Looking Realistically at Asia’s Fighter Aircraft Ambitions

By Marc R. DeVore

The recent emergence of plans by South Korea, Japan, India and China to develop sophisticated domestic jet fighters may seem on the surface like an Asian challenge to the longstanding hegemony of US and European manufacturers of such military hardware.

However, the difficulties in developing indigenous military aircraft are enormous, writes Marc R. DeVore, as he looks back at similar efforts by India and Japan from the 1980s that ultimately ended in failure.

The past decade saw the unveiling of one ambitious combat aircraft project after another, with each aspiring to greater sophistication than current European combat aircraft and capabilities equivalent to the United States’ most sophisticated programs. China led the way in unveiling the Chengdu J-20 and the Shenyang J-31, touted as equal to the US F-22 and F-35 respectively. Not to be outdone, India announced two projects: the domestic Advanced Medium Combat Aircraft (AMCA) and the collaborative Indo-Russian Perspective Multi-role Fighter (PMF). Finally, Japan revealed plans to build a fifth-generation F-3 fighter, and South Korea proclaimed its ambition to develop a slightly less sophisticated fighter, the K-FX, with Indonesia as a minority partner.

Considering that just five countries — the US, USSR/Russia, Britain, France and Sweden — have monopolized the world fighter market since the Second World War, the plans of four Asian states to develop no fewer than six new fighters seem to portend a sea change in the production of military aircraft. Indeed, many see these Asian projects as portentous for global politics. For some, the techno-nationalist urge to develop advanced arms industries heralds an incipient regional arms race. For others, Asia’s fighter programs foreshadow an epochal shift of the locus for weapons development from Europe to Asia.

However, Asia’s current aerospace projects are less novel than they may appear. Indeed, four states — China, India, Japan and Taiwan — launched five sophisticated fighter projects in the 1980s. These too led to speculation that new Asian entrants might displace existing fighter producers and spur a regional arms race. However, far from propelling these countries into the first rank of aerospace powers or even achieving outcomes commensurate with their defense industries’ successes in less complicated domains, these projects were fraught with disappointment.

Projects fell behind schedule, underperformed technologically, went over budget and remained dependent on imported subsystems. In this article I assess why these Asian combat aircraft programs — particularly India’s Tejas and Japan’s F-2 — failed to achieve their objectives and what lessons should be drawn from these failures. To preview my conclusion, I argue that current projects will only succeed where their predecessors failed if policy-makers: 1) develop balanced approaches toward “bottleneck” technologies; 2) achieve adequate economies of scale and scope; and 3) forge intra-governmental consensuses for achieving greater long-term defense-industry autonomy at the expense of medium-term military efficiency.

CHALLENGING TECHNOLOGIES

Developing advanced combat aircraft is an economically and industrially complex task with few equivalents even among other sectors of the defense industry. Consequently, while a large number of countries have successfully built tanks and warships, only the five mentioned above have become sustained combat aircraft developers. Most of the approximately 17 additional efforts to enter this domain ended in abject failure. Among the many factors contributing to these outcomes, three merit particular consideration.

First, combat aircraft are composed of complex subsystems that are individually difficult to develop. Although experts disagree as to the precise number, one study suggests that five “bottleneck” technologies — electronic flight controls, carbon fiber composites, sophisticated radar systems, “glass” cockpits and jet turbofan engines — constitute the greatest obstacles to fourth-generation fighter production. To build stealthy fifth-generation fighters one must add radar reduction techniques and materials to this already arduous list. Because these technologies are difficult to master and are tightly held, producing states...
Economies of scale and scope pose a second major obstacle. Research demonstrates that workers improve their production techniques over long production runs, generating scope economies that reduce the man-hours needed to produce aircraft by 20 to 25 percent for each doubling of output. Likewise, larger production volumes make more efficient manufacturing possible along with better amortization of the fixed overheads of production facilities. Studies indicate that doubling production volumes reduces unit prices by 10 percent. For scope and scale economies together in fighter projects, large orders — 500 is the minimum, according to European producers — are rendered imperative. Since only the US and China purchase fighters in these numbers for their own use, other states depend on exports and/or international cooperation to approach these numbers.

The third obstacle to indigenous fighter development is fragile domestic support. Although domestic development aims to improve a state’s long-term defense-industrial autonomy, it imposes short- to medium-term costs in military efficiency. When states import aircraft, they bear none of the technological risks inherent in developing them and can compare the products offered by foreign producers. Furthermore, competitive tenders oblige exporters to offer prices based on production costs alone, since they have already sunk the R&D costs to develop aircraft and have economic incentives to increase production runs. Therefore, states that import aircraft often obtain more fungible military power for their money than those who develop them autonomously. The cost-effectiveness gap between buying and making aircraft is particularly large for new entrants, where the teething problems experienced by new industries exacerbate the problem. As a result, military and civilian leaders who prioritize military effectiveness or want to reduce defense budgets often turn against domestic aircraft programs.

Drawing on the experience of India’s Tejas and Japan’s F-2, I will demonstrate that no facile solutions exist for these challenges.

**INDIA’S TROUBLED TEJAS**

In theory, few countries have greater potential to develop fighter aircraft than India. With the world’s fourth largest air force, India possesses one of the largest domestic markets for combat aircraft, which mitigates the scope and scale problems faced by other producers. Moreover, India’s Hindustan Aviation Limited (HAL) has manufactured foreign-designed fighters since the 1950s and produced extremely sophisticated local components for its foreign-designed aircraft from the late-1970s. World-renowned engineering schools, such as the Indian Institute of Technology, also suggest that the country could develop an indigenous aircraft design commensurate with its established manufacturing capacity.

It was on the basis of these calculations that India’s government launched its lightweight combat aircraft (LCA) program in 1983, which gave rise to the aircraft known as the Tejas. Recognizing India’s lack of aircraft design experience, Indian authorities sought to develop an aircraft that would both incorporate all recent aircraft developments (e.g. composite materials, digital cockpit displays and electronic flight controls), yet remain small and affordable enough to replace India’s fleet of 500 lightweight MiG-21 fighters. The government also placed a premium on maximizing India’s ability to produce foreign fighters, reduced the intended production run from 200 to 144.

The Tejas’ flight control software also suffered delays when US sanctions imposed after India’s 1998 nuclear tests obliged Lockheed Martin to withdraw and Indian companies to assume full responsibility for software development. Less dramatically, Indian engineers took longer than expected to master the production of carbon fiber composite structures and the digital integration of a modern cockpit. Soon, the individual problems began to aggregate into systemic problems.

The Tejas’ production date was recurrently pushed back since it could not be produced until technological bottlenecks were resolved. This, in turn, generated pressures to order foreign aircraft to compensate for the delays. The air force argued that India would be better served importing more cost-effective foreign aircraft than continuing with the Tejas. The degradation of Indo-Pakistani relations that accompanied the 1999 Kargil War lent weight to the argument that medium-term military effectiveness was more important than defense self-sufficiency in the long-term. The Tejas’ anticipated producer, HAL, even lobbied for an interim contract to manufacture foreign aircraft under license because the Tejas’ delays threatened to close its assembly lines.

Thus, the pro-Tejas consensus disintegrated into a fractious debate between planners who favored Tejas, military leaders who preferred foreign purchases and HAL executives who wanted licensed production. Ultimately, this debate was resolved with compromises which, although individually rational, collectively undermined the Tejas. First, India contracted in 2000 to produce Russian Su-30 fighters under license in order to sustain HAL’s assembly lines. Then, India purchased French Mirage 2000 fighters in 2004 and Rafale fighters in 2015 to assuage its air force. Finally, with India purchasing or assembling 317 foreign fighters, the Tejas program was downsized — from 500 to 149 orders — but was retained to placate advocates of indigenization.

It was after these vicissitudes that the first Tejas left the assembly line in 2015. The technological and managerial challenges inherent in mastering sophisticated aircraft technologies resulted in India requiring 32 years, from 1983 to 2015, to transform its vision of an indigenous fighter into a reality. Unfortunately, such a prolonged development phase blighted the aircraft’s viability. Although it began as a modern design, the Tejas was surpassed by newer technologies. The delay in introduction generated pressure to appease the air force and HAL, including the purchase or production of foreign fighters, reduced the intended Tejas order and impacted the aircraft’s affordability. Thus, although the Tejas will soon serve India’s air force, it is not as capable, cheap or self-sufficient as intended.
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Japan’s Unaffordable F-2

When launched in 1987, Japan’s F-2 fighter project represented the penultimate step in Japan’s move up the aerospace “ladder of production” from licensed manufacturing to fully-indigenous development. As Japan’s rearmament gathered momentum in the 1960s, the country manufactured American-designed aircraft. However, from the beginning, Japan’s powerful Ministry of Industry and Technology Integration (MITI) favored the gradual indigenization of aerospace technologies. Therefore, MITI launched aircraft development projects beginning with a jet training aircraft (the Mitsubishi T-2) and then progressed to an unsophisticated ground attack aircraft (the Mitsubishi F-1). Having honed their design teams through these less challenging projects, government planners then wanted to develop a truly sophisticated fighter.

Certain Japanese policy-makers aspired to develop the fully-indigenous fighter, referred to by some as a “rising sun fighter,” as a successor to the Second World War era Zero. However, more cautious voices ultimately prevailed. Rather than take India’s route of trying to develop a fighter concurrently with all of its constituent technologies, Japan opted for a sophisticated fighter based on a proven American design, the General Dynamics F-16. In theory, this entailed less technological risk and would enable Japan to focus on domestic development. While it is easy to criticize Japan’s careful planning, the F-2 soon experienced problems with bottleneck technologies — both those domestically developed and those acquired from the US.

In terms of domestic development, Japanese industry struggled to produce the carbon fiber composites needed for the F-2’s wings and cracks proved a persistent problem. Meanwhile, Japan also experienced problems in acquiring US technologies once the US Congress began to challenge the technology transfer agreements that the Executive Branch had concluded with Japan. Fearing Japan’s emergence as a commercial competitor, Congress delayed technology transfers, imposed engineering practices to minimize Japan’s ability to domesticate the technologies and insisted that Japan “share” the technologies it was developing for the F-2. On a technical level, Congress’ insistence that radar components be delivered in “black boxed” modules complicated integrating American and Japanese domestic electronics.

The F-2’s costs escalated dramatically as the program experienced difficulties. Although only an incremental improvement on the F-16, the F-2 unit cost was equal to that of importing four F-16s from the US. Part of the problem lay in problematic bottleneck technologies, such as the persistent carbon fiber cracks and high rejection rate of composite surfaces. Another difficulty was in the F-2 contract and the non-competitive selection of Mitsubishi as prime contractor with a provision for “cost-plus” payments that provided few incentives for Mitsubishi to contain costs. Finally, the F-2 also suffered from inadequate scope and scale economies, as even the 141 aircraft originally envisioned constituted a suboptimal production run.

Ultimately, the declining cost-effectiveness of the F-2 program undermined the political consensus behind it. Consequently, Japan reduced its F-2 purchase to a mere 94 aircraft; further diminishing the program’s scope and scale-economies. Moreover, the F-2 experience chastened Japanese policy-makers, who refused to sanction follow-on projects and allowed Japan’s fighter assembly line to close in 2011. Although Japan belatedly announced its F-3 project this past year, the 20-year gap between the F-2’s first flight in 1995 and the development of its successor likely means that the project management skills built up through the F-2 project have been lost.

Lessons for the Future

Asia’s failed fighter programs from the 1980s should serve as a cautionary tale and provide lessons for today’s projects. To begin with, entering the fighter market is a fundamentally difficult endeavor that many policy-makers underestimate. Bottleneck technologies, large scope- and scale-economies and fragile political consensuses undermine many otherwise promising projects. Moreover, as the Indian and Japanese cases demonstrate, there are no facile solutions to these problems. To succeed, policy-makers must seek innovative solutions.

The bottleneck technology problem must be confronted with full knowledge that these technologies are exorbitantly difficult to develop and foreign suppliers are unlikely to sell their know-how. The nature of combat fighter scope- and scale-economies should also be acknowledged, as should the fact that most states cannot achieve efficient economies on a domestic basis alone. Consequently, policy-makers must seek alternatives in international co-operation, such as European states have done, or exports, whose success only comes through governmental efforts to promote sales.

Finally, policy-makers must recognize the need to forge a durable political consensus behind domestic development. While it is easy to convince military officers, industrialists and political parties to support a program in the initial stages, when the true costs are not yet apparent, sustaining that coalition is more difficult once domestic aircraft projects begin experiencing inevitable developmental problems. Very soon the “make versus buy” trade-off emerges, with imported foreign fighters being the preferred outcome for those prioritizing medium-term military effectiveness and domestic development being the favored option for those aspiring to long-term self-sufficiency.

The latter camp is only likely to win these debates if its arguments are grounded in geopolitical realities — in other words, it will be easier to sustain political coalitions favoring self-sufficiency when states are vulnerable to having their ability to buy aircraft curtailed and when they can afford to forgo a degree of military capacity in the medium term.

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