

By John A. Tirpak, Senior Editor

*McDonnell Douglas's entry in the Joint Strike Fighter competition is this tailless JSF (right), reminiscent of the McDonnell/Northrop competitor in the Advanced Tactical Fighter contest. Boeing's candidate (below) is the only one of the three that doesn't require larger wings for naval operations.*



# Strike Fighter



*Lockheed Martin is offering this twin-tailed design. While this concept's lines strongly suggest its F-22 heritage, the two aircraft are decades apart in technology and would have few components in common.*

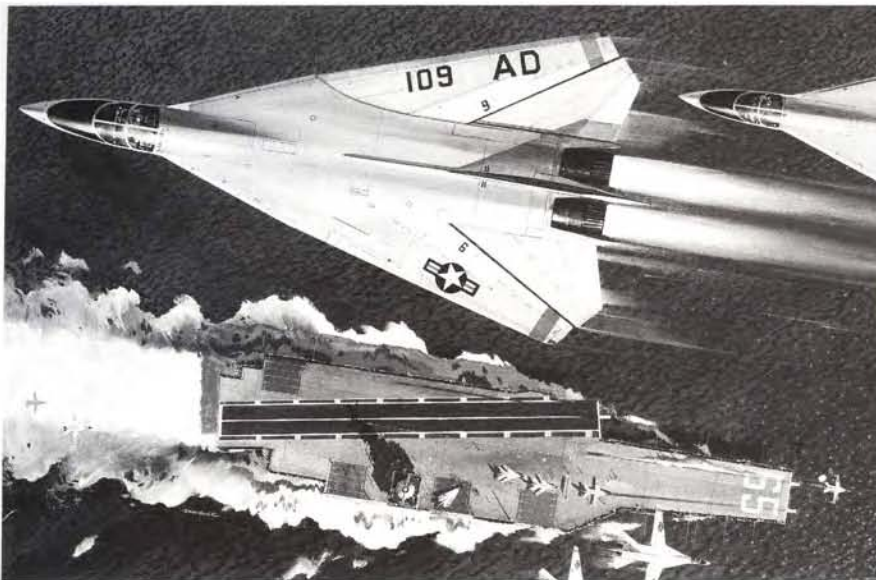
**The Air Force, the Navy, and the Marine Corps have all placed their bets on this aircraft.**

**N**EXT month, just after the Presidential election, the Pentagon will award two contracts for further development of the Joint Strike Fighter. This airplane isn't even fully designed yet but already is carrying a heavy payload. Resting on its small wings are the needs and expectations of three US services, one foreign navy, and numerous friendly air forces, not to mention the US aerospace industry.

The Joint Strike Fighter will have to be a remarkable airplane. If it works, the JSF will be the most cost-effective and versatile combat jet that the US has ever produced. It will become the centerpiece of the Air Force and naval aviation strike missions and a bridge to the aerospace technologies of the far future.

If it fails, it will become another corpse on the pile of false-start modernization projects of the past decade. Failure would also demand expensive work-arounds that would overwhelm the projected defense budgets of the future and starve industry of any all-new fighter work for decades.

"This is the kingpin program in the Department of Defense," re-



**The F-111B—the Navy version of the TFX—was a failure at carrier operations and highlighted the problems of building a common airplane that would serve USAF and the Navy. Streamlined acquisition may help the JSF succeed.**

marked R. Noel Longuemare, principal deputy under secretary of defense for Acquisition and Technology. Speaking at a June conference in Washington, he added, “We are trying to solve all our financial problems with this one airplane.”

The JSF came about through a long chain of program mishaps, shifting strategies, and financial realities. In 1991, the A-12 program, which was to have replaced first the A-6E in the Navy and then the F-111 in the Air Force, was terminated as a result of schedule and cost overruns. Its successor was the A-X, then rearranged into the A/F-X because its mission had been too narrowly focused on deep attack. Meanwhile, the Air Force planned to replace its F-16 squadrons with an aircraft it called the Multirole Fighter.

### From Three to One

Taking office in early 1993, the Clinton Administration concluded that future budgets could not sustain new aircraft development programs for both USAF and the Navy, and their projects were merged into the Joint Advanced Strike Technology (JAST) program. In 1995, a Defense Advanced Research Projects Agency effort to develop a prototype for an advanced short takeoff, vertical landing (ASTOVL) airplane for the Marine Corps was folded into the JAST effort.

JAST was initially chartered to catalog the aircraft technologies al-

ready available in the areas of stealth, propulsion, materials, manufacturing processes, and contracting methods and make them available for swift inclusion in upcoming aircraft projects. However, when deadlines loomed for getting something into the field to fill carrier decks and Air Force squadrons, JAST became an acquisition program dubbed the Joint Strike Fighter.

It would be a vast understatement to call the program “ambitious.” The JSF effort will attempt to produce a highly common family of aircraft that will replace, at a minimum, the

F-16 and A-10 in the Air Force, the A-6E in the Navy, the AV-8B Harrier and F/A-18C/D in the Marine Corps, and the Sea Harrier in Britain’s Royal Navy. It may also fill in behind the F-111, F-117, and F-15E.

Congress and key Pentagon leaders have not always been sure the JSF could work. “I was skeptical” that a one-airplane-fits-all project could actually be developed, said Lt. Gen. George K. Muellner, USAF’s top uniformed acquisition official and former director of JAST. “But the technology has really come a long way . . . and so has the acquisition environment. . . . When the contractors saw we were serious, they got serious,” he added.

Secretary Longuemare was another skeptic. “We’ve tried this before,” he said. “The TFX program (of the 1960s) attempted to build a universal airplane that did everybody’s job and wound up doing everybody’s job poorly.

“In the past,” he explained, “requirements were more like detailed design specs. . . . On TFX, we had such rigidity in our specifications that . . . the contractors . . . had very little opportunity” to innovate. “Manufacturing specifications were so stringent that they constrained efficiencies. . . . In effect, the government predetermined the cost of the equipment.”

The overspecification of TFX naturally led to “three similar designs, and then we decided to go with the



**Boeing’s entry features an expandable inlet to gulp air for short takeoff and vertical landing operations. All JSF entries will be STOVL-capable, possibly paving the way toward smaller Navy carriers.**

lowest bidder. So is it any wonder that program didn't succeed?" This time, instead of setting specifications that contractors had to meet, the JSF program has given contractors a set of performance and cost goals and left them free to innovate in manufacturing techniques, use of new technologies, testing, and materials.

"Expressing true warfighter needs in performance rather than as design specs . . . allows [contractors] the flexibility to actually pull this off," Mr. Longuemare asserted.

He added that the three JSF competitors—contractor teams led by Boeing, McDonnell Douglas, and Lockheed Martin—"have the flexibility to create designs that meet or exceed all the needs but do so at much, much less expense than in the past."

Gen. Joseph W. Ralston, vice chairman of the Joint Chiefs of Staff and chair of the Joint Requirements Oversight Council (JROC), also admitted to having had serious doubts about the feasibility of a JSF that would provide meaningful capability to the Navy, the Marines, and USAF. These doubts, he added, were "snapshots" of the travails the program went through while it was being adjusted to various and competing needs.

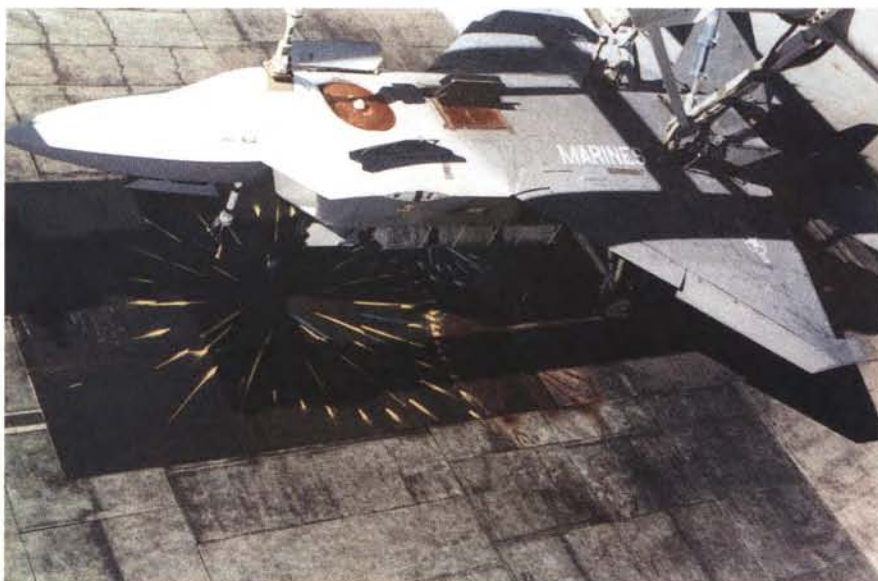
"I'm much more comfortable today than a year and a half ago" about the prospects for the JSF's success, General Ralston said.

### Dropping an Engine

He observed that the services have come a long way in getting their acts together and harmonizing their requirements, which the JROC validated. As an example, he noted that, after long advocacy of a two-engine design, the Navy now finds a single-engine approach acceptable.

Cost has been the most compelling factor. Rear Adm. Craig E. Steidle, JSF program director, estimates that the cost of developing one-for-one replacements for the F-16, A-6E, and AV-8B, individually, would be \$33 billion. By contrast, he said, it will cost less than half that amount—\$16 billion—to develop a family of JSF aircraft to do the jobs of all those airplanes.

The services will realize substantial savings by using a single production line operating at a high output rate rather than several lines



*The JSF program demands extensive testing to reduce risk. Here, Lockheed studies airflow under its design during a vertical landing. Few new technologies—and none that are unproven—will be incorporated into the JSF.*

dribbling out an aircraft or two per month, noted Admiral Steidle. That, combined with savings in parts, avionics systems, engines, and labor, could bring the JSF in for thirty-five to fifty-five percent less than would be the case in separate, noncooperative efforts, he said.

That's just the up-front cost. Paul G. Kaminski, under secretary of defense for Acquisition and Technology, sees "bigger potential" for savings "downstream . . . in the life-cycle costs" of maintaining, operating, and upgrading a single type of aircraft.

"I've seen estimates from the program office as high as \$60 billion" in life-cycle cost savings for the JSF vs. separate efforts, he said. "It's a big benefit."

There will also be an engine competition, patterned after the highly successful "great engine war" between the Pratt & Whitney F100 and the General Electric F110 during the 1980s and early 1990s. Pratt's F119 engine, designed for the F-22, is the "baseline" powerplant for the JSF, but a competitor—likely to be GE's F120—will be brought into the program after engineering and manufacturing development starts in 2000.

Commonality is the key driver of the savings, but the JSF program has not given contractors a specific "metric" on how to achieve it. "There's commonality by weight, commonality by cost, . . . some parts are identical, some are 'cousins,' . . . and some are unique," Admiral Steidle

observed. The commonality goal is eighty percent, but it will be measured within cost proposals.

"We've asked them to go as hard as they can" toward commonality of components, displays, and even machines and tools, he continued.

### More Than 2,000 Needed

The Air Force has the largest requirement for the JSF. The service said it needs 2,216 airplanes to replace F-16s bought in the 1980s and A-10s bought in the late 1970s and early 1980s. Both aircraft types will begin retiring in less than a decade. The F-16 turns in a fine performance, and the new JSF really doesn't need to outfly it in speed or maneuverability. However, the Air Force does want the JSF to be stealthier than the F-16.

Over the past twenty years, the Air Force consciously procured a mix of "high-end" (higher-cost) F-15s and "low-end" (lower-cost) F-16s. The practice has worked well—so well that USAF intends to continue the scheme, with new F-22 air-superiority fighters on the high end and the JSF as a low-end aircraft.

General Muellner said he "would not be surprised" to see USAF's tactical aviation assets evolve into a force composed entirely of F-22s and JSFs. But, he added, "It would be JSF in several variants, to do the mission of the F-117 and F-15E, . . . which will retire after 2010."

Lockheed has proposed to the Air Force that it procure variants of the



*The Air Force JSF will carry two 1,000-pound bombs internally with more slung under the wings when stealth is not as important. The precision and power of future munitions make a smaller, yet more effective, weapon load possible.*

F-22 to carry out missions of the F-15E and F-117 at some point. The Air Force has taken the proposals under advisement. Partly as a result of the proposals and partly at Congress's urging, the F-22's design was modified to accommodate two 1,000-pound Joint Direct Attack Munitions (JDAMs) in its weapons bay.

"The very first one off the assembly line will have the capability to do the strike mission," General Ralston noted.

However, said General Muellner, the Air Force's long-term acquisition plan does not include a follow-on to the F-117 or F-15E. If the JSF succeeds, it probably would be a cheaper solution to replacing the F-117 and the F-15E than the F-22 would be.

The Air Force's needs for JSF capabilities also will be influenced by other assets that either are available now or will be around 2010, General Muellner said. These include the Joint Air-to-Surface Standoff Missile, the JDAM guided bomb, the E-8 Joint Surveillance and Target Attack Radar System (Joint STARS), and the E-3 Airborne Warning and Control System (AWACS) surveillance platforms and such bombers as the B-2 and B-1B.

Under General Muellner's direction, JAST was to determine whether the United States even needed a new fighter if advanced standoff weapons and new bombers were available. The General reported that the

JSF indeed "earned its way into the battle plan. . . and every capability in the plane itself earned its way on board."

For example, the Air Force believes that bombers in the inventory are sufficient in number "to handle the deep target set," General Muellner noted. The JSF will complement bombers with a "higher sortie and surge rate."

The Navy's requirement is for 300 highly survivable, "first day of the war" stealth aircraft, each with the ability to carry two 2,000-pound pre-

cision weapons internally over a range of more than 600 nautical miles.

### Getting Back in the Game

In the Navy view, this type of aircraft would get it back into the "deep attack" game, currently dominated by the Air Force and its long-range strike aircraft. It would restore to the carrier fleet the ability to penetrate enemy air defenses without elaborate help from standoff jammers and defense suppression aircraft, all of which take up precious aircraft space on a carrier deck that could otherwise be used for attack aircraft.

The Navy argues that one JSF-equipped squadron per carrier could effectively serve as "pathfinders" for its F/A-18 fighters, which will continue to provide the bulk of the Navy's air strike assets for the next three decades.

Once the Navy starts getting the bigger and more capable F/A-18E/F Super Hornet, it will begin making a transition to an air wing of thirty-six F/A-18C/D models and fourteen E/F versions. When the JSF starts entering the inventory, the C/Ds will be retired, and the standard mix on a carrier air wing will shift to thirty-six F/A-18E/Fs and fourteen JSFs.

The JSF will give the Navy its first limited capability in the field of stealth, now monopolized by the Air Force with its F-117s, B-2s, and the F-22. The JSF also will serve as a



*The F-22 taking shape here is a testing ground for "lean manufacturing." Production efficiency will be critical if the services are to afford 3,000 JSFs. Rules of the competition insist on eighty percent commonality.*

kind of technology pot from which the F/A-18E/F program can draw, said Rear Adm. Dennis V. McGinn, director of the Navy's Air Warfare Division.

"Because of the open systems architecture" on the Hornet, the Admiral said, "we anticipate the back-fit of technologies from the JSF onto the F/A-18E/F." The two programs, he asserted, will "feed each other" with innovations.

Earlier this year, the F/A-18E/F Super Hornet was the subject of a highly unfavorable report from the General Accounting Office. GAO's report claimed that the Super Hornet would yield only a "marginal" improvement over the C/D model in range and payload, and no improvement at all in agility, but at a high cost. GAO recommended a continued buy of the C/D until the JSF becomes available.

Secretary Kaminski disagreed with the GAO and claimed that improvements to the Super Hornet are not marginal but "significant."

"We are pretty much out of space for growth in the F/A-18C/D," he said, noting that, if the Pentagon defers modernizing naval aviation, F/A-18C/Ds with 1970s and 1980s technologies would be operating until 2010 or even later.

General Ralston noted that some critic in Congress or industry can always be expected to agitate for skipping a current program in order to wait for the next, but this strategy rarely proves wise. "It's always easy toglom onto a paper program to replace a real capability," he said. "The F/A-18E/F is here today, . . . and we ought to take advantage of it."

In addition to providing room for growth, said Secretary Kaminski, the F/A-18E/F provides a hedge against failure in the JSF.

"Having an F/A-18E/F in production as we ramp up the Joint Strike Fighter . . . gives us some options," he said. Specifically, he said, it gives the Pentagon the option to continue buying new aircraft even if the JSF program falters or fails.

### The Terminator

Secretary Kaminski also noted that the Pentagon could terminate the F/A-18E/F program earlier than planned if the JSF proceeds on track and does well.



*The Navy's F/A-18E/F effort gets badly needed aircraft on carrier decks now and is a hedge against potential problems with the JSF. The Super Hornet is neither stealthy nor cheap, however, and may be curtailed if the JSF proves a winner.*

General Muellner said that the Navy is not planning to completely replace its fleet of F/A-18 fighters with JSFs. The combination of JSFs and other systems, such as the Tomahawk land-attack missiles, were figured against the Navy's need for an all-aspect stealth aircraft. The requirement for only 300 airplanes "takes into account the extensive legacy systems we will have," Admiral Steidle noted.

Measured in sheer numbers of aircraft, the Marine Corps requirement for the JSF is even bigger than the Navy's. USMC wants 646 new airplanes to replace its AV-8Bs and F/A-18s and is adamant about having a supersonic short takeoff and vertical landing (STOVL) jump-jet. Such an airplane would be able to operate close to the front lines for quick response to calls for close air support.

The Marine Corps is so determined to have such an airplane that it has bowed out of the Navy's F/A-18E/F program and will make do with what it has until the JSF arrives. It is literally holding itself hostage to the success of the new program.

When an infantryman calls for close air support, "you have to be right there," said Lt. Gen. Harold W. Blot, USMC deputy chief of staff for Aviation. "Despite best efforts" with typical fixed-wing aircraft, he added, the fastest response between a CAS request and bombs on target is twenty-seven

minutes. "That is completely unsatisfactory," he said.

In the Persian Gulf War, operating the AV-8B Harrier, the Marines "proved you could put a sophisticated airplane at the front" and still respond "within five minutes" to a call for CAS. The AV-8B "achieved a ninety percent availability rate . . . and didn't require in-flight refueling," General Blot said. Even so, the Marines want to move beyond the AV-8B and buy a more reliable, faster, and more sophisticated airplane, he said. "That's why we have to have the JSF."

In the Marine Corps version, additional ducting or an engine, or both, will be installed to provide STOVL capability. In the Air Force version, the ASTOVL equipment will be deleted and the space used for fuel.

The Marine Corps managed to get along without STOVL in the Vietnam War and well into the 1970s, and some members of Congress nearly succeeded in getting the STOVL JSF knocked out of the program this year, touting the move as a cost-saver.

Such a move would have a "significant" impact on the JSF program, warned Secretary Kaminski. He said that the Marines "perhaps" could get by with a conventional takeoff and landing aircraft, but "I don't today think that's the best solution." He noted that eliminating the ASTOVL variant would certainly force the Marines back into the F/A-18E/F



**The Pentagon is gambling heavily on the JSF. If it is not a success—in price as well as performance—the cost of modernizing tacair will be prohibitive, and policymakers will have to rethink airpower strategies.**

effort. It would also eliminate participation of the Royal Navy, whose “primary interest” is in the ASTOVL version. It plans to buy about sixty JSFs identical to the Marine Corps version for use aboard Britain’s ski-ramp carriers.

But Secretary Kaminski also said the JSF provides other options “not easily quantified.” He observed, for example, that “there may be some room for a STOVL variant in the Air Force or Navy inventory.”

“Going to shorter fields doesn’t hurt us for some of the Air Force operations in the world of the future, and this may also open up opportunities for alternatives to current carrier size,” he added.

The ASTOVL, he said, needs to be considered “more broadly than thinking about it as a Marine Corps issue.”

General Muellner concurred with Secretary Kaminski’s view and added that “technology has come along that has reduced the penalty” for carrying around ASTOVL-specific hardware.

The JSF was developed by “bringing together” the regional commanders in chief and active-duty operational pilots and unit commanders to define “what was really needed,” General Muellner said.

“These guys were in the habit of saying things like, ‘Well, I need 1,000 miles of range.’ In this program, when that occurred, we said, ‘Okay, but this is what it will cost

you’ ” in price, agility, or weapons load, he explained. “Most of the warfighters were surprised by what things they really didn’t care about” but that they had typically thrown into a requirements package as boilerplate cost, General Muellner noted.

Before any design work was done, the JAST program developed “a matrix of requirements” from each service, having to do with such factors as lethality, maneuverability, and sortie generation, Admiral Steidle said. When this matrix was presented to the JROC, “they agreed that these things were not as far apart as they seemed” and that a family of highly common aircraft could actually meet all needs.

The JSF office continues to run simulations and computer campaign analyses assigning the airplane various capabilities in various scenarios, according to Admiral Steidle.

“The Defense Planning Guidance, which tells us how to prioritize the defense budget, gives us these scenarios,” he explained. The guidance specified two major regional conflicts in general and such scenarios as northeast and southwest Asia in particular.

Such simulations have been run six times. During the most recent one, the contractors were allowed to run their specific concepts to determine the breakpoints in cost-effectiveness. Such analyses will be run throughout the JSF development

cycle. The design will be tweaked if more or less capability in a given area proves a big cost-saver or force enhancer.

### Sorties and Targets

The JSF program measures the candidate designs by a sophisticated formula boiling down to “how many sorties does it take to hit the target . . . or better, how many targets can you hit with one sortie,” Admiral Steidle pointed out.

The JSF will definitely make substantial use of off-board sensors. By piping information into the cockpit from Joint STARS, AWACS, unmanned aerial vehicles, and satellites to gain greater situational awareness, the aircraft can be built with a much less expensive on-board sensor suite.

Systems that once required their own hardware can now be networked to save weight and cost. For example, the JSF’s electronically steered antenna can work on behalf of the radar, communications, and warning systems simultaneously.

The JSF will incorporate only those technologies that have been demonstrated as “low risk” by the time one contractor is picked to do final development and production. This “design freeze” will occur in 2000. The Pentagon hopes the approach will minimize the delays that typically afflict aircraft with unproven technologies.

The JSF office has given briefings in a dozen countries that would be candidates to participate in the development program or would simply like to buy the end product. Norway, Denmark, Belgium, and the Netherlands—the partner countries in the F-16 program—will have a requirement almost identical to that of the Air Force in the next decade or so as their F-16s reach the end of their useful service lives. Thousands of JSFs could be sold abroad, and the airplane would be America’s designated “export fighter.”

Admiral Steidle also said he is not concerned, at this stage, that the JSF will be virtually a winner-take-all program. Should Lockheed win, it would be the Air Force’s sole supplier of fighters; if McDonnell Douglas wins, it would be the Navy’s sole fighter source. Whoever wins, it will be the only US company making fighter airplanes after 2015. ■