the Boeing 777 and the Airbus A330. The Trent 500 is currently being developed for the A340-500/600 and has already won orders and options worth \$5 billion from ten airlines. In the regional jet sector, Rolls-Royce's most successful products are the BR715 for the Boeing 717 and the AE3007 engine for Embraer aircraft. Rolls-Royce's acquisition of Allison Engine Company in 1995 significantly enhanced the company's position in the corporate and regional aircraft sector.

In military aero-engines, Rolls-Royce has strategic positions in most major aerospace programs, including the JSF, the C-130J, the Eurofighter, and the V-22 Osprey. The company has a strong product portfolio, with the Eurofighter's EJ200 entering production, continued development for the JSF, the TP400 selected for the A400M, the MTR390 for the Tiger helicopter (jointly developed with MTU of Germany and Turbomeca of France), and the RTM322 (in collaboration with Turbomeca).

In marine propulsion, Rolls-Royce is also among the global leaders. The acquisition of Vickers in 1999 doubled the scale of Rolls-Royce's business in marine propulsion systems (gas turbines, diesel engines for surface vessels, and nuclear plant for Royal Navy submarines) and added a range of complementary products and services to its existing naval systems. Rolls-Royce expects its marine business to grow substantially over the next five years, due to the beginning of a naval re-equipment cycle and the company's enhanced market position, with a comprehensive product range and solid systems-integration capability.

Rolls-Royce sees itself as a systems integrator in its various areas of activities and is also particularly focused on after-market services. Over the past five years, it has tripled gas turbine deliveries, more than doubled its installed engine base, grown top-line sales by an annual 13 percent, and tripled its aero after-market business. Following the general market trend, Rolls-Royce has increased its business focus on support and maintenance, which is becoming its primary source of profitability as a result of the increased reliability of new engines, which in turn has resulted in a decline in the pace of demand for engine replacement.

The company's stock market performance over the past few years has been very poor, mainly because of a fall in revenue and profits from spare parts and maintenance due to increasingly reliable civil engines. Although, according to industry analysts, the near-term outlook for 2001 remained disappointing, Rolls-Royce is still expected to play a key role in the Europe-wide consolidation of the engine industry. According to

company estimates, Rolls-Royce secured a 31 percent share of engine orders placed during the year 2000 and a 27 percent share of engines delivered. Overall, Rolls-Royce currently is estimated to hold a 25 percent global market share in engines for jets with more than 100 seats, and that share is projected to increase.

At the transatlantic level, the acquisition of Allison has enhanced Rolls-Royce's business in the United States: The Department of Defense is the company's largest defense customer, with a range of engines for combat, trainer, transport, maritime patrol, aerial surveillance, and helicopter aircraft. Also, Rolls-Royce participated in each of the competing aircraft configurations in the JSF program. In 1999, 80 percent of the company's revenues were derived from outside the UK.

The next major European player, SNECMA, has gained a strong position as the European engine sector consolidates, with the acquisition of a majority stake (49.38 percent) in the Labinal group, owner of Turbomeca, Europe's biggest helicopter engine manufacturer. SNECMA is Europe's second-biggest aero-engine manufacturer after Rolls-Royce and the world's fourth largest. It is also Europe's leading manufacturer in space propulsion. The company is 98 percent controlled by the French state with the balance of its shares held by Pratt & Whitney. The French government considers SNECMA to be an exemplary enterprise, given its good performance and professional management, which more closely resembles that of a commercial enterprise rather than that of a state-owned company.

Lately, the French government has been considering the privatization of SNECMA in the hope of making it the centerpiece in a radical restructuring and streamlining of continental Europe's main aircraft engine manufacturers. The timing of the privatization is still unclear, though, mainly due to political reasons.

SNECMA offers a comprehensive range of propulsion products for civil and military aircraft, missiles, satellites, and launch vehicles. Civil engines constitute about 67 percent of the company's sales (5.65 billion Euro consolidated sales in 2000), military engines about 10 percent, and rocket engines about 20 percent (according to company figures). Since its founding in 1945, SNECMA Moteurs has produced nearly all the jet engines for the French military aircraft. Today, SNECMA produces the M88-2 and M88-3 engine for the Rafale's Air Force and Navy version and the M53 for the Mirage 2000 series. In the civil market, SNECMA produces (in a 50-50 joint company with General Electric of the United States) the

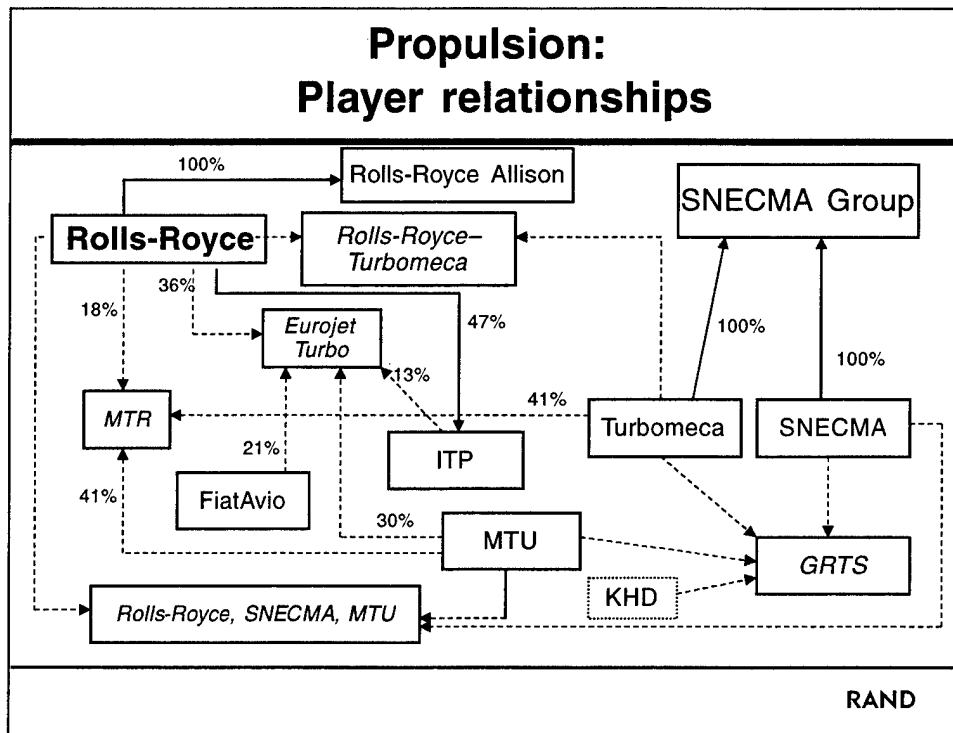
CFM56 family¹ powering the Airbus A318, A319, A320, A321, A340, and Boeing 737. The company is also prime contractor for all three stages of Ariane 4 and the main stage of Ariane 5 and produces propulsion systems for France's nuclear strategic and tactical missiles. Finally, through its acquisition of Turbomeca, SNECMA produces a wide range of helicopter engines, such as the TRI 60 for the Apache and the RTM322 for the NH90. According to company figures, half of SNECMA's sales is to European countries (this includes 20 percent within France), while one-third goes to the U.S. market.

Both SNECMA and Rolls-Royce have benefited hugely from a recent boost in U.S. business. Rolls-Royce has seen strong returns from work with Boeing on the 747, 757, and 777 aircraft, while SNECMA's tie-up with GE in the CFM program has produced the world's most successful civil jet engine line ever.

German company MTU occupied the third place (based on sales revenues) in the European engine segment. MTU produces (mostly through collaborative programs) propulsion systems for aircraft and land and naval systems. In land systems, MTU produces the Series 870 engine for the Leopard 2 (the standard for MBTs, particularly with respect to mobility) as well as the MT883, which belongs to Series 880. The MT883 is employed in the EuroPowerPack destined for third-generation MBTs, such as the Leclerc "tropicalisé," the Challenger 2E, and the Abrams M1. In the naval field, MTU produces propulsion systems for patrol and landing craft, corvettes and frigates, mine countermeasures vessels, and submarines. At the transatlantic level, MTU has had cooperation agreements with both Pratt & Whitney (in the past) and GE—for example, on the NH90 helicopter engine with FiatAvio or on GE's CF6 aircraft engine and its Marine and Industrial derivative programs—but both types of collaboration are purely program based.

FiatAvio is a much smaller engine manufacturer, which develops, produces, and distributes components and systems for airplane and helicopter engines and assembles turbines for marine-propulsion applications in the space sector. It manufactures propulsion systems for launchers and satellites.

¹The CFM56 family of engines is arguably one of the most successful aerospace transatlantic ventures.



PROPULSION: PLAYER RELATIONSHIPS

International partnerships enable companies to share risks, gain access to international markets, and share expertise. All major engine manufacturers have international partners: French engine manufacturer SNECMA is partnered with American GE, Rolls-Royce acquired Allison Engine Company of the United States, and German MTU is partnering with Italian FiatAvio and American Pratt & Whitney.

Within Europe, there are no prospects of a merger between the two main players, number-one Rolls-Royce and number-two SNECMA. The latter is expected to initiate exploratory discussions with independent engine producers such as MTU in Germany, Italy's FiatAvio, and Sweden's Volvo Aero. However, no specific consolidation plan has been determined. Also, SNECMA has formed an equally owned joint venture with French solid motor/munitions manufacturer SNPE, combining their propulsion businesses among others. The product range of the combined entity would include propulsion systems for space launchers, spacecraft, and strategic/tactical missiles.

The diagram above only shows a few of the numerous types of structural relationships that link European engine manufacturers. Examples include

a number of joint ventures producing a specific engine or series of engines:

- The consortium producing the EJ200 engine for the Eurofighter is Eurojet Turbo GmbH 2000, which consists of Rolls-Royce (which owns 36 percent of the enterprise), MTU (which owns 30 percent), FiatAvio (which owns 21 percent), and ITP of Spain (which owns 13 percent).
- GRTS, composed of Turbomeca, SNECMA, MTU, and KHD, produces the Larzac series of aero-engines.
- Rolls-Royce Turbomeca Ltd., jointly owned by the two companies, is producing Adour turbofan aircraft engines and the RTM-322 series of helicopter engines used on the EH 101.
- The Rolls-Royce/SNECMA/MTU joint venture produces the Tyne R Ty20 aero-engine.
- The MTR consortium, consisting of Rolls-Royce (which owns 18 percent), MTU (which owns 41 percent), and Turbomeca (which owns 41 percent), produces the MTR390 turboshaft engine for the Tiger helicopter.
- The RB199 program for the Tornado engine is a collaboration among MTU, Rolls-Royce, and FiatAvio.
- The TP400 engine program is a collaboration among MTU, SNECMA, Rolls-Royce, ITP, FiatAvio, and Belgium's Techspace Aero to produce the sole engine for the new European transport aircraft, the A400M. The A400M is a major program and a major European cooperation initiative in the European engine segment. Formal commitments by European governments were announced at the Paris Air Show in June 2001. Initial plans have allocated MTU, Rolls-Royce, and SNECMA with a 24.8 percent stake each in the TP400 project, ITP with a 13.6 percent stake, FiatAvio with an 8 percent stake, and Techspace Aero with a 4 percent stake.
- Finally, Rolls-Royce and SNECMA are collaborating (as of February 2001) on a technology acquisition program for advanced engines, but this program has low priority and low funding so far due to its very long time horizon (beyond the 30-year range).

In addition to intra-European partnerships, the engine segment is one of the most active in transatlantic cooperation arrangements, which are further analyzed in the next section.

Propulsion: Market insights and trends	
• Segment performs well, driven by strong civil side • Civil market — Increased competition and engine reliability put pressures on prices, profit margins — More emphasis on product support — High development and compliance costs • Military market — Better profit margins, but long-term uncertainty • Intra-European consolidation—more to come? • Transatlantic dimension much stronger than in other segments	
RAND	

PROPULSION: MARKET INSIGHTS AND TRENDS

The engine segment, driven mainly by the commercial side, is in good condition today, whereas the military market is stagnating or even declining.

Civil Market

Today, engines are considerably more reliable than those of previous generations as a result of competition, technical improvements, and customer demand. This reliability further depresses the potential for engine sales by adding to the projected engine life spans.

Furthermore, given the degree of competition in the engine segment, potential customers have two or three comparable engines to select from when procuring new aircraft. This leads to considerable competitive price pressures on new engine sales, driving profits to very low levels, and possibly even to losses, with the hope of realizing profits through life-cycle service contracts. In addition, increased reliability has stretched the timeline to profitability, which implies a slower return on investment for engine manufacturers.

Low sales profits and slow return on investment justify companies shifting their business focus from engine manufacturing as a single core competency to product support, spares, and service, such as leasing or providing depot-level support. Innovations such as maintenance agreements that are priced as a function of the amount of time an engine is operated—for example, Rolls-Royce's "power-by-the-hour" program—are becoming common for both commercial and military aircraft.

Finally, development costs for engines have increased, because of the necessity to comply with environmental regulations, in particular pollution restrictions. For example, SNECMA spends about 13 percent of its revenues on research, technology, and development, three times the share amount spent in other industries (such as the automobile industry) and comparable only to R&D spending in the pharmaceutical industry. One of the principal drivers of this spending, according to company officials, has to do with the necessity to make engines more environmentally friendly. In addition, the risks and high cost of engine design and development have led to frequent collaboration on specific engine projects through limited partnerships.

Military Market

The military market has been reduced to only one-third of the civil market in dollar value after the demise of numerous cold war-era combat aircraft programs. Unlike the civil market, the military one is consistently lucrative and generally has guaranteed profit margins but is also characterized by considerable uncertainty. The EJ200 engine for the Eurofighter, built by Rolls-Royce, MTU, FiatAvio, and ITP, has strong export prospects and is the closest thing to a secure next-generation program. The rest of the market is less clear. SNECMA is building the M88 engine for the Rafale and the M53 engine for the Mirage 2000. While sales of the latter remain strong, the Rafale is facing a lot of uncertainty and remains vulnerable to budget cuts and industrial restructuring considerations.

European military engine contractors face the same long-term uncertainty as fighter manufacturers. The United States is the only country funding both active production programs and next-generation advanced technology programs. In contrast, European funding for current production efforts is limited and government-funded technology development programs are small. In the United States, the Integrated High-Performance Turbine Engine Technology (IHPTET) initiative will benefit future developments of the JSF engines and increase the skills of

U.S. propulsion manufacturers, who are likely to use IHPTET to increase their military dominance through new product development. Some Europeans may also benefit from that effort, such as Rolls-Royce, through its work on the JSF and indirectly through its Allison unit. More alliances may result from this situation in which smaller contenders will look to the big manufacturers for work and technology while big contractors will be looking for risk-sharing and market-penetration opportunities.

Intra-European Consolidation

Because of the engine segment's good performance so far, it lacks the restructuring incentives that are found in other segments. Therefore, restructuring has not moved very quickly in the engine segment. According to several analysts, further consolidation of the propulsion sector is inevitable. Mergers in the engine segment are aimed at guaranteeing higher margins, particularly for European manufacturers, compared with their Anglo-American competitors. Specifically, mergers have spread internally funded R&D spending over a broader base, particularly in countries where the flow of military orders for engine makers is uncertain. These mergers also help build a better position in dealing with major order-placers (such as Airbus, Boeing, and others) because they involve a higher percentage of supplies. These mergers also enhance the potential for cross-fertilization between civil and military products because there is little difference between a commercial engine and a military engine, except perhaps for the higher levels of maintenance required for military engines as a result of large changes in speed. At the intra-European level, it is most likely that consolidation will happen through integration of smaller players, such as MTU, FiatAvio, and Volvo Aero, by one or more of the big players, such as Rolls-Royce and SNECMA.

Transatlantic Linkups

Whatever driving forces are tugging Europe's aircraft manufacturers toward a Euro-centric consortium, they are entirely different from those that underpin Europe's engine manufacturers. Engines are one area where Europe has been able to penetrate the U.S. market, partly because engine technology is likely to be subject to fewer technology transfer restrictions than other defense technologies, and partly because it is an area in which the United States is not vastly superior to Europe.

Transatlantic links date back to 1974 (GE teaming with SNECMA, Rolls-Royce with Pratt & Whitney, Pratt & Whitney with MTU). Perhaps the

best example of effective European penetration of the U.S. defense market in the engine segment is Rolls-Royce's takeover of Allison Engine Company in 1995. Although this takeover sparked the creation of several security requirements, in April 2000, in a radical move, the U.S. Department of Defense (DoD) announced that it was lifting the proxy board requirement for Allison, replacing it with a more flexible Special Security Arrangement (SSA). The SSA creates a board composed of U.S. nationals and citizens of the country of the parent company, whereas the proxy board consists of only U.S. nationals. While this is a positive move by the DoD, it does not necessarily predict a more widespread replacement of proxy boards by SSAs. Rolls-Royce has preserved American jobs and technology, despite the fact that in some aspects of the aero-engine business, British technology was superior to that of the U.S. The company's example seems to suggest that in order to succeed in the United States, European companies need to build businesses there and to employ Americans in senior positions.

Another example of Rolls-Royce's transatlantic links is its teaming with Northrop Grumman to supply the new WR-21 marine gas turbine for the British Royal Navy's Type 45 destroyer program. The turbine has been developed by prime contractor Northrop Grumman's Marine Systems business unit and Rolls-Royce under a U.S. Navy contract awarded in 1991 and through additional funding support received from the UK and France. (Northrop Grumman and Rolls-Royce have signed a licensing agreement with French shipbuilder DCN for the marketing and manufacture of approximately 10 percent of the WR-21 engine.)

SNECMA is also very active in transatlantic collaboration, primarily through its 50-50 joint venture with GE (CFMI), which produces the best-selling CFM56 engine used on the Boeing 737 and a series of Airbus models (A318, A319, A320, A321, A340). The CFMI venture represents about one-third of SNECMA's revenues. According to SNECMA's own estimates, CFMI captured 45 percent of the world market in commercial aircraft engines in terms of cumulative company orders from 1985 to 1999. SNECMA also has a much smaller relationship with Pratt & Whitney in the space business (producing nozzles for rocket engines) and a joint venture with Lockheed Martin.

The structure of the global propulsion segment is likely to change due to potential consolidation pressures in light of recent world events. The failure of GE to acquire Honeywell has left the segment in a state of

uncertainty.² The delayed privatization of SNECMA coupled with renewed financial pressure on Rolls-Royce suggests that a transatlantic marriage may not be far away (for example, GE-SNECMA or Rolls-Royce-Pratt & Whitney).

²The European Commission's blocking of the GE-Honeywell merger could have broader implications in terms of slowing down potential aerospace and defense industry mergers in the United States as well as at the transatlantic level. The Commission's decision may also affect the types of relationships sought by firms on both sides of the Atlantic, which may resort to joint ventures rather than full-scale mergers.

Defense electronics: Ranking of European players

Company	Main products	Estimated 2000 Revenues (Euro bn)
BAE Systems	Avionics, communications, identification friend or foe, C4I, EW	4.0
THALES	Communications, avionics, C4I, optronics, radar, EW	3.3
EADS	C4I, surveillance, reconnaissance, radar, avionics, EW	1.3
Finmeccanica	Avionics, C4I, communications	0.8
Saab	Avionics, C4I, EW, sensors	0.3

Source: Merrill Lynch estimates, September 2000.

RAND

DEFENSE ELECTRONICS: RANKING OF EUROPEAN PLAYERS

The definition of defense electronics used for the purposes of this documented briefing is quite broad and includes several subsegments—two of which will be examined in more detail in the illustrations that follow. The broad subsegments are:

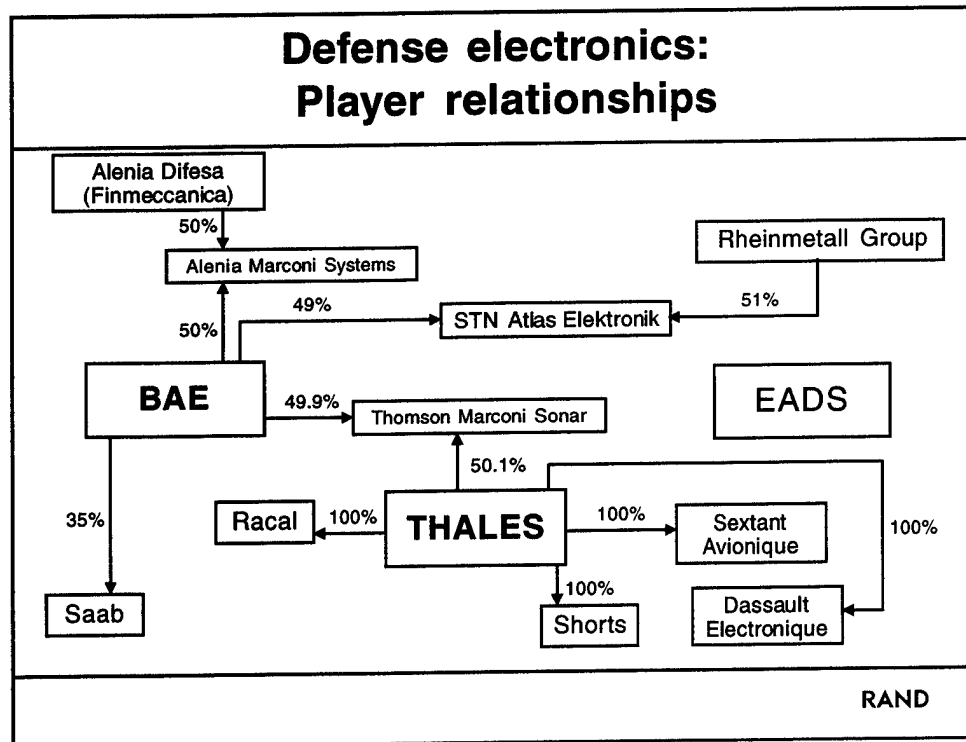
- Avionics (monitoring systems, flight management, control and warning systems, displays, navigation systems, and such)
- Military communications
- Ground-based radar
- Electronic warfare (EW)
- Airborne radar
- Electro-optics
- Naval systems
- Command, Control, Communications, Computer, and Intelligence (C4I), a parallel category—the provision of integrated systems that incorporate many of the products in the above categories.

Missile systems and missile electronics are excluded because they are included in the missile segment.

Industry data on the various areas included in defense electronics are less well defined and more debatable. The table in this section presents estimates, produced by Merrill Lynch, of the revenues generated in the field of defense electronics by the major European participants. At the global level, U.S. players Lockheed Martin and Raytheon have 35 percent of the global market for defense electronics.³ The other main U.S. players are Boeing, Northrop Grumman, TRW, and Litton Industries. U.S. companies with niche strengths include General Dynamics, Honeywell, ITT Industries, L-3, and Rockwell.

BAE Systems and THALES dominate the European market. BAE recently purchased Lockheed Martin's Aerospace Electronics Systems (LMAES), which consists of the Sanders, Fairchild Systems, and Space Electronics and Communications businesses. The AES businesses had 1999 revenues of \$1.2 billion. Besides the two market leaders, BAE and THALES, Aérospatiale Matra and DASA (both part of EADS), have a major presence in this segment with smaller market shares, while Finmeccanica and Saab have a minor presence with small shares in several subsegments of this market. Finally, there are also some European specialists or niche players, such as Racal Electronics (now part of THALES) in military communications and Smiths Industries in avionics. A number of commercial electronics companies also have exposure to the defense electronics markets.

³Year 2000 estimates are by Lehman Brothers.



DEFENSE ELECTRONICS: PLAYER RELATIONSHIPS

The figure above shows one more illustration of the “European spaghetti bowl” with three big players, a number of smaller ones, and several joint ventures or other structural relationships linking them.⁴

At the transatlantic level, Raytheon and THALES have just formed a structural alliance, THALES Raytheon Systems, by combining their air-defense, command and control (C2) and ground-based battlefield radar activities into a single business serving clients in North America, Europe, and third-party markets. The companies estimate that the new entity will have about 40 percent of the world market in its sector. The new company will be able to offer “total solutions” for C2 and battlefield radar requirements. Customers will benefit not only from significant cost and price reductions (among other benefits, due to the complementarities of

⁴An important relationship between two smaller defense electronics firms (not shown in the diagram) is the merger between Smiths Industries and TI Group, a deal that should strengthen TI Group’s position as a first-tier aerospace supplier in the advanced defense electronics segment. According to TI’s CEO, the merger will allow the new group to offer greater expertise in systems integration. Smiths is also looking to further that position in

the two product lines) but also from potentially increased interoperability between NATO and European standards, which should also lead to increased sales within NATO for the new entity. The venture will differ radically from existing cooperative schemes, which are geared to specific programs, because it will be the first transatlantic *structural* alliance in the defense sector.

the United States with the \$100 million acquisition of Orbital Sciences' Fairchild Defense Division, announced in September 2000.

Defense electronics: Market insights and trends
• Market size: around \$70 billion per annum • Growth areas: EW and C4I; systems upgrades • Military avionics: a fragmented market with high growth potential • Military communications: three key trends 1. Some commercial firms exit the market 2. Armed forces increasingly use commercial telecommunications technology 3. Internet and multimedia platforms gain popularity
RAND

DEFENSE ELECTRONICS: MARKET INSIGHTS AND TRENDS

According to an estimate by Lehman Brothers, based on the value of defense electronics components and systems only,⁵ the total market for defense electronics in 2000 was estimated to be worth around \$70 billion per year (more than \$40 billion per year in the United States and \$20 billion in Europe).

Before the 1999 Kosovo conflict, the global defense electronics market was projected to grow by as much as 6 percent per year. Following the conflict, which highlighted shortcomings in the allies' equipment, some areas should see faster growth. The main growth areas are likely to be EW and C4I. Another driver of growth will be systems upgrade programs, such as fitting new avionics to older aircraft. With new emphasis on regional conflicts and peacekeeping missions, new avionics and electronics programs should focus on precision weapons delivery for surgical strikes in populated areas and for aircraft protection against surface-to-air

⁵As most defense electronics products are integrated into other defense platforms, one has to avoid double counting.

missiles (SAMs). The Kosovo air campaign revealed the need for greater volume of EW capability—such as equipment to jam enemy radar and communications when attacking defenses, to confuse enemy communications and disrupt operations, to protect aircraft or vehicles entering the theater of war, and to enable secure C2 between allies—and it revealed the need for sophisticated C2 systems such as C4I. Europeans have little of the aforementioned capabilities, with the UK and France being the only countries with even minimal capability in that area. Most European defense companies are seeking to enhance their EW capabilities and integrate EW systems into an increasing number of military products.

Military avionics has become a growth market as the avionics component of military aircraft has steadily increased. According to estimates by Lehman Brothers, this segment is expected to grow faster than the overall market for defense equipment because advances in software capability are growing much faster than advances in hardware. The rapid advances in software also allow for large retrofit opportunities because the performance and lifespan of old aircraft can be successfully enhanced with modern avionics, saving the cost of an entirely new platform.

The defense avionics market is highly fragmented (with a large number of players in a variety of product areas) because most countries try to maintain some form of defense capability. Even if countries buy the airframe from a foreign supplier, they insist on a percentage of the avionics work being given to domestic suppliers. However, consolidation among European aircraft manufacturers has reduced the number of customers for avionics suppliers. To remain a leader in military avionics, therefore, it is essential to have links to the remaining European (or American) primary contractors: BAE Systems, EADS/Dassault and Boeing, Lockheed Martin, and Northrop Grumman (to a lesser extent). Note, however, that both Finmeccanica and Saab have in-house avionics businesses that design products specifically for the aircraft their parent company produces: Finmeccanica designs products for the Eurofighter (for Italy) and Saab designs products for the Gripen (both the domestic and the export version). These in-house businesses are not major players in avionics but nevertheless earn reasonable returns due to their captive domestic market and, in Finmeccanica's case, due to their role in receiving the national share in multinational programs.

The military communications subsegment has changed significantly in the past five years, and one can distinguish three major trends in this subsegment:

- The withdrawal of several major telecommunications equipment companies, such as Nokia and Siemens, from the military market. At the same time, however, several predominantly commercial companies, such as Alcatel, Ericsson, and Marconi, still serve military markets. Alcatel actually increased its exposure to the military market during 1999 by raising its stake in Thomson-CSF from 16 percent to 25 percent, stating that it believes in the synergies between the civil and military markets.
- The increase in the use of commercial telecommunications technology by the armed services in many countries to carry their nonbattlefield communications traffic. For example, the UK government has contracted a consortium of three companies—British Telecom, Lockheed Martin, and BAE Systems—to rationalize the country's fragmented defense telecommunications networks into a single operation.
- The realization by both the users and providers of military equipment that the Internet and multimedia systems are an excellent platform on which to build the command, control, and communications systems that are important to modern warfare. Although the U.S. military is some distance ahead of Europe in this area, THALES and Racal were the first two companies to begin looking for ways to use a multimedia broadband system to enhance communications between combat vehicles and command headquarters.

Radar/Sonar: Ranking of European players

Sub-segment	Players
Ground-based radar Air defense (surveillance and air C2) Battlefield surveillance (missile early warning and tracking)	THALES Alenia Marconi Systems (AMS) THALES AMS, Ericsson
Airborne radar (early warning and surveillance)	THALES DASA-Aérospatiale Matra (EADS) BAE Systems Saab/Ericsson
Naval radar and sonar Radar: air defense surveillance, coastal surveillance, fire control, navigation Sonar: mine countermeasures, defense ASW	THALES , BAE Systems Thomson Marconi Sonar, STN
NOTE: AMS is a major player in both subcategories of ground-based radar. There are no major players in the airborne radar and naval radar segments, only market leaders and minor players.	
RAND	

RADAR/SONAR: RANKING OF EUROPEAN PLAYERS

This section identifies the most important European players in each of the subsegments of the radar/sonar market segment: ground-based radar, airborne radar, and naval sensors (radar and sonar).

Ground-Based Radar

Raytheon, Northrop Grumman, and THALES are the largest prime contractors for air defense radar systems. THALES is the market leader in Europe, followed by Alenia Marconi Systems (AMS), a joint company of BAE Systems and Finmeccanica. AMS is a close contender in both ground-based and naval systems, ranked by Merrill Lynch as the European market leader in those subsegments. Swedish firm Ericsson also has a significant presence in that segment.

In battlefield surveillance, THALES is, again, the leading European manufacturer and also a leader at the global level together with Raytheon. Furthermore, THALES is leading the Euro-ART consortium (consisting of Raytheon, Racal, Siemens, and Lockheed) developing the COBRA, Europe's next-generation-battlefield radar system. Finally, a smaller market presence in the battlefield surveillance subsegment is Ericsson,

whose ARTHUR (ARTillery HUNting Radar) system is successful in Scandinavian markets.

Airborne Radar

The United States has traditionally dominated this field, with Northrop Grumman and lately Raytheon. Major players on the European side are THALES, EADS (DASA and Aérospatiale Matra), BAE Systems, and Saab/Ericsson.

In air-to-ground surveillance, a joint venture including THALES, Aérospatiale Matra, DASA, Alenia, and TNO (a Dutch research organization) produces SOSTAR (Stand-Off Surveillance and Target Acquisition Radar), which is competing for NATO's Alliance Ground Surveillance (AGS) program. The system is being planned for UAVs, the NH90 helicopter, and for multiengine jets. In recent years, technological advances have reduced the size and cost of many airborne radars, which allows companies such as Saab/Ericsson and DASA to enter the market with highly advanced products.

Naval Sensors (Radar and Sonar)

The naval radar segment covers air defense surveillance radar, coastal surveillance, fire control, and navigation radar while the naval sonar segment comprises mine countermeasures and anti-submarine warfare (ASW).

Major defense/aerospace contractors dominate the naval radar and sonar markets, each of them typically owning one division in each segment. However, there is a second tier of manufacturers that specializes in one or two particular applications of naval sensors. Navigation radar is a particularly strong application for this second-tier participation. Top-tier participants in the global naval radar market include Lockheed Martin Naval Electronics & Sensor Systems, THALES, Raytheon Systems, and BAE Systems; top-tier participants in the global naval sonar market include Lockheed Martin Naval Electronics & Sensor Systems, Thomson Marconi Sonar, STN Atlas Elektronik, Raytheon, and Northrop Grumman Oceanic Systems.

Both the naval radar and sonar markets are saturated, as the top-tier competitors in each segment control more than 80 percent of the market in terms of sales revenues. However, competitors in each market segment are facing a number of challenges, the most formidable perhaps being the need to address competitive conditions arising from an increase in

international partnerships and joint ventures among manufacturers, which allow competitors to gain regional advantages.

Radar/Sonar: Market insights and trends

- | |
|--|
| <ul style="list-style-type: none"> • Current U.S. and European interest is in air-to-ground surveillance systems, rather than airborne early warning <ul style="list-style-type: none"> — European procurement programs: AGS, ASTOR • Increasing role for UAVs in airborne battlefield surveillance • Naval sensors (radar and sonar) <ul style="list-style-type: none"> — Moderate sales growth (12%) over next decade — Growth of transatlantic agreements and partnerships • Raytheon/THALES joint venture: a model? |
|--|

RAND

RADAR/SONAR: MARKET INSIGHTS AND TRENDS

This section first highlights the most important trends prevailing in the radar and sonar market segment, and then identifies key business relationships between companies in that segment on both sides of the Atlantic.

General Market Trends

Airborne early warning and command (AEW&C) radar systems such as AWACS have been important military electronics procurement programs in the United States and Western Europe for the past decade or more. However, with changing conflict patterns and most procurements now complete, air-to-ground radio frequency (RF) surveillance systems, such as Northrop Grumman's JSTARS (Joint Surveillance Target Attack Radar System), are likely to replace AEW&C as the most significant operational airborne electronics system in production. RF surveillance systems are also expected to surpass airborne early warning (AEW) aircraft as the high end of airborne radars (still, although JSTARS is the world standard, NATO's AGS program has so far avoided a quick choice of that system). Moreover, the fact that most major procurements for AEW radar systems have already been completed could imply that the long-term future for

Western European and North American contractors may lie in space-based surveillance systems.

Important NATO and European procurement programs in the radar field include NATO's AGS and the British Airborne Stand-off Radar System (ASTOR). With respect to the first program, the continuing debate over the provision of an AGS centers on two options providing sensor solutions. Four European nations—France, Germany, Italy, and the Netherlands—launched the SOSTAR program in May 1999 to rival the U.S.-sponsored NATO Transatlantic Advanced Radar (NATAR) proposal championed by Northrop Grumman and Raytheon. The U.S. side has recently made efforts to merge the two projects by offering to share more of its sensitive sensor technology with its European allies, but U.S. allies have shown no signs of altering their independent track. In the ASTOR program, the UK has chosen a Raytheon-developed system to fulfill its battlefield surveillance requirement, which is scheduled to enter service with the Royal Air Force in 2005.

In addition to the manned systems, airborne battlefield surveillance is increasingly being undertaken by radar- and multisensor system-equipped UAVs. Operations in the Balkans have established the operational viability of the American Predator system and the previous-generation CL-289 reconnaissance drones operated by the armies of France and Germany. Both countries have plans to introduce synthetic aperture radar/moving target indicator (MTI) radar on their surveillance UAVs in the short term.

Turning to the new generation of electronically scanning, multifunction radars for fighter aircraft, work in the field is taking place in Europe, where THALES, DaimlerChrysler Aerospace, and BAE Systems have teamed on the Airborne Multi-Role Multifunction Solid-State, Active-Array Radar (AMSAR) program. The program aims to create a world-class electronically steered fighter radar suitable to retrofit aboard the Eurofighter Typhoon, Mirage 2000, Rafale, and Tornado combat aircraft.

The market in naval sensors, radar and sonar, is significantly affected by increasing international procurement demand for smaller ships that will require a new generation of sensors to equip them. New missions, such as the need to add a theater ballistic missile defense capability to NATO and U.S. warships, are fueling demand for new radars to meet this threat. Likewise, programs such as the Franco-Italian Horizon frigate or the Type 45 destroyer and future aircraft carrier programs in the UK also require new radar developments.

The two major categories in the naval sensor industry will experience moderate revenue growth through 2008.⁶ The compound annual growth rate for both segments will be 11.3 percent over the decade 1998 to 2008.

In addition, a spate of transatlantic agreements and partnerships could inject more competition into the naval radar marketplace in coming years. Major industry players BAE, Lockheed Martin, Raytheon, and THALES all have struck alliances or study agreements to prepare for upcoming competitions to build new shipboard radar systems and new types of warships. One example is the four-month agreement (announced in July 2000) between BAE and Lockheed Martin Naval Electronics and Surveillance Systems to develop a feasibility study of opportunities for cooperation on international shipboard radar developments.

Transatlantic Links

Raytheon and THALES already have a joint venture, called Air Command Systems, that develops fully integrated systems with a high unit value, such as NATO's Air Command and Control System (ACCS) and Switzerland's new air defense system, FLORAKO. The two companies have also just formed a structural alliance—THALES Raytheon Systems—that cuts across many different market segments, including naval radar, by combining their air-defense, C2, and ground-based battlefield radar activities into a single business. The new enterprise will have operating subsidiaries in Fullerton, California, and Paris, France. It will produce an estimated \$500–700 million in annual revenue. This joint venture will combine the complementary businesses of the two companies and extend their global reach by providing reciprocal transatlantic market access. The venture could also potentially enhance interoperability.

The new THALES-Raytheon venture is considered by several industry analysts to be a strong combination and a potential model for other cooperative ventures. THALES possesses a wealth of radar talent and is also majority owner of Signaal (Hollandse Signaalapparaten B.V.) in the Netherlands, which has developed the Active Phased Array Radar system for shipboard uses. Raytheon is developing the Multifunction Radar for the U.S. Navy's DD-21 Land Attack destroyer and has numerous other radar systems in production. This new joint venture could lead the way in addressing a number of regulatory and industrial policy issues (such as

⁶Frost & Sullivan, *World Markets for Naval Radar and Sonar*, Market Report Number 7214-16, April 18, 2000.

technology transfer, export controls, protectionist policies, and other issues) that have haunted and even prevented transatlantic linkups in the past. Dealing with such issues will be crucial to the long-term success of the THALES-Raytheon joint venture.

Electronic warfare: Ranking of European players
• BAE Systems is the global leader in EW and subsystems, with Northrop Grumman number two • Other European presence is mainly in countermeasures/decoys and naval EW — Decoys: Marconi Electronic Systems (MES), DASA (EADS), Celsius — Naval EW: MES, THALES
RAND

ELECTRONIC WARFARE: RANKING OF EUROPEAN PLAYERS

For the purposes of this research, the EW segment includes virtually all-electronic devices that permit gathering, analyzing, and countering electronically generated signals. These devices include radio frequency receivers and analyzers that collect electronic signals for study purposes, to completely automated and integrated EW suites that detect and analyze hostile electronic emissions and initiate a defensive response to protect weapons platforms from attack by guided weapons.

BAE's Ariel retractable towed decoy is the most successful British system in service and has been flying on British Nimrod Maritime Patrol Aircraft since 1990. A new version, the Towed Radar Decoy, will be the standard fit on the Eurofighter. BAE has also teamed with Dassault to develop the towed decoy for the Mirage 2000 and the Rafale.

But decoys only supplement, not replace, RF jammers. The biggest EW program of the decade⁷ will be the Integrated Defensive Electronic Countermeasures (IDECM) program, Lockheed Martin Sanders'

⁷Aviation Week & Space Technology, *Aerospace Sourcebook 2000*, McGraw-Hill, Vol. 152, No. 3, January 17, 2000.

integrated electronic countermeasures suite for the F/A-18 E/F. There is currently little else in the United States to challenge IDECM's dominance in the market, although the successors to IDECM, the next-generation integrated EW suites (emphasizing stealth rather than active jamming) for the JSF and the F-22, are already under development.

Important European players include German DASA (EADS), which develops the Sky Buzzer fiber-optic towed decoy for German Tornados and large multi-engine aircraft, and Swedish CelsiusTech Electronics, which produces the BO2D decoys for the JAS39 Gripen and Viggen. In terms of collaborative ventures, Dassault along with THALES and Aérospatiale Matra (also part of EADS) produces the Spectra integrated countermeasures system used on the Rafale, while BAE together with Elettronica and ML Aviation (United Kingdom, Italy, Spain, and Germany) produce the EuroDASS (Defensive Aid SubSystem) used on the Eurofighter. Spain, Italy, and the UK have been developing the DASS, and Germany has rejoined the program. EuroDASS seems to be ahead in development, and Spectra will be phased in incrementally.

In the field of naval EW, Marconi Electronic Systems (now part of BAE), THALES, and Elettronica (also owned by THALES) had planned to cooperate on developing the future-generation naval EW system. However, the UK's pulling out of the Horizon frigate program, planned as a joint program among the parent governments of these companies, may undermine this endeavor.

Electronic warfare: Market insights and trends

- EW capabilities have become a priority
- Annual worldwide production peaks in 2005
- Airborne towed decoys likely to dominate as next decade's fastest growing market
- European products are quite solid: decoys and countermeasures, directed infrared countermeasures (IRCM), and helicopter EW

RAND

ELECTRONIC WARFARE: MARKET INSIGHTS AND TRENDS

Annual worldwide production of EW systems will reach an all-time high in 2005, spurred by Russia's decision to upgrade MiG-29s in 2003 and the U.S. Navy's 2004 scheduled start for fielding F/A-18 E/Fs.⁸

Suppression of Enemy Air Defense (SEAD) has replaced fighter superiority as the primary focus of militaries. Aircraft missile defense is a top priority and as a result airborne towed decoys will likely dominate as the next decade's fastest growing market. The war in Afghanistan has further reinforced the importance of solid EW systems. European manufacturers specializing in EW, particularly those that are UK-based but also other continental firms, are gradually becoming aware of and seeking new niche opportunities in that market and are expected to benefit from the changed security environment post-September 11.

Europeans offer solid products in this field, such as Marconi's Ariel retractable towed decoy. In addition to decoys and countermeasures, Europeans have strong products in directed infrared countermeasures (IRCM) and helicopter electronic warfare. Directed IRCMs are another big

⁸Forecast International, *2001 Electronic Warfare Market Analysis*, January 2001.

trend in the EW market. Short-range infrared-guided surface-to-air missiles (SAMs) have been responsible for most aircraft lost during the past decade, and IRCM suites are likely to be produced in the thousands in the next decade. In Europe, DASA has been developing its own directed IRCM, the Flying Laser Self-Defense System Against Seeker-Head Missiles (FLASH), and France has also signed onto the program. FLASH is intended for Transall C-160 and Lockheed Martin C-130 transports, but could eventually see service on a wider range of helicopters or jets. The preferred missile warning system for cuing FLASH will be Litton/DASA's AN/AAR-60.

In helicopter EW, there is Sanders' AN/ALQ-212 ATIRCM (Advanced Threat Infrared Countermeasures) and AN/AAR-57 CMWS (Common Missile Warning System). Unfortunately, it will be years before production begins on either of these programs.

Landing systems: Market leader

MESSIER DOWTY

- Part of the SNECMA group
- World leader in the design, development, and manufacture of landing gear systems
- Only company able to produce fully integrated landing gear systems in both Europe and North America
- Annual turnover around \$500 million

RAND

LANDING SYSTEMS: MARKET LEADER

With facilities in eight different countries (France, the United Kingdom, Canada, the United States, Singapore, and three others), Messier Dowty is the European and world leader in the design, development, and manufacture of landing systems, with an annual turnover of about \$500 million. Messier Dowty supplies 30 airframe manufacturers and supports 600 operators of large civil aircraft, regional and business aircraft, military aircraft, and helicopters. The company takes part in many major programs and supplies most major companies including Airbus, Boeing,⁹ Embraer, and others. Messier Dowty is part of the SNECMA group and is backed by the group's global network of customer and product support services.

Messier Dowty is involved in a number of important aerospace programs. It is investing heavily in ramping up production rates for the Eurofighter as it enters production, for Dassault's fast-selling Falcon Jets, and for Bombardier's regional jets. Messier Dowty is also a risk-sharing partner on the Airbus A340-500/600, responsible for the design and supply of the

⁹Messier Dowty aims at building upon its limited involvement with the Boeing fleet. It has a 25 percent joint venture relationship with Coltec Menasco (which has belonged to Goodrich, formerly BFGoodrich, since 1999) on the Boeing 777.

entire landing gear system, and is participating in the A400M European transport aircraft. Messier Dowty also was responsible for the landing gear design and system on the Boeing Joint Strike Fighter.

Messier Dowty is the only company worldwide able to produce fully integrated landing systems in both Europe and North America, offering a complete range of services from design and manufacture to customer and product support. The company specifically provides landing gears (it is number one in this market in Europe and worldwide); braking systems, thrust reversers, and nacelles (it is number one in Europe and number three worldwide); and maintenance and repair of all landing and braking systems, with an extensive permanent customer support network.

Messier Dowty's closest competitor in commercial as well as in defense markets is Goodrich, which created a solid competitor to Messier Dowty by merging its landing gear business with Coltec Menasco, which it acquired in 1999. For example, Goodrich won the contract for the main landing gear for the Airbus A380, while Messier Dowty has been preselected for the nose landing gear system of the aircraft. Winning the contract for the A380 landing gear was a major victory for Goodrich Aerospace, particularly because Messier Dowty is Airbus' traditional European-based producer of landing gear systems. The A380 contract marked the first time Airbus turned to the United States for the undercarriage, and Goodrich displaced Messier Dowty as the sole supplier there.

Key European defense market drivers

- Current and projected demand
 - Trends in European defense budgets:
 - Procurement spending
 - R&D spending
 - Trends in demand for particular platforms and subsystems
- Company business strategies
- Technological trends and investment focus
- Developments in the civil market
- Developments in the U.S. defense market

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PART III ANALYSIS OF KEY EUROPEAN DEFENSE MARKET DRIVERS

Following the analysis of developments in Europe's main military market segments, this part of the briefing identifies the main driving forces shaping the structure and future of the European defense industry as a whole. These market drivers originate from both the demand side and the supply side of the industry, and they include:

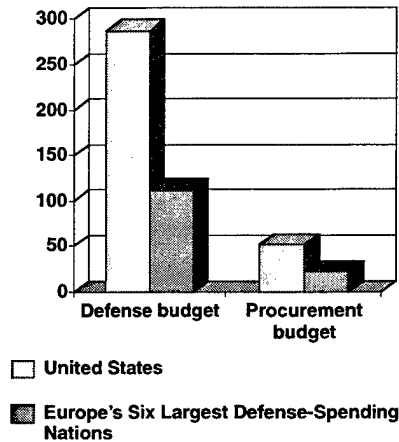
- Current and projected demand. This briefing considers two aspects of this driving factor:
 - Trends in budgets/spending for equipment procurement and for research and development (R&D)
 - Trends in the demand for particular types of platforms and subsystems.

- Company strategic orientation and business models. This factor relates to the strategic orientation in defense firms' choice of products, their role in the industry (for example, as a systems integrator or niche producer), target markets, and other issues.
- Technological trends and projected focus of future investment for both European governments and industry.
- Developments in the civil market, which could have extensive impacts on military industry developments.
- Developments in the U.S. defense industry, government budgets, or arms programs. For example, progress on the Joint Strike Fighter (JSF) program could have an immediate impact on the fate of the next-generation European fighter aircraft and consequently the main European military aerospace contractors.

Trends in European defense budgets: Procurement spending

**Procurement spending =
today's capabilities**

- U.S. defense/procurement budget is approximately 2.5 times larger than that of the "Europe 6"
- Stagnant European budgets, projected to increase
- Europe needs to spend more efficiently



Source: International Institute for Strategic Studies, 1999.

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TRENDS IN EUROPEAN DEFENSE BUDGETS: PROCUREMENT SPENDING

Procurement spending is considered one of the main drivers of a nation's current military capabilities.

The chart above uses data from the *Military Balance 1999–2000*¹ report to compare the defense and procurement budgets of the six most important defense-spending nations in Europe with equivalent U.S. budgets. The six European countries include the four big spenders—the United Kingdom, France, Germany, and Italy—and two smaller but significant spenders (that is, with defense budgets of more than \$3 billion)—the Netherlands and Spain. The "big four" spend around 2 to 3 percent of their gross domestic product (GDP) on defense.

The wide gap between defense budgets in Europe and the United States is well known: In 1999, total defense spending in the United States was \$275 billion, almost double the \$140 billion spent by NATO's 13 European members (excluding the newest members—Hungary, Poland, and the Czech Republic). Compared with the six largest defense spenders in

¹Figures are in billions of 1999 dollars.

Europe combined, as shown in the chart, the United States spends 2.5 times more on defense.

European defense budgets have been falling by an average of 5 percent in real terms every year since 1995. Recently, however, budgets have remained flat. In early 2001, NATO sources had revealed that several European Alliance members had been planning real increases in defense spending, driven by the Europeans' desire to develop capabilities for a European Rapid Intervention Force. Among these countries are the UK, Denmark, Greece, Italy, Hungary, Norway, Poland, Portugal, Spain, and Turkey.

The reports of increased defense spending were subsequently put into serious doubt by the press leak of an internal NATO briefing paper which stated that, according to NATO's own assessments, only six of these countries (Hungary, Norway, Poland, Portugal, Spain, and Turkey) were planning real spending increases over the next five years. Five other countries, European NATO members including the UK and Italy, were regarded as having "halted the decline" in defense spending but were not considered to be spending more, after inflation. According to some observers, European spending increases were nominal rather than real, and when one considers how much the Euro has fallen against the dollar, many of the increases in spending would be better described as declines in spending. France gave a small (1.3 percent) boost to its procurement budget for 2001 to be used largely for the purchase of 20 Rafale aircraft and 52 Leclerc tanks. Germany is notably absent from the list, revealing concerns with respect to investment in equipment. The matter caused great controversy in transatlantic defense relations.

Therefore, there are as yet no concrete changes in the European defense budget picture. Given the lack of urgent and credible security threats against Europe and the increasing number of competing priorities of European governments, raising defense spending will be difficult. In addition, one could describe European nations as being in a sort of "prisoner's dilemma," in which individual governments have no incentive to increase national defense spending if that decision will benefit other countries as well and not just their particular country. In other words, there is the temptation to avoid spending one's own money and simply benefit from others' increased spending.

According to John Dowdy, a principal for McKinsey and Co.,² in the absence of more money for defense budgets, European governments should more closely examine what they are spending their money on—they should consider rebalancing what they are spending on items such as recruiting, training, and housing troops versus what they are spending on arming them. Europeans spend a larger proportion of their defense budgets on personnel (recruiting, training, salaries, pensions, housing, uniforms, and food) than on the development and procurement of new equipment. This spending pattern helps widen the gap between European and U.S. capabilities. Dowdy believes that Europe might be better served by better equipping a smaller number of troops by reducing and modernizing its forces and reallocating funding toward equipment budgets to provide forces with transport, precision weapons, and command and control (C2) infrastructure.

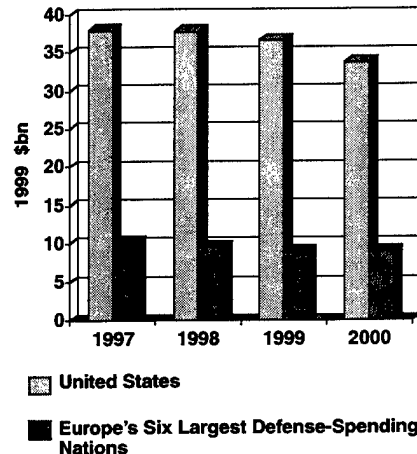
Furthermore, Europe could aim at more-efficient defense spending. According to NATO's Secretary General George Robertson, Europe currently spends 60 percent of what the United States spends on defense but gets no more than 10 percent of the American capacity to sustain out-of-area operations. There are a number of competing new programs in Europe (such as the Eurofighter, the A400M transport aircraft, and plans for naval and battlefield modernization, among others), and allocating limited funds among them will involve making some tough decisions.

²Author's interview with John Dowdy, McKinsey and Co., London, England, December 11, 2000.

Trends in European defense budgets: R&D spending

R&D spending = tomorrow's capabilities

- U.S./European defense spending ratio steady at 4:1
- Government participation in R&D varies by program
- Growth industries sometimes lose to state-controlled "champions"
- No real collaborative R&D in Europe yet
- Consequences could be critical



Source: International Institute for Strategic Studies, 1999.

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TRENDS IN EUROPEAN DEFENSE BUDGETS: R&D SPENDING

In contrast with procurement spending, R&D spending is the driver behind a nation's *future* military capabilities.

The difference in spending levels between the six major European "spenders" and the United States is even more pronounced if one looks at R&D budgets in which the spending ratio is four-to-one and has been relatively steady at that level for the past four years.³ Europe's six largest spenders devote about 6 percent of their overall defense budgets to military R&D, whereas the United States spends 13 percent. This disparity has existed for some time and shows no sign of diminishing. The impact on Europe for both military capabilities and civil technology spin-offs could be profound. Maintaining the technological base for defense

³This relationship refers to *state* funding for R&D and does not take into account company contributions, which vary among different countries and market segments. If one wanted to estimate the impact of including private company expenditures on the

requires long-term investments in R&D, with particular attention given to mission-critical technologies and the exploitation of both civil and military technology. The costs incurred by R&D in defense nowadays are such that state assistance becomes a necessity for companies to remain competitive. Unfortunately, Europeans lack adequate scale or a solid base from which to work because the nation states (in Europe) see their role more as one of controlling industry rather than one of supporting it by means of a more dynamic approach to capitalism. European government approaches to R&D support are very diverse. The percentage of government participation in defense companies' R&D varies widely. In France, it averages around 50 percent overall, but that figure varies and may even be nonexistent for some sectors of the French defense market. In Britain, the government's investment in aerospace R&D averaged 11 percent of the total turnover in 1999, while the corresponding investments in Germany, France, and the United States were around 22 percent, 15 percent, and 14 percent, respectively. At the European level, governments provide around 60 percent of the total funding for military aerospace R&D with the remaining 40 percent of expenditures financed by each country's defense industry.

Additionally, there is a tendency in Europe for government money to go to "lame ducks"—often state-owned or state-controlled entities such as French contractors DCN (shipbuilding) and GIAT (land systems)—thus putting growing industries that could potentially make more efficient and productive use of those funds at a disadvantage.

Therefore, although defense contractors have access to some degree of government R&D funding, they need to seek additional sources of capital, mostly internally generated funds or commercial borrowing. Financing R&D—as well as financing new products—is made more difficult by several factors:

- the length of time required to achieve positive financial returns and the uncertainty involved in those returns
- the heavy up-front investment required for individual programs, relative to company resources
- the small production runs, in contrast to civil industry, which make it difficult to offset R&D costs

comparative R&D spending between Europe and the United States, one would have to make sure that such expenditures are included for both European and U.S. companies.

- the increasing pressure on companies to contribute to defense program development costs
- the often short-term focus of financial markets and institutions.

Such issues are exacerbated for smaller and medium-sized firms because many of those firms are required to invest a larger percentage of their balance sheets in R&D than are most of the larger companies.

Furthermore, currently there is no coherent European policy for R&D, a lack of which is often seen as an obstacle to industrial growth. The consequences of low R&D funding could be dramatic:

- There is a real danger that future capabilities of European forces will be significantly compromised.
- European firms could be at a competitive disadvantage compared with U.S. firms. This disadvantage would be primarily financial because European firms would have to devote a larger proportion of their own funds to R&D.
- Low government R&D funding decreases incentives for European companies to invest in the military side of their businesses and could increase the risk that companies will choose to move out of defense—particularly those companies that can take advantage of dual technologies and other nonstate funding sources—and move to more-profitable civil activities.

Company business strategies

- The defense market is characterized by a trend toward systems integration
- The big three European players have three different business models: BAE is focused on systems integration and transatlantic markets, EADS is focused on European cooperation, and THALES has adopted a multi-domestic strategy
- Strategies for the U.S. market: European companies are better positioned and willing to acquire U.S. defense firms
- State ownership and involvement in the management of European defense companies is declining

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COMPANY BUSINESS STRATEGIES

This section consists of four parts. First, the trend in the global defense industry toward systems integration is described and illustrated. Second, the business strategies of major European defense contractors are presented and contrasted. Third, transatlantic strategies are briefly presented. Lastly, trends in the role of the state in the ownership structures of defense companies are presented.

SYSTEMS INTEGRATION TREND

The trend for defense contractors to become systems integrators originated in the United States and is now reaching Europe. Defense spending in Europe, as in the United States, increasingly is driven by technology upgrades rather than new platforms for new systems. As a consequence, systems integrators and suppliers of defense electronics are best positioned to benefit from future spending trends. Systems capability, in particular, is the key resource necessary to integrate the many diverse materials and technologies that constitute modern platforms and other defense products. In addition, systems integration skills are vital in managing and coordinating the physically distributed international design-and-build teams now used in major transnational programs. In

other words, a transformation is taking place with defense contractors shifting away from being traditional producers of specific hardware to seeking value in becoming "turnkey facilities" that can provide complete systems.

Another way to view this trend is through the increasing globalization of the defense industry, which could create the necessity for European companies to be able to maintain design, development, and production of a full range of products in order to remain competitive in the global market. According to some analysts, the only viable route to success would be for prime contractors to develop into large systems integrators, whether in aircraft, naval vessels, armored vehicles, missiles, or electronics. Such companies would be able to control a whole contract for defense equipment and therefore should possess the potential to compete globally in almost every area of the defense market.

BAE Systems is a prime example of the systems integration trend in Europe, as shown in the following table. The table illustrates BAE's strategy of systems integration by listing its various capabilities in multiple areas.

Perceived Capabilities of BAE

	Air	Land	Sea	C4I
Prime contractor	Yes	Yes	Yes	No
Systems integrator	Yes	Yes	Yes	Yes
Platform	Yes	Yes	Yes	Yes
Systems	Yes	Yes	Yes	Yes
Weapons	Yes	Yes	Yes	No
Support	Yes	Yes	Yes	Yes
Sensors	Yes	Yes	Yes	Yes
Equipment	Yes	Yes	Yes	Yes
Software	Yes	Yes	Yes	Yes
Logistics	Yes	Yes	Yes	Yes
Capabilities	10/10	10/10	10/10	8/10

BAE is a participant in the Joint Strike Fighter (JSF) but is also a main contractor for Great Britain's Future Aircraft Carrier program. BAE is also one of only two remaining British shipbuilders for military vessels and is a player in land systems through its link to STN Atlas and in defense electronics through Marconi/Tracor and STN. BAE emerges as the only British company likely to win prime contracts for a range of defense products from aircraft carriers to combat aircraft. Marconi has complemented the production range of BAE with its interests in

shipbuilding, sonar, radar, avionics, missiles, and munitions, and has also brought a lot of potential synergies between military and civil production.

BUSINESS MODELS

Each of the "big three" European defense companies has followed a different development path and strategic business model.

BAE Systems

The strategic direction of BAE was deeply affected by its acquisition of Marconi Electronic Systems. Specifically, before that acquisition, BAE was one of the key partners in the European consolidation efforts. Its priorities changed after it bought Marconi.

BAE is strong in aerospace and land systems whereas Marconi's area of strength is naval systems. BAE's key strategic priority is to become a systems integrator to keep its focus on defense and aerospace activities while expanding and spreading its expertise across capabilities and domains (air; sea; land; and command and control, communications, computers, and intelligence [C4I]). It appears that the company sees its ability to offer the customer an integrated approach, a "system of systems," as its key competitive advantage.

Transatlantic links have also become a priority. BAE seeks to capitalize on its ownership of U.S. contractor Tracor (inherited from GEC Marconi) and on its more recent acquisition of Lockheed Martin's Aerospace Electronics Systems. BAE's strategy is to acquire 100 percent of some U.S. companies—even those with proxy boards—and to behave like a "good U.S. citizen" so that eventually the U.S. Department of Defense (DoD) will treat it as being equal to an American company. According to company estimates, North American sales represented 31 percent of BAE's total sales in 2000 and that proportion was expected to rise further in 2001.

BAE wants to keep its ties to Europe (through its stakes in MBDA, STN Atlas, and Saab) while clarifying its position with respect to its European joint ventures, particularly Airbus. For example, an exit from Airbus would widen BAE's scope of potential U.S. partners (so far, however, BAE has not expressed any intentions to abandon its stake in Airbus). BAE is in a good negotiating position with EADS. Only 27 percent of BAE's revenues come from programs involving EADS, whereas 68 percent of EADS' programs involve BAE, which makes EADS more dependent on BAE in terms of program revenue than BAE is on EADS, with respect to European joint ventures.

EADS

EADS, unlike BAE, is a fairly typical example of the kind of approach that is likely to be applied to the consolidation of the European defense industry. While BAE owes its creation to market forces, EADS is more the result of a political and industrial agreement to pool what governments deem to be strategic industrial capabilities.⁴

EADS' strategy (so far) seems to be focused on developing and improving platform capabilities, mainly through horizontal integration. Still, one should not exclude the possibility of EADS becoming influenced by the tendency toward systems integration strategies in the European defense sector.

EADS is above all a "European company," and it is looking for European partners. At the same time, however, the German part of the group has been cultivating American connections for a few years. Recently, EADS agreed on a strategic alliance with Northrop Grumman, covering surveillance and reconnaissance equipment. The two firms will also collaborate in developing the weather radar for the A400M transport aircraft and may eventually co-produce a range of electronic and space products. A full merger is unlikely, partly because of European firms' dissatisfaction with cumbersome U.S. regulations with respect to export controls, technology transfer, and proxy boards. Still, EADS and Northrop Grumman are currently reviewing prospects for a closer corporate relationship to consolidate a number of program teaming efforts, memoranda of understanding, and minor joint-venture arrangements. Such a relationship would open up additional market opportunities for both companies in product areas such as electronic warfare and radar technologies. According to some analysts, EADS could penetrate the U.S. market but that would be mostly in small niches or in less-sensitive areas, such as civilian telecommunications and space, which are less likely to be subject to restrictive regulations.

⁴Governments were involved in several stages of the long process that led to the creation of EADS. For example, the original plan for the creation of a European Aerospace and Defense Company (EADC) was government initiated; the French partner of EADS, Aérospatiale Matra, was created through a process of national consolidation and privatization, which was also politically initiated. For a full account of the process that led to the creation of EADS, see Schmitt, Burkard, "From Cooperation to Integration:

EADS has a complex structure, which reflects its complex business and political situation. One of the main problems with the EADS business model is that it is very unstable. EADS is the first company of its kind and has a complex "twin-CEO" (French and German) administrative structure that is intended to balance different interests, but which, in combination with political sensitivities and national sovereignty concerns, could compromise the company's future. One of the questions remaining to be answered is whether EADS' management will be strong enough to stand its ground against political pressures from more than one side at the first suggestion of factory redundancies within the new company and the resulting necessity for plant closures and job losses.

In addition, EADS' future presence in defense is ambiguous: 80 percent of its sales are in the civil sector and the largest part of those sales (56 percent of the total) comes from Airbus, which is EADS' main source of business strength. Positive Airbus performance and a solid order book are the main factors behind EADS' success so far. EADS has activities in a range of military market segments: military aircraft, through its 62 percent stake in the Eurofighter;⁵ missiles, through its participation in Matra BAe Dynamics (MBDA) ownership;⁶ helicopters—EADS (with Eurocopter) is the leader in civil helicopters, but its continued presence in military helicopters will depend on the governments' funding commitments; and launchers—EADS is generating more business from the Ariane program, which it runs, than from its military space activities.

In sum, EADS has not demonstrated that its future lies in defense. One could think of a scenario in which BAE would sell its Airbus stake to EADS, and a European aerospace and defense conglomerate between BAE and EADS would result, with EADS consolidating the commercial side and BAE the military side.⁷

Defence and Aerospace Industries in Europe," Chaillot Paper 40, Paris: Western European Union Institute for Security Studies, June 2000.

⁵However, the technical know-how lies mainly with BAE.

⁶In missiles, via MBDA, as with military aerospace, BAE is dominant.

⁷In addition to its stake in the Eurofighter, BAE is a partner in the European Technology Acquisition Program (ETAP), which aims at developing next-generation technologies for air combat. More important, BAE's involvement in the U.S. JSF will allow it to stay in the forefront of technological developments in the next generation of military aerospace.

THALES

The company totally changed its identity, strategy, and positioning in the second half of the 1990s. Specifically, it shifted from being a typically French company to one that has adopted a multi-domestic strategy—that is, a strategy of growth outside France—by acquiring medium-sized companies abroad, producing with those companies locally, and building up a domestic identity for itself in the process. The idea is to “keep the core vehicle” (i.e., THALES) and expand it by obtaining controlling shares of companies that have a large client base within their own countries. Examples of those companies include the Australian Defense Industries, the British firm Racal, and the Korean firm Samsung.

THALES has a big presence in Europe. Its strategy has been to become established in European countries by buying small players. THALES started in the late 1980s in the Netherlands (acquiring Signaal), then invested massively in the UK (where it became a small, number-three player) and took advantage of opportunities in other countries such as Germany, Switzerland, and Spain, growing into a significant European player in the 1990s. The acquisition of Racal Defence Electronics not only changed THALES’ strategy with respect to the UK but also signaled a change in the company’s identity. A quarter of THALES’ size, Racal is much larger than the companies THALES usually buys and, in addition, is involved in the civil sector. The Racal acquisition has meant that THALES is no longer a low-profile small player but has become a solid number-two defense prime contractor in the UK (with its THALES–UK subsidiary).

At the transatlantic level, after a failed effort to enter the U.S. market through its attempted acquisition of the Missile Division of LTV Corporation in the early 1990s, THALES decided in 1997 to adopt a more humble approach. Specifically, THALES’ new strategy calls for its image to be that of a U.S. company in the United States and a European company in Europe.

THALES’ approach in civilian activities differs from its approach in military activities. In the civilian market, THALES’ strategy is to buy small U.S. companies in order to learn how to do business in the United States. THALES now has 2,400 people located all over the United States, three-quarters of them active in civilian sectors. In the defense market, THALES’ strategy is to create teaming arrangements on cooperative programs with American firms rather than trying to merge with those firms.

THALES currently has more than 40 different transatlantic programs. It tends to link up with small companies that need its technology, although perhaps its most successful partnership to date is with Raytheon. In 1999, the two companies cooperated on a program to supply an air defense system for NATO.

The next step in THALES' transatlantic strategy is to create joint ventures rather than engage in 100 percent acquisitions, the former being a more workable and politically acceptable concept. Joint ventures can help build a relationship between the partners and eventually lead to more free-flowing information and technology transfers and other synergistic benefits. An example of this business model is THALES' joint venture with Raytheon. Some observers also view the Racal acquisition as a transatlantic bridge-building exercise: Having a British subsidiary could go a long way to overcoming lingering U.S. reticence to deal with French defense firms. According to THALES officials, one of the primary ultimate goals of such moves is interoperability between European and U.S. systems.

THALES' global business strategy could be seen as a reflection of the corporate group's focus on defense electronics and command and control, intelligence, surveillance, and reconnaissance (C2ISR) capabilities. By linking defense technologies with electronics, THALES can draw extensively from a worldwide talent pool and can more readily pursue a business strategy that is as broad as possible and still be politically feasible.

TRANSATLANTIC STRATEGIES

European firms now have more freedom to invest in U.S. defense firms. The number of such deals in the defense market hit a record estimated \$75 billion in 2000.⁸ Among the potential "buyers" is EADS, which is working with U.S. firm L-3 Communications to acquire U.S. firms. L-3 is also working with THALES on a joint deal involving an L-3 subsidiary that represents one-third of L-3's air-traffic control systems. BAE Systems is, for the moment, pausing to digest its \$1.6 billion Lockheed Martin acquisitions.

⁸*Forbes*, January 22, 2000.

OWNERSHIP

State ownership of European defense industries is declining under pressures from European governments to improve state budgets and the industry drive for creating multinational defense companies. State-owned entities will face increasing competition from private industry for human talent, among other competitive pressures. To illustrate this trend, the French government is decreasing its share in Aérospatiale Matra, the Swedish government is selling its Celsius stake to Saab, the Spanish government is selling CASA to EADS, and the Italian government is reducing its stake in Finmeccanica. As a result, company management may be better able to manage its own cost base without external interference from national governments.⁹

⁹This statement does not necessarily imply that European companies will operate without support from their governments or that they will surrender their historic and national identity in becoming global integrated technology corporations. Although governments will progressively limit their involvement in the day-to-day operations and strategies of defense firms, those firms will seek to retain the support and commitment of their national governments, which is particularly critical in securing work on major defense programs.

Technological trends and investment focus

Viewpoints of defense market analysts

- Europeans can combine different national capabilities
- But, Europeans are hampered by a small production base and weak R&D funding
- European competitive advantage: stand-off weapons, missiles, new-generation fighters
- Potential future European focus: airborne and air-to-ground surveillance, battlefield tactical communications

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TECHNOLOGICAL TRENDS AND INVESTMENT FOCUS: VIEWPOINTS OF DEFENSE MARKET ANALYSTS

There are some areas in which Europeans have an edge over U.S. companies, not necessarily in terms of technology but in terms of development. Those areas tend to be ones that Americans have abandoned or not pursued at all, such as conventional submarines and mine warfare. According to some analysts, Europeans have the advantage of flexibility—the ability to combine different national capabilities, competencies, and expertise. According to other analysts, Europeans are entering product markets that the United States has traditionally dominated and potentially are threatening that dominance. Such markets include attack helicopters, high-performance transport helicopters, medium-range air defense, military transport, fighters, tactical missiles, and launchers.

A post-Kosovo paper prepared in November 1999 by the French defense ministry, "Les Enseignements du Kosovo: Analyses et Références," identified certain technological advantages held by European partners, such as advantages in unmanned air vehicles (Germany), suppression of

enemy air defenses (United Kingdom, Germany, and Italy), and air-to-air refueling (United Kingdom, Germany, Italy, Spain, and the Netherlands).

European efforts are, however, hampered by certain limitations, which include the following:

- Technology that is often “prototype only” or produced in very limited quantities. Compared with the United States, where there is a much larger base of expertise due to large production runs and other factors, the European base of expertise is limited.
- Limited R&D funding—again, compared with the United States—affecting the development of next-generation technologies. Because of insufficient R&D funding, Europe may fall behind in most sectors and may eventually have to buy equipment from the United States, particularly as the value-for-money approach in procurement increasingly becomes a necessity.

Some analysts insist that Europeans are serious about focusing their efforts on military-unique areas in order to gain a competitive advantage over the United States in areas such as stealthy systems, laser weapons and precision-guided munitions, and military satellites. In addition, areas of current and future competitive advantage include stand-off weapons, missiles, and next-generation fighter aircraft. Those areas in which Europeans should focus greater efforts include airborne and air-to-ground radar and battlefield tactical communications.

Trends in the civil market and U.S. developments	
• Civil market • Cross-fertilization (primary example is EADS with Airbus; less applicable to BAE with 80% of its sales in the military market) • U.S. developments • JSF progress and outcome will be critical • Export controls and other regulations regarding technology transfer, foreign acquisitions of U.S. companies, and other activities will affect transatlantic prospects	
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TRENDS IN THE CIVIL MARKET AND U.S. DEVELOPMENTS

Because of the symbiotic relationship between civil and military aerospace, the principal European aerospace engineering companies should benefit from Airbus-related work during the early part of this decade. This is particularly true for EADS: It owns 80 percent of Airbus, which has a positive performance because of a favorable currency situation (EADS "builds in Euros and sells in dollars")¹⁰ and a sizable order book due to its competitive prices.

Developments in the JSF program should have an impact on the structure of the European defense and aerospace industry. The DoD's awarding of the JSF contract to Lockheed Martin offers many possibilities for transatlantic links, given the participation of several European companies in the bidding team led by Lockheed Martin. Furthermore, given the sole-contractor philosophy that prevails in the U.S. government and in the DoD with respect to that contract, it should be more advantageous for the

¹⁰As of this writing, 1.00 Euro was worth 0.89 U.S. dollars or, conversely, \$1.00 was worth 1.13 Euros.

United States to keep the Europeans "in the game," that is, involved in the U.S. defense and aerospace market to preserve competition.

Additional developments with respect to the regulation of export controls, technology transfer, and foreign investment in the U.S. defense sector will have a significant impact on European defense companies and on their strategies.

Directions for follow-on research on the European defense market
• Extension of the analysis to include the defense establishments of other significant European players—Sweden, the Netherlands, Norway • In-depth analysis of European market leaders and major players, and their capabilities • Projection of the structure of the European defense industry over the next 3–5 years
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PART IV
DIRECTIONS FOR FOLLOW-ON RESEARCH ON
THE EUROPEAN DEFENSE MARKET

The findings presented in this briefing suggest the value of extending the scope of the research into the current structure of the European defense market by examining several related issues in a follow-on study phase. Possible topics for a follow-on study include the following:

- Extension of the analysis to include the defense establishments of other significant European players, namely Sweden, Norway, and the Netherlands
- In-depth analysis of European market leaders and major industrial players and their capability to produce next-generation weapon systems
- Projection of the structure of the European defense industry in the near term (the next three to five years) by developing alternative scenarios, taking into consideration both supply-side and demand-side factors.

Key issues

- Can Europe sustain that many players?
- What will be the future of European consolidation in land, naval systems, subtiers?
- To what extent will consolidation be plagued by integration problems? Examples:
 - BAE has a very complicated business model
 - THALES-Racal integration could be problematic
 - EADS integration challenges have not been addressed yet

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KEY ISSUES

Some key issues stand out after this analysis of the European defense market and should be addressed in a follow-on phase of this project. These issues include:

RESTRUCTURING AND CONSOLIDATION

In the United States, having two or three major companies in each market segment can bring cost savings and help ensure sufficient innovation and competition. In Europe, where the overall defense budget is only two-thirds the size of the U.S. defense budget, it is much more difficult to sustain multiple players in each segment. In many cases, however, multiple players do exist in some market segments due to the prevalence of political issues and concerns¹ over economic realities. In addition, the progress in developing a common European security and defense policy (ESDP) and European defense capability will inevitably have an impact on the defense industry structure. It remains to be seen whether European

¹Examples of such concerns include the desire to preserve employment and/or maintain a national industrial base in particular segments.

governments will continue to be able to justify the survival of (often inefficient) national champions or whether consolidation will become necessary for the survival of the sector.

Specifically, the likely next phase of European defense industry development will be cross-border second-tier consolidation, although at a smaller scale than in the United States, for the simple reason that the European supplier base is smaller than the American one. The most significant drivers of this consolidation will be the major players' outsourcing policies, their decisions to downsize their supplier bases, and the creation of so-called "full-authority" subcontractors. It is very likely that a larger proportion of the risk of undertaking a weapons program will be transferred to the second- and third-tier suppliers and that consolidation will be a way to spread that risk.

INTEGRATION RISK

Another important issue, and major uncertainty, in the European defense market is *integration risk*—whether consolidation will result in truly integrated, efficiently run companies. The example of U.S. companies such as Lockheed Martin and Raytheon that had serious problems "digesting" their mergers and acquisitions is not very encouraging. Given that most European players have been engaged in consolidation activities, there will be many interesting cases to follow. Particular issues to examine include the disparities in different industrial groups' strategic goals, the various national cultures, the extent of state ownership, and models of integration and growth. Integration issues concern most large European players:

- **BAE Systems:** Financial markets are increasingly skeptical with respect to the (claimed) ease and benefits of Marconi's integration into BAE; this skepticism has become more intense given the problems U.S. contractors are having with the integration of their own acquisitions. Specific market concerns include problems with vertical integration, which is perceived to be more difficult than horizontal integration because it involves new relationships with suppliers and customers, and the need to integrate the ongoing platform activities of the entities to be combined. Additionally, financial markets are not yet convinced that the Marconi acquisition will generate the savings that BAE claims it will.
- **THALES:** The integration of Racal may be problematic, particularly in terms of combining the two cultures. Racal has a very entrepreneurial

culture, in contrast to THALES' rather bureaucratic management structure.

- **EADS:** As mentioned earlier, EADS' complex structure reflects a company that was not purely the result of market pressures but was also a product of strategic government decisions. EADS could represent a step in the right direction for European consolidation, but in the near future it could be facing several problems linked to its attempt to integrate a number of markedly different national and corporate cultures. The company must develop an "EADS mentality" by taking the positive aspects of each of these cultures and merging them into a strong and unified whole. So far, there is no strong evidence of progress in that regard. However, integration seems to be easier to achieve on the civil side where the issues are less politically sensitive. For example, savings from the consolidation of Airbus into the Airbus Integrated Company (AIC) are starting to be realized. The military side, on the other hand, is highly political and is influenced not only by economic concerns but also by noneconomic ones, such as employment and industrial base considerations, which create problems for the downsizing and rationalization that are often necessary for successful integration. It seems that EADS has not yet begun to deal with the issues of integration and assimilation of its various parts, cultures, and systems.

Projecting a European defense industry structure: Important considerations

- Do policymakers want specialization or diversification?
 - Will the systems integrator/vertical integration model prevail or will vertical and horizontal integration models coexist?
- Will all customers adopt the same procurement policies?
- What will be the source of innovation?
 - Are large, integrated companies or small specialized manufacturers better able to exploit technological breakthroughs?

RAND

PROJECTING A EUROPEAN DEFENSE INDUSTRY STRUCTURE: IMPORTANT CONSIDERATIONS

In attempting to project the European defense industry structure over the next three to five years, it is useful to consider the following questions, in addition to the market's main drivers:

- Will European governments automatically expect defense prime contractors to assume responsibility for systems integration, or will they decide that subsystems should be competitively bid? In other words, are policymakers prepared to tolerate monopolistic positions in specific sectors if those "monopolies" enhance efficiency and produce cost savings?
- Which model—vertical integration or horizontal integration—will prevail, if either one of them does? Could the two models coexist?

According to a December 2000 report prepared for the Assembly of the Western European Union,² consolidation of the European defense

²Assembly of the Western European Union, *The Interim European Security and Defence Assembly, The Consequences of Mergers in Europe's Defence Industries—Reply to the Annual*

industry, which is most advanced in the aerospace sector, will present the European Union and member-state governments with the problem of how to manage a monopoly. Although EADS, for example, denies that it enjoys a monopolistic situation, if the industries of the four countries with the largest defense producers in Europe (the three EADS partners—France, Germany, and Spain—plus Italy) join forces within a single company, the result is a *de facto* monopoly, at least in the field of heavy systems such as combat aircraft. Although defense contracts are not strictly comparable to ordinary procurement contracts, it is conceivable that reducing the number of suppliers to two, or perhaps even to one, is not conducive to controlling costs and promoting innovation in defense markets.³

It is interesting to note that consolidation in the European defense industry may have produced one of the least efficient market structures for that industry because an oligopolistic market structure,⁴ such as the one it currently has, tends to produce more excess capacity than either a monopolistic or competitive market. At the same time, those firms that have remained in the defense industry have become much larger, with more-specialized weapons systems integration capability, and they will compete fiercely with their rivals to produce the next generation of leading-edge weapons systems. As a result, governments inadvertently may have found a replacement for the technological competition of less-concentrated market structures—the intense oligopolistic competition among the high-technology defense contractors committed to supplying the most advanced weapons worldwide.

Another question worth examining is whether all customers (that is, governments) will adopt the same procurement policies. For example, the UK's "smart procurement" approach appears, at least initially, to encourage the development of large integrated enterprises, which can share some of the development and integration risks on large and complex programs.

Finally, one should consider the sources of future innovation in the industry. Are those sources going to be the large integrated conglomerates

Report of the Council, report submitted on behalf of the Technological and Aerospace Committee by Mr. Kolb, Rapporteur, Document A/1719, Paris, December 6, 2000.

³Such consolidation could create classic monopoly problems of higher prices, reduced incentives for innovation, and others.

⁴An *oligopolistic* market structure is distinguished by a small number of relatively large firms, which, among other characteristics, are interdependent in terms of their sales, production, investment, and advertising plans.

or the smaller or medium-sized specialized manufacturers? Will the large conglomerates be more competitive in reaching technological breakthroughs and utilizing them in new product development or will the second-tier, specialized defense companies be more adept at doing that? A related issue is whether integrated companies are better able than are smaller firms to exploit commercial developments.

APPENDIX A

EUROPEAN DEFENSE MARKET OVERVIEW

Table A.1
Matrix of Companies and Their Presence and Positioning Across Market Segments

SUBSYSTEMS													
PLATFORMS													
Company	Country	Military Aircraft	Helicopters	UAV	Missiles	Land Systems	Shipbuilding	Space	Propulsion	Defense Electronics	Radar/ Sonar	Electronic Warfare	Landing Gear
BAE Systems	UK	L		MajP	L (4)		L (8)	L (12)		L (MinP) (18)	MajP (23)	L (25)	
EADS	F / G / SP	MajP	L (1)	L (3)	L (4)			L (12)	MinP (16)	MajP	MinP	P	
THALES	FR				MajP		L (9)	L (13)		L (19)	L (24)	P (26)	
Dassault	FR	MajP											
Rolls-Royce	UK					MajP (5)			L				
Fimmeccanica	IT	MinP	L (2)		L (4)	MinP (6)	L (10)	MinP (14)		MinP (20)	MajP (23)		
Rheinmetall	G					MinP				MinP (21)			
Saab	S	MinP			MinP		MinP (11)	MinP (15)		MinP (22)	MinP		
GKN	UK		L (7)			MajP (7)							
GIAT Industries	FR					MajP							
Krauss Maffei Weermann	G					MajP							

Table A.1—Continued

PLATFORMS										SUBSYSTEMS			
Company	Country	Military Aircraft	Helicopters	UAV	Missiles	Land Systems	Shipbuilding	Space	Propulsion	Defense Electronics	Radar/ Sonar	Electronic Warfare	Landing Gear
LFK	G				MinP								
BGT	G				MinP								
DCN	FR						L						
Vosper Thornycroft	UK						MajP						
HDW	G						MinP (niche market)						
Thyssen Industries	G						MinP						
Izar (formerly Bazan)	SP						MinP						
Alcatel	FR							L (13)					
Ericsson	S							MinP (15)		MinP	MinP	MinP	
SNECMA Group	FR								MajP				L
Fiat SpA	IT								MinP (17)				
Volvo Aero Corporation	S								MinP				
ITP	SP								MinP				

Table A.1—Continued

KEY TO ABBREVIATIONS:

L—Leader, MajP—Major market player, MinP—Minor market player, P—Player (the exact position of the company in the market is unclear); FR—France, G—Germany, IT—Italy, S—Sweden, SP—Spain, UK—United Kingdom

KEY TO NUMBERS:

- (1) EADS is a leader in the helicopter segment through its subsidiary Eurocopter.
- (2) Finmeccanica is a leader in the helicopter segment through the joint company Augusta Westland.
- (3) Joint venture between Aérospatiale Matra and CAC Systèmes; EADS is also a minor player through Dornier.
- (4) Both BAE Systems and EADS are leaders in that segment through their stakes in Matra BAE Dynamics (37.5% for BAE and 37.5% for EADS; 25% for Finmeccanica-AleniaMarconi Systems).
- (5) Rolls-Royce is a major player in the land systems segment through its subsidiary Vickers Defence Systems.
- (6) Finmeccanica is a minor player in the land systems segment through its subsidiary Alenia Difesa.
- (7) GKN Defence merged with Alvis plc, which owns major land systems player Alvis Vehicles.
- (8) BAE Systems owns Yarrow Shipbuilders, VSEL (Vickers Shipbuilding & Engineering), and Kvaerner Govan.
- (9) Linkup with DCN in naval shipbuilding and combat systems.
- (10) Finmeccanica is a leader in the shipbuilding segment through Fincantieri.
- (11) Saab owns 100% of Celsius, which owns 25% of niche shipbuilder HDW.
- (12) Both BAE and EADS have a stake in Astrium (75% for EADS; 25% for BAE Systems).
- (13) THALES is a leader in the space segment through its stake in Alcatel Space (51% for Alcatel; 49% for THALES).
- (14) Finmeccanica is a minor player in the space segment through its subsidiary Alenia Spazio.
- (15) Saab is a minor player in the space segment through the joint venture Saab Ericsson Space.
- (16) EADS owns 100% of engine manufacturer MTU.
- (17) Fiat owns 100% of FiatAvio.
- (18) BAE Systems is a leader in the defense electronics segment through Marconi Electronic Systems; BAE is also a minor/niche player through its 49% stake in STN Atlas Elektronik.
- (19) THALES' defense electronics subsidiaries include Racal Electronics, Sextant Avionique, Thomson-CSF Detexis, Thomson-CSF Detexis, Dassault Electronique, Signaal, Pilkington Optronics, and others.
- (20) Finmeccanica is a minor player in the defense electronics segment through its subsidiary Alenia Difesa Avionic Systems and Equipment.
- (21) Rheinmetall is a minor player in defense electronics through its 51% stake in STN Atlas Elektronik.
- (22) Saab is a minor player in defense electronics through both the New Saab and through the joint venture Ericsson Saab Avionics.
- (23) Stakes in Alenia Marconi Systems (BAE Systems 50%; Finmeccanica 50%); BAE also has a 49.9% stake in Thomson Marconi Sonar.
- (24) THALES is a leader in the radar/sonar segment as an individual company and through the joint venture Thomson Marconi Sonar (50.1% stake).
- (25) BAE Systems is a leader in the EW segment through Marconi Electronic Systems, as well as through Lockheed Martin Sanders (a subsidiary of Lockheed Martin Aerospace Electronic Systems).
- (26) Particularly naval EW.

APPENDIX B **MAJOR EUROPEAN PLAYERS AND THEIR OWNERSHIP STRUCTURE**

Table B.1
Ownership Structure of Major Players, by Product Sector

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
PLATFORMS			
MILITARY AIRCRAFT	BAE Systems	UK	British Aerospace—Marconi Electronic Systems
	EADS	FR/G/SP	DASA (DaimlerChrysler Aerospace) Aérospatiale Matra CASA
	Dassault Aviation	FR	Aérospatiale Matra 46.5% Groupe Industriel Marcel Dassault 49.5% Public 4%
	Alenia Aerospazio SpA	IT	Finmeccanica 100%
	Aermacchi	IT	Fiat SpA 75% Alenia Aerospazio SpA (Finmeccanica) 25%
	"New" Saab AB	S/UK	BAE Systems 35% Saab 65%

Table B.1—Continued

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
PLATFORMS			
HELICOPTERS	Eurocopter	FR/G/SP	EADS 100%
	Agusta Westland	IT/UK	Agusta (Finmeccanica) 50% GKN Westland 50%
	NH Industries	IT/FR/G/NL	Agusta 32% Eurocopter 63% Stork Aerospace (formerly Fokker) 5%
	EH Industries	IT/UK	Agusta 50% GKN Westland Helicopters 50%
UAV	EADS (Dornier, Aérospatiale Matra)	FR/G/SP	
	CAC Systèmes	FR	
	BAE Systems	UK	
	GIE Eurodrone ^a	FR/UK/G	Matra BAe Dynamics STN Atlas Elektronik
	SAGEM	FR	
	Meggitt	UK	
	STN Atlas Elektronik	G/UK	BAE Systems 49% Rheinmetall 51%
	Meteor Aircraft & Electronics	IT	Finmeccanica 100%

Table B.1—Continued

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
PLATFORMS			
MISSILES	MBDA	FR/G/SP/UK/IT	BAE Systems 37.5% EADS 37.5% Finmeccanica (AMS) 25%
	THALES	FR	
	EADS (Aérospatiale Matra Missiles, LFK)	FR/G/SP	
	LFK GmbH	G/UK	EADS 70% Matra BAe Dynamics 30%
	"New" Saab AB	S/UK	BAE Systems 35% Saab 65%
	BGT (Bodenseewerke Geraetetechnik)	G	Diehl Stiftung & Co 80% MBDA 20%
	Shorts Missiles Systems	FR	THALES (Thomson-CSFAirsys) 100%
	Alenia Marconi Systems	UK/IT	BAE Systems 50% Finmeccanica 50%
	Bofors Missiles	S	Celsius Tech Group 100%
	Saab Bofors Dynamics	S	Joint venture between Saab and Celsius
	Euromissile consortium	FR/G	Aérospatiale Matra 50% LFK (DASA) 50%
	Eurosam GIE	FR/UK/IT	Thomson-Detexis 33% Aérospatiale 33% AMS 33%

Table B.1—Continued

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
PLATFORMS			
LAND SYSTEMS	GIAT Industries	FR	French State
	Alvis Vehicles Ltd	UK	Alvis plc 100%
	Krauss Maffei & Wegmann GmbH	G	(merged with GKN Defence armored vehicles)
	Vickers Defence Systems	UK	Mannesmann AG 49%
	Rheinmetall DeTec AG	G	Wegmann & Co 51%
	Alenia Difesa	IT	Rolls-Royce 100%
	Santa Barbara-ENSB	SP	Fimmeccanica 100%
	Royal Ordnance	UK	General Dynamics 100%
	MaK Systems GmbH	G	BAE Systems
	Swiss Arm. E. and Swiss Ordnance E.	CH	
	Steyr-Daimler-Puch Fahrzeugtechnik	A	RUAG SUISSE
	Iveco SpA	IT	General Dynamics majority shareholder
	Consorzio IVECO Fiat-OTO Melara	IT	Fiat SpA 100%
	Renault Vehicule Industries	FR	Fiat SpA—Alenia Difesa Otobreda division
SHIPBUILDING	DCN (Direction des Contructions Navales)	FR	
	Yarrow Shipbuilders	UK	French State
	VSEL (Vickers Shipbuilding & Engineering [BAE Systems])	UK	BAE Systems (Marconi Electronic Systems) 100%
	Vosper Thornycroft plc	UK	BAE Systems (Marconi Electronic Systems) 100%

Table B.1—Continued

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
PLATFORMS			
	HDW (Howaldtswerke Deutsche Werft AG)	G/S	Babcock Borsig AG 50% Pressag AG 25% Celsius 25% (owner of Kockums, Celsius 100% owned by Saab)
	Thyssen Nordseewerke	G	Thyssen Industries AG 100%
	Blohm & Voss Industries GmbH	G	Thyssen Industries AG 100%
	Fincantieri SpA	IT	Finmeccanica 100%
	Izar (formerly Empresa Nacional Bazan)	SP	SEPI 100%
SPACE	Astrium	FR/G/SP/UK	EADS 75% BAE Systems 25%
	Alcatel Space	FR	Alcatel Alsthom 51% THALES 49%
	Alenia Spazio SpA	IT	Finmeccanica 100%
	Saab Ericsson Space	S	Joint venture between Saab and Ericsson
SUBSYSTEMS			
PROPULSION	Rolls-Royce plc	UK	
	SNECMA Group (SNECMA, Turbomeca)	FR	French State 98%, balance held by Pratt & Whitney
	MTU (Motoren-und-Turbinen Union GmbH)	G	EADS 100%
	Volvo Aero Corporation	S	Volvo AB 100%
	Fiat Avio SpA	IT	Fiat SpA 100%
	ITP (Industria de Turbo Propulsores SA)	SP	
	HDW (Howaldtswerke Deutsche Werft AG)	G/S	Babcock Borsig AG 50%

Table B.1—Continued

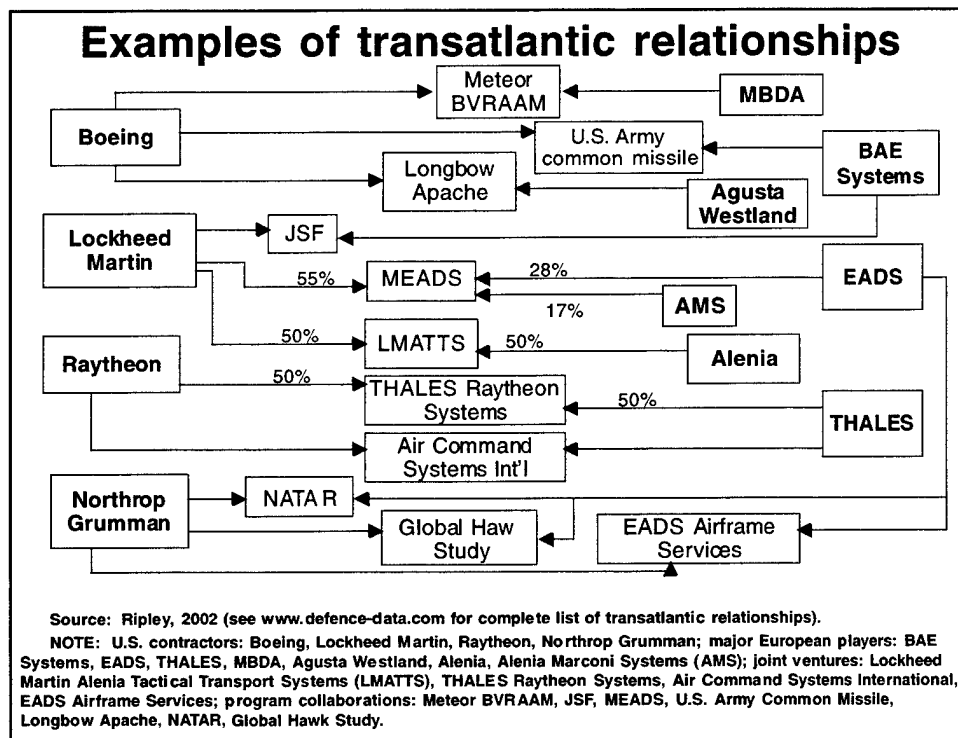
PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
SUBSYSTEMS			
DEFENSE ELECTRONICS	THALES (including missiles)	FR	
	Subsidiaries:		
	Racal Defence Electronics Ltd.		
	Shorts Missile Systems		
	Thomson-CSF Detexis		
	Thomson CSF Communications		
	Dassault Electronique		
	Elettronica SpA		
	Signaal		
	Sextant Avionique		
	Pilkington Optronics Ltd.		
	Alenia Marconi Systems (NV)	UK/IT	BAE Systems 50% Alenia Difesa (Fimmeccanica) 50%
SONAR	STN Atlas Elektronik GmbH	G/UK	Rheinmetall 51% BAE Systems 49%
	EADS	FR/G/SP	
	"New" Saab	S/UK	BAE Systems 35%
	THALES Underwater Systems (formerly Thomson Marconi Sonar)	FR	Now THALES Underwater Systems; was THALES 50.1% and BAE Systems (Marconi) 49.9%
	SAGEM	FR	
	Smiths Industries	UK	
	FIAR SpA	IT	
	Ericsson Saab Avionics	S	Joint venture between Ericsson and Saab
	Ericsson Microwave Systems AB	S	Ericsson 100%

Table B.1—Continued

PRODUCT SECTOR	MAJOR PLAYERS	COUNTRY	OWNERSHIP STRUCTURE
SUBSYSTEMS			
RADAR	THALES	FR	
	Subsidiaries:		
	Thomson-CSF Detexis		
	Racal Defence Electronics Ltd		
	Alenia Marconi Systems	IT/UK	50% BAE Systems 50% Finmeccanica
	EADS	FR/G/SP	
	STN Atlas Elektronik GmbH	G/UK	Rheinmetall 51% BAE Systems 49%
	Celsius (naval systems)	S	Saab 100%
	Ericsson	S	
	Euroradar	UK/SP/IT/G	BAE (through its GEC Marconi Avionics subsidiary); Enosa (SP); FIAR (IT); EADS
LANDING SYSTEMS	Messier-Dowty (SNECMA group)	FR	100% SNECMA

NOTE: FR—France, G—Germany, IT—Italy, S—Sweden, SP—Spain, UK—United Kingdom.

^aGIE Eurodrone was a consortium formed between Matra BAE Dynamics (a French and British company) and the German STN to develop the Brevet UAV. Development costs were shared 60% by Germany and 40% by France.



APPENDIX C

EXAMPLES OF TRANSATLANTIC RELATIONSHIPS

The chart above illustrates some of the most important relationships among the major European defense and aerospace contractors and their counterparts in the United States. Overall, collaborative programs outnumber joint ventures, indicating a large number of regulatory requirements and other hurdles that are standing in the way of creating a greater number of structural relationships. Details of the relationships listed by the major U.S. contractors are as follows.

BOEING

Programs/partners:

- U.S. Army Common Missile (United States/United Kingdom) with BAE Systems
- Meteor (United States/United Kingdom /France/Germany/Spain/Italy/Sweden)—potential joint development with MBDA of European Meteor beyond visual range air-to-air missile (BVRAAM) weapon for U.S. market

- AH-64D Longbow Apache (United Kingdom/United States)—production license for UK production with Agusta Westland.

LOCKHEED MARTIN

Joint ventures:

- Lockheed Martin Alenia Tactical Transport Systems (LMATTTS) (United States/Italy)—50-50 venture on the C-27 aircraft.

Programs/partners:

- Joint Strike Fighter (United States/international) with BAE Systems and Northrop Grumman; other European partners include Rolls-Royce, Fokker, Airbus Industrie, and others
- Medium Extended Air Defence System (MEADS)—55 percent Lockheed Martin, 28 percent EADS/LFK, and 17 percent Alenia Marconi Systems (AMS) for continued development of MEADS.

RAYTHEON

Joint ventures:

- Air Command Systems International (ACSI) Raytheon and THALES consortium to provide Air Command and Control System Level of Capability 1 (ACCS LOC1) to NATO
- THALES Raytheon Systems new joint venture encompassing air-defense/command and control centers and ground-based air surveillance and weapons-locating radars.

NORTHROP GRUMMAN

Joint ventures:

- EADS Airframe Services (France/Germany/United States)—Northrop Grumman holds 19%.

Programs/partners:

- High-Altitude UAV study (United States/Germany) with EADS on versions of Global Hawk UAV
- NATO Transatlantic Advanced Radar Project (NATAR)—Participating nations include Belgium, Canada, Denmark, Luxembourg, Norway, and the United States. Prime contractors include Alliance Ground Surveillance Working Group—Northrop Grumman (United States),

Computing Devices Canada (Canada), Kongsberg (Norway), EADS (Germany, France, Spain), Barco (Belgium), Terma (Denmark), Cargolux and Euro-Composites (Luxembourg), HAI and Intracom (Greece), ESDAS and TAI (Turkey), Alenia/FIAR and IAMCOI (Italy), OGMA and TAP Air Portugal (Portugal).

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Defense Systems Daily: www.defence-data.com

Foresight (UK): www.foresight.gov.uk

Jane's Europe News: www.janes.com/regional_news/europe

2001 Defense News Top 100: www.defensenews.com/current/top100/2001chart1.html

COMPANY SITES

BAE Systems: www.baesystems.com

Dassault Aviation: www.dassault-aviation.com

European Aeronautic Defence and Space Company: www.eads-nv.com

Giat Industries: www.giat-industries.fr

Rolls-Royce: www.rolls-royce.com

THALES: www.thalesgroup.com

INDUSTRY ASSOCIATIONS

Defence Manufacturers Association of Great Britain: www.the-dma.org.uk

European Association of Aerospace Industries: www.aecma.org

The European Defence Industries Group: www.edig.org

German Aerospace Industries Association: www.bdli.de (German and English)

Groupeement des Industries Françaises Aéronautiques et Spatiales:
www.gifas.asso.fr (French)

The Italian Industries Association for Aerospace Systems and Defence:
www.aiad.it (Italian and English)

The Society of British Aerospace Companies: www.sbac.co.uk