SUMMARY

In the first couple of decades following World War II, over a dozen firms competed vigorously to develop and produce U.S. military aircraft. During the ensuing years, some firms left the business and others merged, so that by 1990 only eight firms survived. In the following few years, the pace of consolidation quickened. Today, only three firms are capable of developing and producing major military aircraft systems. Policymakers have expressed concern that further consolidation could erode the competitive environment, which has been a fundamental driver of innovation in the military aircraft industry.

The issue crystallized in the fall of 2001 when the Department of Defense (DoD) chose Lockheed-Martin as winner of the Joint Strike Fighter competition and as the prime contractor to develop and manufacture the F-35. That decision came after an intense, 5-year competition between concept development and demonstration teams led by Lockheed-Martin (and including Northrop Grumman) and Boeing. The F-35 is the only new major military aircraft program currently planned. Its production is scheduled to continue through 2026. Over that period, some 3,000 of the jet fighters are slated to be integrated into forces fielded by the United States and the United Kingdom (UK), and as many as 3,000 more might be purchased by U.S. allies. The U.S. and UK sales alone, worth some $300 billion (in then-year dollars), make the F-35 one of the largest acquisition programs in history.

Even before DoD chose Lockheed-Martin as the F-35 prime contractor, senior DoD officials and members of Congress had begun to

voice concerns about the effect of that contract award on the ability of all three U.S. prime contractors to remain active designers and producers of military aircraft and on their long-term ability to operate in competitive and innovative ways. In December 2001, the U.S. Senate requested (in the DoD Appropriations Act of 2002) that DoD prepare a comprehensive analysis of and report on the risks to innovation and cost of limited or no competition in contracting for military aircraft and related weapon systems for the Department of Defense.

STUDY OVERVIEW AND APPROACH

In February 2002, the Under Secretary of Defense for Acquisition, Technology, and Logistics asked RAND to analyze the current and future adequacy of the military aircraft industrial base in light of (1) the trend toward consolidation and (2) the prime contractors' abilities to remain competitive and innovative. RAND built upon its earlier studies of the U.S. defense industrial base (Drezner et al., 1992; Birkler et al., 1993, 1994, 1997, 1998) to explore various ways that demand for military aircraft might unfold in the next couple of decades, how the industry might respond to those different levels of demand, and how competition and innovation might evolve, given those changes in demand and industry structure.

We translated Congress' concerns into four research tasks:

1. *Describe the military combat aircraft industry*—This task involved characterizing the current industry structure and capabilities qualitatively and quantitatively, as well as examining how the industry structure, capabilities, and business environment have changed over the past several decades.
2. *Evaluate what is needed to maintain a high level of innovation in the military combat aircraft industry*—We adapted an analytic model of innovation (Porter, 1990) used in business and economic studies to understand the contribution of competitive pressures as a stimulus to technological innovation.
3. *Assess prospects for innovation and competition in the military aircraft industry*—In this task, we assessed the effect of alternative future aircraft-demand scenarios on prime contractors' abilities

to remain competitive in the military aircraft industry and their incentives to innovate.

4. *Identify policy options open to DoD*—In this task, we assessed policy options available to DoD to guide the evolution of the industry and ensure maintenance of critical abilities and characteristics.

The analysis RAND conducted attempted to stay close to congressional concerns as expressed in legislation. Thus, we have focused on maintaining the present competitive structure and capabilities of the current prime contractors. We limited our analysis to consideration of fixed-wing aircraft, drawing on information that is now unclassified.

In support of this analysis, we collected information from three prime aircraft contractors: Boeing, Lockheed-Martin, and Northrop Grumman. We also held discussions, including site visits, with each firm. Various DoD offices provided substantial supporting information and data.

RESULTS

Task 1—Describe the Military Aircraft Industry

The U.S. military aircraft industry has been evolving continuously for almost a century. The number of prime contractors peaked at 16 in 1945, after which firms either merged or exited, and no new firms entered. Changes in industry structure—in particular, the number of dominant firms—are closely associated with *revolutionary changes* in aircraft technology, changes that led to a fundamental transformation in the performance of combat aircraft—e.g., jet engines, low observability. In most cases, the key innovations enabling those changes in technology came from firms that were not dominant players at that time and who thus became dominant in the area of their innovation. Revolutionary innovation rarely came from the dominant firms in an era.

Task 2—Evaluate Methods for Encouraging a High Level of Innovation

According to economic and business literature, this pattern—in which revolutionary change and innovation come from firms that are not dominant—is similar to the experience of other industries. Although it is not possible to directly measure innovation, past analyses have identified factors affecting the pace and degree of innovation within an industry. Some of these factors are beyond the direct control of any government agency, but DoD can exert significant influence over three critical factors: It can directly affect investments in the technology base and the level of demand for aircraft, and it can indirectly affect the level of competition in the industry by the way it structures programs and distributes business among the firms.

Task 3—Assess Prospects for Competition and Innovation in the Military Aircraft Industry

Several changes related to competition and demand have affected the military aircraft industry in recent years. First, the nature of demand is changing. Funding has been increasingly focused on fewer programs, with emphasis on platforms that are joint, interoperable, and common across service and mission. For instance, in the past, the three versions of the F-35 would have been three distinct programs: Conventional Take-Off and Landing (CTOL), Short Take-Off and Vertical Landing (STOVL), and carrier-based. The consolidation of all three functions into one aircraft will likely make competitions for manned aircraft, both experimental air vehicles and major combat aircraft, less frequent.

Second, the complexity of the systems being developed has grown significantly through increasing reliance on information technology to provide enhanced functionality. Additionally, Unmanned Air Vehicles (UAVs) and Unmanned Combat Air Vehicles (UCAVs) have entered the market, posing a new set of design and development challenges to defense contractors.

Lastly, the role of prime and subcontractors has changed. To address the performance demands of the customer, the primes have increasingly focused on the complex system-integration function. Design tools, such as computer-aided 3-D programs, and institutional

structures, such as integrated product teams, have allowed the supplier base to become responsible for design, development, and production of key components. Significant innovation now occurs at all levels of suppliers, as well as at the prime-contractor level.

The most serious risk facing major prime contractors today is that there might not be enough new military aircraft design and development work in the second half of this decade to enable all three of the present primes to sustain an adequate team of engineers and technical managers for conducting technology development, advanced design studies, and demonstrator/prototype development and test of future system concepts. Sustaining an adequate team of such specialists is necessary if the firm is to be a strong competitor for future programs. Those teams, and the skills they comprise, represent the true foundation of future aircraft designs. If no major aircraft-development programs are initiated in the next few years, it seems likely that those teams will dwindle to below-critical size in at least some of the primes.

We also note that the industry is entering an era in which decisions on starting or stopping even one program can have major effects on overall industry size and composition.

Task 4—Identify Policy Options

Our findings indicate that procurement funding will likely be adequate to sustain the basic institutional structure of the current prime military aircraft contractors through at least the end of the present decade. New research and development (R&D) activities with a high likelihood of occurrence (a new tanker, new intelligence, surveillance, and reconnaissance [ISR], and a new UCAV) may be sufficient to sustain the design and development capabilities of the current primes through the middle of this decade. However, commercial derivative and UAV/UCAV programs as currently planned will be insufficient to sustain the current industry structure and capabilities beyond this decade. A DoD decision to begin a new major combat-aircraft program before the end of this decade would provide a stronger basis for sustaining current structure and capability. Conversely, if the number and frequency of major aircraft programs continue to diminish, it will be increasingly difficult to sustain an industry of the present size and posture.

We also explored ways to sustain the design and development capabilities of the current primes in the absence of any major near-term system-development programs. Co-production of the F-35 had been suggested, but that option is very expensive and does little to directly support design and development skills. A more attractive option would be to fund a number of design and development projects for Advanced Technology Demonstrations (ATDs) or Advanced Concept Technology Demonstrations (ACTDs) that push technology in directions reflecting desired future military capabilities. This option, which we believe would help sustain competition and innovation in the military aircraft industry, is not a complete solution in itself: It does not address production and the underlying business base needed to support design and development infrastructure over the long term.

A CONCLUDING OBSERVATION

This research has focused on preserving competition and innovation in the current military aircraft industry. But this focus begs the question of whether it is in the country's interest to preserve the current industry structure and capabilities for military aircraft. U.S. defense policymakers should recognize that industry has already evolved toward a different posture and different capabilities in response to a changing demand and business environment. The policy questions that need to be addressed are, What role can the government play and what role should it play in this natural evolution of industry structure and capabilities?