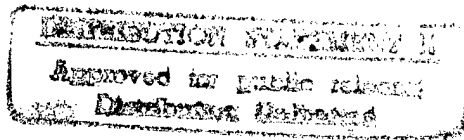


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# Maintaining Experience in Military R&D

With the continuing contraction of the aerospace industry, defense planners may need to implement special measures to maintain the industry's capacity to meet future military R&D requirements. RAND has been doing research on this problem for the last five years and was a pioneer in pointing to the importance of consciously maintaining development capability as the number of new military development projects dwindles to one or two at the turn of the century. Recent research continues in that tradition by focusing on the role of experience in maintaining key technologies and skills needed to preserve the defense industry base.

In *Bomber R&D Since 1945: The Role of Experience*, Mark Lorell reviews the historical record of major prime contractors in developing new bomber aircraft and attempts to determine the significance of established R&D experience in building and maintaining a competitive design and development capability for such aircraft. Focusing on the development of bombers from the early 1940s to the mid-1990s, the authors conclude that existing expertise in bomber R&D was a critical factor behind the success of those U.S. prime contractors that made the most significant contributions during this period.

## Three Types of Experience and Success

The authors proceed by generating useful definitions of contractor R&D "credibility" and "success," then defining and explicating the concept of "experience." In doing so, they refer to distinctions developed by previous RAND analysts who divided aerospace industry knowledge and capabilities into three categories: general, system specific, and firm specific. General expertise is possessed by all active contractors in the aerospace industry. System-specific expertise is possessed only by firms that specialize in certain types of aerospace systems, such as jet bombers. Firm-specific expertise refers to unique capabilities—such as stealth technology—possessed by only one or two companies in the field. The authors then compare and contrast the roles of these types of expertise in the development of bombers in the United States over the past five

decades. Finally, they examine the historical correlations between "experience" and "success."

## Three Main Periods of Bomber Development

This analysis divides the decades since World War II into three broad periods of bomber development. The first segment covers the mid-1940s to the end of the 1950s; the second runs from the 1960s to the mid-1970s; and the third spans the mid-1970s to the present. While there is overlap in bomber R&D between one period and the next, the authors found that the periods differ substantially in a number of key respects: Each era has its own clusters of dominant technology challenges, military requirements, procurement environments, and attitudes toward the role and importance of the heavy bomber.

The earliest of these historical periods is characterized by the central role of the bomber in U.S. military planning under the doctrine of massive retaliation. It was a time of dramatic technological change and innovation, during which the government funded large numbers of procurement and technology-demonstration programs. System-specific experience correlated closely with R&D success. The jet bomber developers making the largest contributions at the end of the period—Boeing, North American, and Convair—had also been leaders in bomber R&D when the period began. However, firm-specific expertise was also significant and ultimately led to a change in leadership among these companies. Boeing had entered the period as the dominant developer of heavy bombers and by far the most important contractor in the field. However, as North American and Convair developed specialized expertise in very-high-speed supersonic flight, they surpassed Boeing by becoming industry leaders in the cutting-edge technology needed for the development of the strategic bomber.

The middle period is characterized by increasing doubts about the role and utility of strategic bombers. New generations of air-defense missiles and interceptors made bombers vulnerable—and the arrival of ICBMs, vir-

tually untouchable by enemy air defenses, suggested that the manned bomber had reached the end of its usefulness. Moreover, a doctrinal shift toward limited tactical warfare led the industry to concentrate on improving the capabilities of fighter aircraft. These factors, combined with reductions in government funding for new programs, diminished bomber R&D to such an extent that not a single new bomber completed development. Since there were no radical new technological advances, the relative importance of special firm-specific knowledge declined. System-specific experience relevant to bomber R&D, however, seems to have remained critical: Rockwell, which had continued work on strategic bombers for two decades, stood out as the only credible bomber developer left in the field.

The last period, which spans the mid-1970s to the present, is dominated by the stealth revolution that rescued the strategic bomber from probable extinction. Similar to the first period, this segment is characterized by dramatic advances in technology that breathed new life into bomber R&D and shook up existing leadership ranks among aerospace contractors. Unique firm-specific experience and capabilities once again increased dramatically in importance relative to bomber system-specific capabilities. Indeed, it can be argued that firm-specific experience became more important than system-specific experience at this time. Two companies, Northrop and Lockheed, which had specialized in niche areas and had not been significant fighter and bomber developers in the 1960s and 1970s, took over the leadership role in stealth combat aircraft in the 1980s. Conversely, the dominant fighter and bomber developers of the middle period, who had built leadership positions on their substantial expertise in conventional combat aircraft development, lost most of the competitions for the new stealth combat platforms.

### Relevant Experience Matters

From his examination of the history of bomber R&D, the author concludes that defense-related experience matters. Prime contractors tend to specialize and thus develop system-specific expertise. For most of the period under

consideration, successful contractors built on a clear and uninterrupted progression of related R&D programs, as well as design and technology projects. Such system-specific experience was most important during periods of normal technological evolution when high intra-industry entry barriers prevented prime contractors from changing their areas of specialization. During periods of radical technological change, however, it was firm-specific experience that played a dominant role. Entry and success by previously marginal contractors that had new areas of specialization caused major changes in R&D leadership. Significantly, general expertise played only a minor role: The evidence shows no important correlation between expertise in commercial transport development and successful bomber R&D. In fact, it is most unlikely that the basic methodologies and technologies behind radical new developments in military capabilities—ranging from supermaneuverability to stealth—could have ever emerged from the commercial marketplace.

### Special Measures Needed to Maintain the Proper Experience Base

The study suggests, therefore, that a heavier dependence on "dual-use" technology development may not be the best way to proceed: Commercial aircraft development programs are unlikely to provide the necessary experience base for future military aircraft R&D programs. Therefore, the Department of Defense needs to consider options that will help maintain system-specific experience levels during long periods when no major R&D programs are under way. Such a strategy could focus on prototyping or technology demonstration. Additionally, since firm-specific skills become vital in periods of dramatic technological change, it may be important to support a significant number of companies—or at least divisions—engaged in a wide variety of different specializations. Finally, since basic and applied research programs funded by the government have led to key technological breakthroughs, especially in periods of dramatic change, further cutbacks in government-funded science and technology may be risky for the future.

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*RAND research briefs summarize research that has been more fully documented elsewhere. This research brief describes work done for RAND's Project AIR FORCE; it is documented in Bomber R&D Since 1945: The Role of Experience, by Mark Lorell, MR-670-AF, 1995, 93 pp., ISBN 0-8330-2341-1, and is available from RAND Distribution Services (Telephone: 310-451-7002; FAX: 310-451-6915; or Internet: [order@rand.org](mailto:order@rand.org)). Abstracts of all RAND documents may be viewed on the World Wide Web (<http://www.rand.org>). Publications are distributed to the trade by National Book Network. RAND is a nonprofit institution that helps improve public policy through research and analysis; its publications do not necessarily reflect the opinions or policies of its research sponsors.*

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