In the early 1990s, the U.S. aerospace industry entered a period of profound change and uncertainty characterized by extensive consolidation as well as by some divestiture or “demerger” activities. Beginning in the late 1990s, European industry also consolidated dramatically to the point at which leading European companies are now on roughly the same financial and technological plane as leading U.S. companies. The resulting U.S. and European “megafirms” have increasingly begun to initiate cross-border business relationships that encompass more than just trade. Most of these relationships are between U.S. and European firms, but some involve companies headquartered in other parts of the world. Thus, the consolidation of the U.S. aerospace industry appears to be evolving in the direction of greater globalization, with both the structure and the characteristics of the more globalized industry remaining uncertain.

The U.S. Air Force needs to understand the changes that are taking place both in the United States and overseas in order to develop strategies for proactively shaping those changes as well as responding to them. In 2001, the Air Force tasked RAND to examine and report on the rapidly consolidating and globalizing aerospace industrial base. One objective of this research is to develop evidence, information, and analysis that the Air Force can use to provide assessments both to the Office of the Secretary of Defense (OSD) and to Congress of the effects of new cross-border business arrangements as well as other industry changes, new procurements, and proposed laws and regulations affecting the industrial base. The research is also intended to assist the Air Force in developing strategies and
policies that will help it exploit potential opportunities and mitigate potential problems that may result from structural changes to the industrial base.

RAND’s first step was to conduct an exhaustive survey of OSD, Air Force, and other U.S. government–published analyses and evaluations, as well as the open literature, with respect to the structure and performance of—and the future prospects for—a highly consolidated and increasingly globalized U.S. aerospace industry. This evaluation led to the following findings:

• Many authoritative observers, including leading U.S. aerospace executives, view increased globalization—including foreign outsourcing and other types of international alliances and collaboration—as a key strategy for maintaining a healthy U.S. industrial base following a decade of mega-mergers.

• They further believe that globalization will promote increased competition, innovation, and fair prices in an increasingly concentrated aerospace industry.

• They also believe that further globalization is inevitable.

• Nevertheless, relatively few in-depth analytical studies have been undertaken on the implications of globalization compared to other aspects of the aerospace industry.

Together, these findings led us to focus our research on the implications of a globalizing U.S. aerospace industry. This report presents the findings from our initial FY 2001 research activities and discusses gaps in our understanding that would benefit from further research.¹

OVERVIEW

Consolidation and Globalization

According to most expert observers, the central aspects of the changes that have taken place in the U.S. aerospace defense industrial base over the past decade, as well as those that have more re-

¹The information cutoff date for this document is September 2001.
ently shaped the European aerospace defense industrial base, include the following:

• “Merger mania,” or horizontal and vertical consolidation and integration on the prime-contractor level and, to a lesser degree, on the second and lower-tier subsystem supplier levels.

• Increased globalization through strategic as well as product-specific alliances, international teaming and joint ventures, cross-border mergers and acquisitions (M&As), and a heightened interest in foreign exports and foreign lower-tier suppliers.

• Increased dependence on already highly globalized commercial markets and products.

A fundamental cause of the consolidation and restructuring of the aerospace industry in the United States, in Europe, and elsewhere has been a dramatic decline both in overall defense authorizations and, particularly, in military aircraft procurement budgets since the end of the Cold War. Between 1985 and 1997 the Department of Defense (DoD) aircraft procurement budget declined by nearly 75 percent. During the same period, DoD missile procurement and space procurement went down by 82 and 56 percent, respectively. Military aircraft production in the United States fell from a high of about 450 a year in 1986 to fewer than 100 per year from 1993 through 2000. In Europe, procurement expenditures for “heavy equipment” declined by 18 percent from the late 1980s to the early 1990s. Initial cuts were largest in Germany, one of the most important European weapon-procuring nations. By the mid-1990s, other

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2See, for example, the American Institute of Aeronautics and Astronautics (AIAA) (2001), Chapter 1. Note, however, that extensive consolidation also took place in many other sectors of the U.S. economy during this period. Although the 1990s “procurement holiday” appears to be ending in the wake of the events of September 11, most analysts believe that the current industry structure on the U.S. prime-contractor level will remain stable for some time, while consolidation on the second and lower tiers will continue.


4See, for example, Meth et al. (2001), which presents data from an unpublished study conducted by the Office of the Director, Industrial Capabilities and Assessments, Deputy Under Secretary of Defense for Industrial Affairs, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.
key European players such as France began slashing procurement budgets as well.5 According to one industry executive, North Atlantic Treaty Organization (NATO) European defense budgets declined overall by 21 percent from 1995 through 2000, while NATO European expenditures on research and development (R&D) went down by an even greater percentage (Kresa, 2001).

The natural response of aerospace contractors to a rapidly shrinking market was to consolidate horizontally and vertically through M&As; to lay off workers; to sell excess assets; and, in some cases, to exit the industry. As a result, during the 1990s the number of credible U.S. combat aircraft prime contractors as integrators for fighters and bombers declined from seven to two. Similarly, from 1990 to 1998, the number of U.S. missile manufacturers fell from fourteen to four, while space launch vehicle producers declined from six to two. By 2001, only one credible U.S. developer of air-to-air missiles remained active. In most major avionics subsystem and propulsion areas, one or two firms now dominate the U.S. market; in some instances, these firms have been acquired by one of the remaining dominant aerospace prime contractors. The naval and land weapon sectors of the defense industry experienced similar declines in numbers of firms. Overall, the number of defense companies that accounted for two-thirds of all defense sales shrank by 60 percent between 1990 and 1998.

By the beginning of the new millennium, similar consolidation trends had begun to reach fruition in NATO Europe. The leading European aerospace firms consolidated into three large, closely linked megafirms: the European Aeronautic Defence and Space Company (EADS), BAE Systems, and the Thales Group. EADS—which is composed of Aerospatiale Matra, DaimlerChrysler Aerospace (formerly Deutsche Aerospace SA [DASA]), and Construcciones Aeronauticas SA (CASA)—also owns a 46.5 percent share in Dassault Aviation and is forming a 50-50 joint venture with Alenia Aeronautica called the European Military Aircraft Company (EMAC). Following its recent acquisition of major divisions of Lockheed Martin, BAE Systems—formed after British Aerospace ac-

5See Brzoska et al. (1999). The dates chosen for comparison represent the “peaks and valleys” of procurement and R&D spending and thus represent the extreme points in the period of change.
quired General Electric Company’s (GEC’s) Marconi Electronic Systems in 1999—has become the world’s largest defense contractor by revenues. BAE Systems has also linked up with Dassault to study next-generation fighter technologies in a 50-50 joint venture called European Aerosystems. The third European giant is the Thales Group, the former Thomson-CSF of France. Thales has acquired numerous other European companies, including a major British defense contractor, Racal Electronics PLC. As shown in Table 1.1, these three newly structured European firms are on roughly the same scale as the new, consolidated U.S. primes.

With government political backing, these three megafirms have the potential to dominate the European military aerospace market and thus to reduce U.S. industry’s historically significant share of that market. This was dramatically demonstrated by the recent unexpected victory of a BAE Systems/Saab marketing joint venture for the JAS 39 Gripen fighter in Hungary and the Czech Republic, in competition with the Lockheed Martin F-16. The new European megafirms will also pose even more vigorous competition in third-country markets, where the battle for sales among U.S. and European firms is already fierce. Further, BAE Systems, Rolls-Royce, Smiths Industries, and other European firms (mostly British) have been highly successful in penetrating the U.S. market through new acquisitions, the most important of which are Lockheed Sanders and Allison Engines. At the same time, their larger size and growing technological and system integration capabilities make these megafirms more attractive potential partners for collaboration with U.S. firms.

**DoD’s Position on Defense Industry Consolidation**

In the early 1990s, DoD strongly encouraged greater defense industry consolidation.6 European government officials adopted a similar approach throughout the decade. The reasons were simple and straightforward. As noted above, procurement budgets (and, to a lesser extent, R&D budgets) had diminished dramatically since their high point in the mid-1980s and were continuing to go down. Consolidation and commercialization were seen as potential ways to

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6DoD was especially supportive of consolidation at the plant level, rather than simply at the corporate accounting level, because of the greater potential for cost savings.
Table 1.1

Global Ranking of Aerospace and Defense Companies, 1999

<table>
<thead>
<tr>
<th>Rank/Company</th>
<th>Country</th>
<th>1999 Defense Revenues ($ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: BAE Systems</td>
<td>UK</td>
<td>19.0(^a)</td>
</tr>
<tr>
<td>2: Lockheed Martin</td>
<td>United States</td>
<td>17.8</td>
</tr>
<tr>
<td>3: Boeing</td>
<td>United States</td>
<td>16.3</td>
</tr>
<tr>
<td>4: Raytheon</td>
<td>United States</td>
<td>14.5</td>
</tr>
<tr>
<td>5: EADS</td>
<td>France/Germany/Spain</td>
<td>6.1</td>
</tr>
<tr>
<td>6: Northrop Grumman</td>
<td>United States</td>
<td>6.0</td>
</tr>
<tr>
<td>7: Thales Group</td>
<td>France</td>
<td>3.6</td>
</tr>
</tbody>
</table>


\(^a\) Takes into account BAE Systems’ purchase of Lockheed Martin Aerospace Electronics Systems.

retain essential industrial base capabilities in an efficient and cost-effective manner as the market significantly declined.

Yet at the same time, some DoD and other expert observers expressed concern about the excessive concentration of the U.S. aerospace industry.\(^7\) According to the U.S. General Accounting Office (GAO), as early as 1994 the Defense Science Board (DSB) reported to DoD that

Reducing the number of firms capable of developing a suitable design for a new weapon system may lead to higher prices, poorer products, smaller advances in technology, and a reduction in the number, variety, or quality of the proposals that companies submit to DOD (GAO, 1997, p. 22).

In like manner, DoD’s 1996 annual report noted that

Consolidation carries the risk that DOD will no longer benefit from the competition that encourages defense suppliers to reduce costs, improve quality, and stimulate innovation (GAO, 1997, p. 21).

\(^7\) At least some senior DoD officials subscribed to the view that in the defense sector, two firms are often enough to ensure fierce competition owing to the “lumpy” nature of DoD demand. A formal version of this argument was first made by Peck and Scherer (1962).
A 1997 DSB task force also examined the possible anticompetitive potential of increased vertical integration in the industry, noting that "vertical integration enables several potential behaviors that may negatively affect defense product cost, quality and performance" (DSB, 1997, p. v). Concluding that "vertical integration poses future concern to DoD," the task force recommended that DoD “revise its policy and practices to increase the focus on retaining competition and innovation in its acquisition and technology programs” (DSB, 1997, p. xii).

The July 1997 announcement by Lockheed Martin and Northrop Grumman of their intention to merge deepened these concerns and led the senior levels of DoD to cooperate with the Justice Department in quashing the merger plans. The reasons given were the same as those expressed in DoD documents cited above—namely, that reduced competition among a much smaller number of vertically and horizontally integrated prime contractors and second-tier contractors could result in declining technological innovation and increased cost to the government.

Although the pace of consolidation slowed somewhat after the government blocked the proposed Lockheed Martin/Northrop Grumman merger, concerns persisted about the reduced levels of competition in the industry and its potential effects on innovation and price. Added to these concerns was a continuing perception of other weaknesses in the industry that might negatively affect competition, quality, price, and innovation. Chief among these were worries about allegedly insufficient levels of research, development, test, and evaluation (RDT&E) funding; the change in industry emphasis toward short-term, project-specific goals; and a decline in independent research and development (IR&D) expenditures (American Institute of Aeronautics and Astronautics, 2001, p. 2). A 1999 National Research Council report expressed great concern that industry-funded R&D for aircraft and missiles had declined by nearly 50 percent between 1988 and 1997 (National Research Council, 1999).

Uneasiness over declining competitiveness and innovation also emerged from perceptions that, over the long term, there would be insufficient numbers of fixed-wing combat aircraft and related technology projects to support more than one or two full design, RDT&E,
and manufacturing engineering teams. This was particularly the case in the area of fighter aircraft, where it was widely believed that the Joint Strike Fighter (JSF) would be the last manned fighter development and procurement project for decades. Following the downselect to one prime contractor in the fall of 2001, some observers envisioned the losing contractor effectively withdrawing from the fighter market sector, leaving only one viable fighter developer/integrator in the United States with a de facto monopoly on the market. Indeed, in the FY 2002 National Defense Authorization Act, Congress mandated that DoD direct a major study of the potential negative effects of such a monopoly on innovation and cost in future fighter aircraft development.

The Globalization Strategy

One possible solution to the problem of an increasingly concentrated U.S. aerospace industry lies in greater government encouragement of the existing trend toward globalization. In the early 1990s, for example, many observers believed that heavier government emphasis on U.S. aerospace exports could expand the market, support more domestic competitors, and help maintain U.S. industry capabilities. Given the rapid consolidation and restructuring of European industry, however, it had become evident by the beginning of the new millennium that the exporting of finished major weapon systems to Europe would become increasingly untenable. In fact, it was apparent that competition from the new European megafirms for third-country markets could become increasingly intense (Zakheim, 2000).

Therefore, rather than merely promoting exports, a more complex approach to globalization calls for increased participation of foreign
contractors in the U.S. defense market on all levels, as well as more cross-border teaming, joint ventures, mergers, strategic alliances, foreign direct investment in the United States, and weapon system development collaboration. Many economists and other expert observers have pointed out that expanded participation of foreign contractors in the U.S. market would increase competition, thereby providing economic benefits to the U.S. government. Generally, however, closer international linkages among aerospace firms could also bring noneconomic benefits, foremost among which would be the potential for greater equipment rationalization, standardization, and interoperability (RSI) among the United States, NATO Europe, and other key allies. At the same time, globalization also poses challenges, in particular how to preserve national capabilities and prevent the proliferation of advanced U.S.-developed military technologies.

Regardless of the costs and benefits of globalization as perceived by the U.S. government, given the contraction of the domestic market over the last decade and the strongly favorable attitudes of U.S. industry leaders, increased globalization seems inevitable. A recent major survey of aerospace and defense CEOs by a leading business consulting firm, for example, concluded that U.S. defense business leaders now view globalization as “an imperative” (Deloitte & Touche and Deloitte Consulting, 1998, p. 6). According to the report:

Globalization of the aerospace and defense industry is rapidly increasing as manufacturers move beyond national markets to exploit new opportunities in uncharted markets abroad. Indeed, economic necessity is beginning to wear away the industry’s insulation, forcing companies to compete as well as cooperate across frontiers . . . This marks a dramatic turnaround from the

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10 See, for example, Kovacic (1999).
11 RSI is a NATO-related acronym that was coined in the late 1970s. Rationalization refers to the avoidance of unnecessary duplication and to the rational allocation of funding and work tasks among NATO alliance members for weapon system R&D and manufacture. Equipment standardization refers to allied procurement of weapon systems that are identical or nearly identical. Equipment interoperability signifies allied procurement of weapon systems that may not be identical but can use the same consumables, such as fuels, lubricants, and ammunition, and can communicate through common frequencies, data formats, and the like. The U.S. government has promoted RSI in NATO for at least two decades, if not since the inception of the alliance.
views of executives who participated in the 1993 Vision in Manufacturing study. In 1993, globalization was not a top initiative, executives did not have clear global strategies and capabilities were low. Today, the survey finds that leading executives have changed their perspective and are actively taking steps to “go global” (Deloitte & Touche and Deloitte Consulting, 1998, p. 7).

Yet although numerous studies have examined and assessed the domestic aspects of U.S. aerospace industry consolidation over the past ten years, increased globalization—and the effects on U.S. industry of the more recent European consolidation—have not been subjected to equally intensive analysis. Indeed, few assessments of appropriate government responses to globalization issues are available. One important reason may be the relative lack of reliable data on—and analysis of—the nature and current degree of aerospace industry globalization. Yet devising policies that enhance industry competition, improve preparedness for coalition operations, and maintain the national security requires a better understanding of how, why, and with whom U.S. aerospace companies are establishing international business relationships.

RESEARCH GOALS AND ORGANIZATION OF THIS REPORT

The central purpose of this report is to examine issues related to aerospace industry globalization; to outline initial findings; and to propose a future research agenda that will help the Air Force develop a more effective policy and strategy for exploiting the claimed benefits of globalization while minimizing its associated risks. During FY 2001, the project thus pursued four major research goals:

- The collection and analysis of a wide range of government, industry, and private databases related to aerospace industry globalization, and the development of a typology of cross-border

12This is not to suggest that globalization issues are rarely addressed. Indeed, many government and privately supported studies of the subject have been undertaken. Recent government studies related to globalization include DSB (1996 and 1999). AIAA (2001) also includes an important discussion of globalization issues. Nonetheless, most of these studies rely on anecdotal evidence and the insights of industry and government “wise men” rather than on in-depth and systematic analysis of data.
business relationships and activities prevalent in the defense aerospace industry.

- The examination and analysis, based on OSD, Air Force, and other U.S. government analyses as well as the open literature, of both the opportunities and challenges the Air Force faces as a result of the ongoing globalization of the aerospace industrial base.

- A detailed examination of OSD, Air Force, and other U.S. government regulations, policies, and procedures with respect to purchases of foreign military equipment and services; foreign direct investments in the United States, including international M&As; and other forms of international industry alliances and collaboration.

- A survey of more than 30 case studies providing recent examples of cross-border business relationships, focusing mainly on the U.S. and European aerospace industries and stressing new and innovative types of approaches.

Analysis of aerospace and defense industry trade and investment data suggests that U.S. industry is closely tied to the global economy through exports but, compared to some other high-technology and manufacturing industries, does not heavily exploit imports or foreign technology. Most major U.S. weapon system platforms appear to have only small foreign content by value (DoD, 2001). This conclusion tentatively suggests that U.S. industry is not fully exploiting the potential economic and technological benefits of cross-border outsourcing. However, the data also show an increasing trend toward deeper industry-led cross-border relationships. These business relationships, although heavily oriented toward UK firms, could strengthen U.S. ties to all of the European NATO allies and offset any tendency toward competing transatlantic fortresses.

We identified three overarching objectives motivating Air Force interest in and concern about globalization: (1) the need to equip aerospace forces with affordable yet exceptionally capable weapons systems, both today and in the future; (2) the need to prepare the United States, its NATO partners, and other key allies to participate in future coalition operations, in part through the procurement of interoperable or standardized equipment; and (3) the need to protect U.S. national security, including technology security and domestic
industrial capabilities. Although we found at least some discussion of the implications of globalization for each of these objectives, there appears to be very little analysis of how globalization may affect trade-offs among them.

We also found that while competition is seen as key to equipping U.S. warfighters with superior yet affordable weapon systems, the potential role of foreign contractors in making U.S. defense markets more competitive is not given prominence. Further, while there is considerable emphasis on international cooperative development, procurement, and support of weapon systems in the context of coalition operations with NATO and other friendly nations, national security–related constraints on technology transfer and foreign direct investment in the United States may be preventing improved transatlantic collaboration. This appears to be the case despite major policy reform efforts such as the Defense Trade Security Initiative (DTSI) and the Defense Capabilities Initiative (DCI).

We conclude that industry-initiated cross-border business relationships may well be the most promising approaches toward achieving the economic benefits and equipment interoperability sought by DoD if they are organized as marketing agreements, teams, or joint ventures that are motivated by business and market factors rather than by government-mandated programs, and if they focus on subsystems, smaller programs, or narrow market sectors rather than on large traditional platform programs. We also conclude that further research is necessary to answer many crucial questions that remain, including the following:

- How do the current domestic and foreign regulatory environments affect the structuring of industry-initiated cross-border relationships, and how are DoD and foreign reform efforts changing the environment?
- What types of industry business relationships and structures are most effective in promoting both U.S. economic and political-military objectives?
- How are legitimate security of supply, technology transfer, and other technology security issues being handled, particularly in the new multipolar, multinational business environment?
To answer these questions, we propose the need for follow-on research using a detailed case study analysis.

Chapter Two of this report establishes a framework for analysis consisting of quantitative and qualitative indicators of globalization. On the basis of aggregate data on cross-border trade and investment as well as arms transfers, it assesses developments in U.S. aerospace globalization by comparing that industry to other major high-technology and manufacturing sectors in the United States.

Chapter Three draws on the open literature as well as on economic theory to review the economic, political-military, and national security opportunities and challenges posed by greater globalization of the U.S. aerospace industry. While it discusses issues surrounding globalization of the low-value parts and components supplier base, it focuses on the implications of globalization for the design, development, manufacture, and integration of high-value systems and subsystems.

Chapter Four reviews some of the more important existing legislation, regulations, and policy approaches that influence how the U.S. defense aerospace industry interacts globally. It also discusses how the Air Force implements DoD as well as its own unique policies and regulations related to industry globalization and international collaborative procurement, and it then offers an initial assessment of the effectiveness and influence of these policies. It concludes by reviewing some of the major globalization reform initiatives recently launched by NATO and by the U.S. government, concentrating on NATO’s DCI and on DTSI as jointly put forward by DoD and the Department of State (DoS).

Finally, Chapter Five surveys recent cross-border business relationships, organized under the categories of market agreements, teams, joint ventures, and parent/subsidiary arrangements. The focus is on cross-border business relationships initiated by the aerospace defense industry. The purpose of this survey is to gain initial insights into whether or not the new forms of cross-border business relationships are bringing the hoped-for benefits of increased globalization and, if so, which types of business relationships appear to be most effective. Chapter Six summarizes our findings, identifies gaps in our research results, and suggests future research to provide the Air
Force with a more comprehensive understanding of, and potential policy options for, effectively managing industry-initiated globalization.