Prototypes of the Advanced Tactical Fighter begin flying next year. Program managers report excellent progress—and see the ATF as progenitor of technologies for fighters of the future.

The ATF and Its Friends

BY ROBERT S. DUDNEY
SENIOR EDITOR

THE rakish, high-technology flying machine will be more than just an exotic addition to the Air Force's stable of aircraft. It shapes up as "the cornerstone of our future tactical fighters."

Lt. Gen. Mike Loh, Commander of the Air Force Systems Command's Aeronautical Systems Division, attributes that significance to the Advanced Tactical Fighter, a futuristic craft that ASD is set to begin flying in prototype form next year.

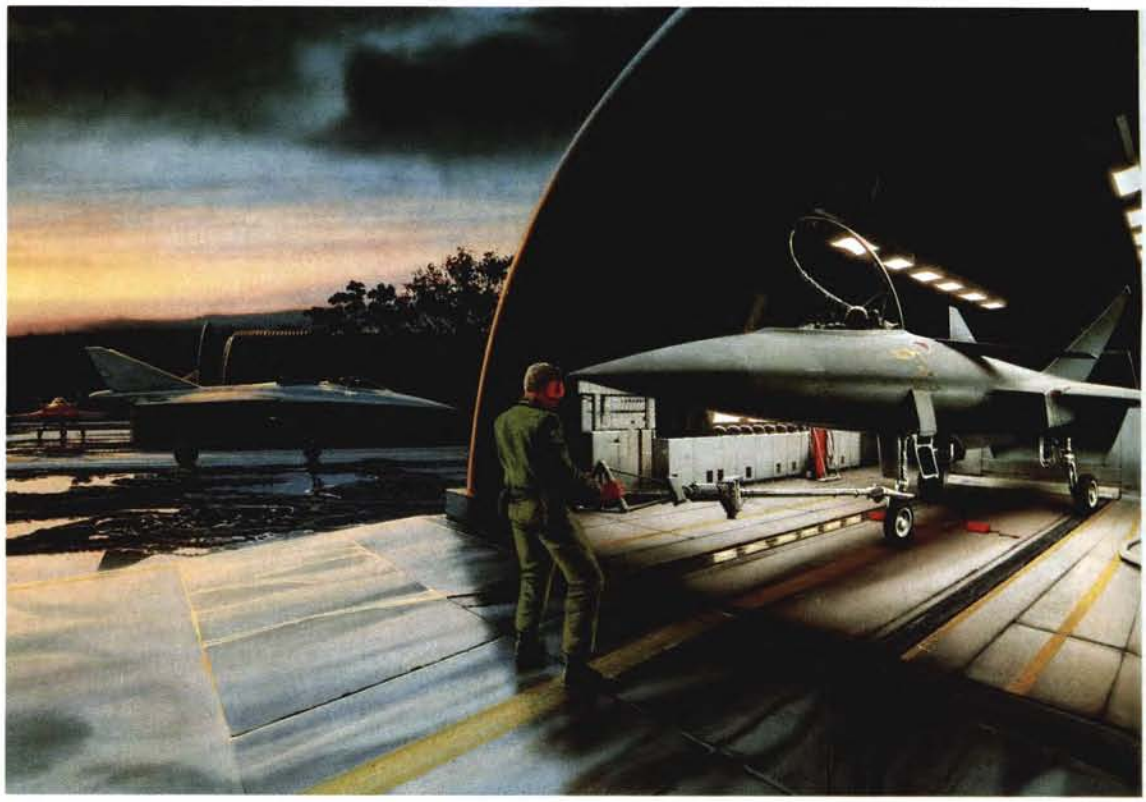
General Loh means that the innumerable revolutionary aerospace technologies now being stimulated and perfected by the high-profile ATF effort will feed the Air Force's appetite for developing new fighters on a wide-ranging scale.

For example, standard F-16s and F-15s, destined for heavy duty into the next century, may receive ATF-type engines and avionics. Even "low-observable" technologies that provide "stealthiness" for ATF might well be infused into either or both of these aircraft.

"Absolutely," claims General Loh. "Applications of low-observable technology to those aircraft can happen. . . . We're studying all of that now. We see lots of mileage in F-15s and F-16s as we bring ATF along."

Further in the future, say officers,

Given the new fighter's $9.9 billion development cost, USAF has set high goals for it. Prototypes are to fly early next year.



Initial ATF deployment, now scheduled for the mid-1990s, probably will come in Europe. Advanced technologies, Air Force officials claim, will make the ATF more reliable and easy to maintain, increasing USAF's ability to generate the large number of sorties that may be needed in a conflict with the Warsaw Pact.

more ATF technologies may work their way into a proposed Agile Falcon makeover of F-16, the Air Force version of the Navy A-12 Advanced Tactical Aircraft, future ATF clones, and other airplanes not yet in public view.

"The ATF is far more than just a single aircraft development program," claims General Loh. "The ATF is bringing along with it the whole technological base—avionics, structures, materials, flight controls, engines, cockpits, microprocessors—for future fighters."

Fueling the revolution are ATF's awesome goals. Plans call for ATF not only to be able to elude detection, cruise at supersonic speeds without afterburner, take off over short distances, and handle better than any other fighter. It will also have to be reliable and easy to service, with its avionics blended in ways once thought impossible.

Whatever the precise makeup of the final, production-line aircraft, however, this much is certain: The air-superiority ATF shapes up as a technological progenitor in the same way that its predecessor, the original F-15 Eagle, was father to many technologies that have found their way into the F-16, F-111, and F-15E.

In light of ATF's development cost of $9.9 billion (measured in 1985 dollars), Air Force officers are promoting the airplane's broader legacy as a distinct political plus. "This is a point people often overlook," General Loh says. "Development of ATF is expensive. There is no doubt about it. But the payoff goes well beyond ATF itself."

Helping to make the payoff possible, for ATF as well as its aeronautic friends, has been the pioneering work by ASD technologists at Wright-Patterson AFB, Ohio, and its many aerospace contractors.

Picking Up Momentum

The ATF project itself is picking up momentum. Prime contractors Lockheed (teamed with General Dynamics and Boeing) and Northrop (teamed with McDonnell Douglas) are far along in competition for a $7 billion full-scale development contract that will be awarded in January 1991.

They are nearing the moment of truth in a fifty-month demonstration and validation phase aimed at reducing ATF's development risk. Each is fabricating two prototype airframes—Lockheed's YF-22A and Northrop's YF-23A—that must be ready to go no later than early 1990 for a year of flying. The primes also must complete ground-based prototypes of ATF's avionics in time for critical demonstrations starting late this year.

Similarly, ATF prototype engines are nearing completion at powerplant builders Pratt & Whitney and General Electric. Three models of their respective engines, the P&W YF119 and the GE YF120, are being hammered together for use in both ATF airframes.

For Col. James A. Fain, Jr., ASD's program director for the ATF, progress to date leaves little doubt that the prototypes will be ready on schedule. "We are definitely going to get an aircraft into the air in early 1990," reports Colonel Fain. "No question about that."

Although the details of ATF's proposed flight characteristics, signatures, and electronics are heavily classified, there can be little question that it will be a fighter of unprecedented power.

The Air Force isn't budging from its position that the ATF must possess a unique first-look, first-kill power—the ability to find and kill a foe before being targeted in return—among other attributes.

That's for the future. What ASD will be looking for in its prototypes, reports General Loh, will be a demonstration of "supersonic cruise without afterburner in a low-observ-

able-shaped planform that exhibits fighter handling qualities and fighter maneuverability."

What gives ASD officials confidence that they can do what's never been done before is the array of new technologies that the ATF effort is both extending and bringing to life.

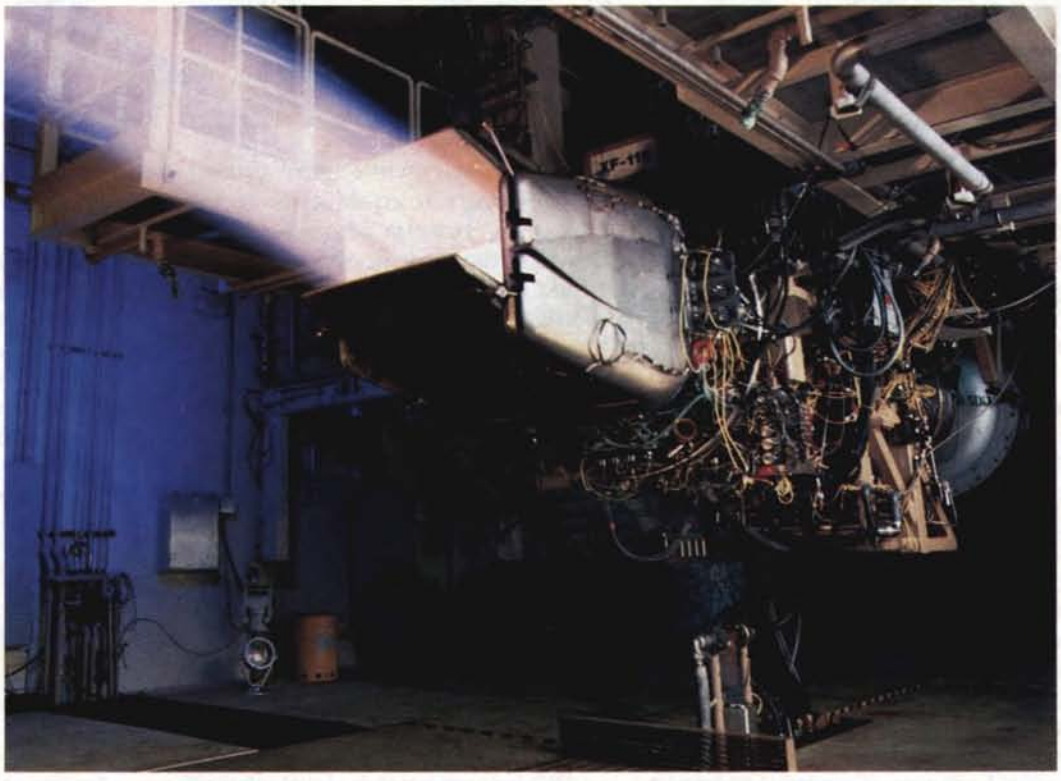
One obvious area of high-technology exploitation for ATF—and for its aeronautic descendents—concerns development of advanced airframes.

The ATF's contractors and associated ASD laboratories now are deeply engaged in a multifaceted exploration of structures, materials, and flight controls. The goal: Use advanced technologies to reduce ATF weight, drag, and signatures and in the process meet USAF's unyielding demand for a resilient, hard-to-spot, extremely agile air vehicle.

Evidence is they are succeeding. "The airframes are coming together," reports Colonel Fain. "We're comfortable with how they're going to build the airframes, what kind of materials they'll use."

One result will be highly advanced flight controls. The ATF contractors are pushing the state of the art in the technologies of fiber optics, digital fly-by-wire electronic controls, and the like to improve aircraft handling and stability. Explorations proceed into possible use of "active" wing surfaces. Also among technologies being explored are self-repairing flight-control systems that would permit an aircraft to complete its mission even after being damaged in battle.

Development of advanced materials is also getting a boost. For more efficient aerodynamic and structural design with reduced weight, plans call for widespread use of composite materials—as much as fifty percent of the total airframe. Areas of interest include graphite epoxy, thermoplastics, and carbon structures—materials that will impart great strength and endurance without adding much weight or cost.



A version of the Pratt & Whitney YF119 powerplant, featuring a two-dimensional exhaust nozzle, undergoes sea-level testing at the company's West Palm Beach facility. Use of these kinds of nozzles on the aircraft is expected to give ATF great maneuverability and responsiveness in air combat.

Low Observables

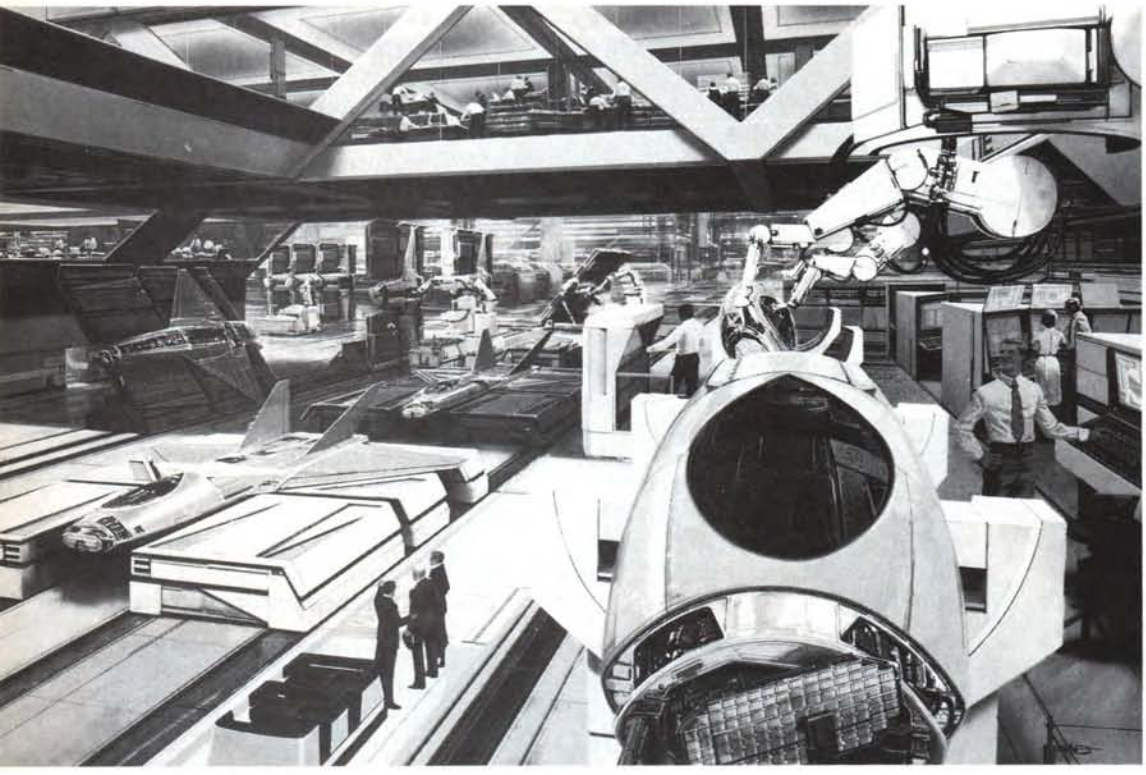
The ATF's greatest contribution may come in the area of advanced "low-observable" technologies needed to reduce the aircraft's visual, electronic, and infrared signatures. Conformal sensors and internal weapons carriage will help. Also under way is exploration of advanced coatings and radar-absorbing materials. Some believe the ATF's radar cross section will be a small fraction of the F-15's.

Colonel Fain ranks low observables among the most critical technologies being developed in the ATF airframe during the demonstration phase. He is confident that a significant degree of stealthiness can be achieved without sacrificing ATF's performance.

"We're working on the last ten percent" of the equation, he says. "I haven't found any major hiccups, major disasters, major problems, working that last few percent. I think we know pretty much where we are in the LO arena. . . . We are going to have a low-observable aircraft that will be blended with the other attributes of the aircraft to give us a very effective weapon system."

ATF's engine requirements also promise to bring about a major boost in advanced propulsion technologies applicable to future fighters no less than to ATF itself. In simplest terms, engine technologists are finding ways to increase the thrust, stabilize the weight, enhance the flexibility, and expand the reliability of a powerplant.

Research by ASD and its contractors is producing high-strength, heat-resistant alloys and cooling techniques, plus new turbine blade designs and combustion technologies. These are expected to enable ATF's engines to develop thrust of 32,000 pounds or more.



Unless budget pressure forces a change in Air Force plans, either Lockheed or Northrop will build to an annual production rate of seventy-two ATFs for an overall force of 750 of the new fighters. Lockheed's concept of what the production line would look like includes use of robotic processes and interchangeable tooling.

At the same time, the weight of the engines is being kept within bounds, possibly by use of new nonmetallic materials. The ATF engines will have fewer parts, perhaps forty percent fewer, than engines of today.

Taken together, these factors are expected to enable the ATF's powerplants to far outpace those of the F-15 and F-16 in terms of their thrust-to-weight ratios at supersonic speed and at high altitudes. This will permit the new fighter to cruise at supersonic speeds, somewhere between Mach 1 and Mach 2, without using the afterburner. Specific fuel consumption thus will decline. Such "dry" supersonic flight will give ATF a much wider combat radius and fighting energy.

Both prototype engines, based initially on technologies developed in the ASD Aero Propulsion Laboratory's Joint Advanced Fighter Engine program, are in altitude testing. Colonel Fain is satisfied with their progress. "They look good," he says. "I don't see any major problems."

Other new technologies are expanding the ability of an aircraft to vector the direction of its engine thrust. A key to this feature of ATF is development of advanced engine nozzles and control mechanisms.

The prototype nozzles to be installed on the twin-engine aircraft will demonstrate an ability to vector thrust by twenty degrees, up or down, in the same or opposite directions. Once perfected, this feature would provide the ATF with short-takeoff capability and the power to make tight turns at high speeds, among other maneuverability attributes.

The mating of engines and airframes shapes up as yet another ATF technology. The problem: How to integrate the engine/nozzle complex with the airframe in ways that will provide performance over a large flight envelope—from subsonic to supercruise, high to low altitude—and also reduce drag and signatures. The answer is anything but clear.

"We're concerned about engine/airframe compatibility," reports Colonel Fain. "We've got a lot of work to do in that area."

The same could be said of the Advanced Tactical Fighter's exotic, supersophisticated avionics suite, a system that will lie at the heart not only of this fighter but also, in all likelihood, of future ones.

Much work remains in the incomparably tough task of creating a totally "integrated" layout. The effort entails pulling together all functions and support technologies in a coherent system of thoroughly blended elements that will make today's disjointed systems obsolete.

The prize is great: a single central nervous system capable of coordinating sensors, flight and propulsion controls, weapon controls, cockpit displays, and countermeasures. The payoff would come in the form of powers for detecting, identifying, and engaging foes beyond visual range, enhanced situational awareness, expanded self-defense, reduced signatures, higher reliability, lower pilot work load, and lower cost.

In pursuing that goal, ATF developers have turned the airplane program into a huge "kicker"—financial and otherwise—for technologies that hold the key to future avionics effectiveness.

Among the technologies being evaluated are next-generation, very-high-speed integrated circuit (VHSIC) chips; advanced multimode, active-element-array radars; shared apertures; shared antennas; laser ranging; infrared search and track; "smart-skin" sensors; advanced cockpit displays; voice-recognition systems; fiber optics; and systems of artificial intelligence.

Awesome Amounts of Data

In a very real sense, the technology most critical to the integrated avionics system is integration itself.

The ATF's developers are devising means for fusing awesome amounts of data from multiple sources to provide reliable, instantaneous satisfaction of needs, from target classification and weapon selection to optimum flight path.

Within the framework of Pave Pillar architecture developed at ASD's Avionics Laboratory, ATF contractors are developing VHSIC common signal processors to communicate with and tie together such avionics elements as radar, infrared search and track, and collections of major offensive and defensive functions.

The latter include Integrated Electronic Warfare Systems (INEWS) and Integrated Communication Navigation Identification Avionics (ICNIA), both under development for years at ASD and avionics houses.

Colonel Fain and his chief avionics deputy, Lt. Col. John Borky, make it clear that no INEWS or ICNIA "black boxes" themselves will make it into the system. They are viewed as technologies only, technologies that will be incorporated, to a greater or lesser degree, in common modules run by VHSIC processors and high-speed data buses.

This, in the words of one ATF officer, amounts to "a massive change in the way we do business" in avionics. The benefits are that modules selected from a limited variety of multipurpose units could be tailored for specific requirements. They would eliminate many sources of avionics failures by using fewer cables and connections. As small units with common specifications, they could be built by a large number of contractors, thereby ensuring competition and lower cost.

The entire approach is experimental. The principal risk is that, in the new world of integration, one contractor working on one piece of the avionics puzzle may be proceeding along an altogether different path from those working on others.

Fears of this type were eased in recent months by some startling successes. Example: When a piece of applications software written by one ATF contractor was installed in a processor built by another, they played together harmoniously on the first flip of a switch. That came as a mighty relief to ATF officials.

"I didn't expect 'em to plug the software in and make the thing turn on right away," says Colonel Fain. "That's very positive. Very, very positive for my very, very cautious approach to avionics."

Even so, officers say all avionics elements may not be ready for the first ATFs that become operational in 1995. More broadly, while the basic goals for ATF remain unchanged, it will not possess each and every one of the features laid out for it originally. As ATF officers have acquired more hard data, trade-offs have been made.

"Our expectations for ATF have been lowered over the past two years," explains General Loh. "With any 'paper' airplane, expectations are always somewhat higher than the reality. That was true of the F-15."

Elimination of some features was in keeping with a 50,000-pound weight objective that the Air Force has set for the ATF. Elimination of others was associated with a limit of $35 million, in unit flyaway cost, that USAF has set. The service wants to build 750 ATFs at that price in 1985 dollars based on a production run of seventy-two fighters a year. Because weight usually means cost, the two limits are obviously interrelated.

Saving Weight and Money

Last fall, Air Force leaders undertook a major review of the ATF's performance goals to determine where to save weight and money, making a number of specific design decisions.

In earlier reviews, ATF transonic maneuvering capability had been reduced by one-half G, and the fighter's internal weapons carriage was lowered somewhat. While it still wants a short-landing capability, the Air Force dropped its requirement for thrust reversers when it learned that they would add significant cost and weight to the aircraft. Now, ATF will make short landings by using mobile, ground-based arresting barriers that are scheduled to be put in place for other aircraft.

For technologists now developing the ATF's exotic avionics suite and cockpit, much work remains to be done. Contractor prototypes of the ATF's totally integrated avionics will undergo the first phase of a long series of critical demonstrations in late 1989.

Such technology trade-offs are painful. More are yet to come. Says Colonel Fain: "We will continue the requirements refinement process throughout dem/val. The requirements will be based on the threat, the cost, and the weight. It is very important that we provide the senior leadership with the best possible aircraft within the cost and weight goals established for the program."

Some observers outside the Air Force, however, speculate about whether the cost and weight figures are firm, unchangeable limits or less-than-ironclad goals. They suggest that the Air Force can ill afford to build a less-than-adequate airplane just to stay within those limits. Faced with a choice, it is possible that USAF could ease cost and weight limitations somewhat.

The ATF's basic performance characteristics will have implications not only for ATF itself. They could affect the politically difficult proposal for the Navy to make use of ATF's technologies.

Under pressure from Congress, the Navy is committed to take a serious look at using a "wet" variant of ATF—a Naval ATF, or NATF—to replace its F-14 Tomcat fleet defender at the turn of the century.

Few question the financial benefits. In taking this step, claims the General Accounting Office, the Navy could avoid the $7 billion cost of developing its own new fighter.

But the Navy has been keeping a close and skeptical eye on the suitability of the Air Force's plane for Navy missions. Some Navy officers had suspected—and some continue to believe—that ATF's capabilities are being compromised in pursuit of arbitrary cost and weight goals.

Officially, the Navy is committed to trying to make NATF a reality. The service last summer assigned a Navy team to Wright-Patterson to oversee development of preliminary system specs. The Navy also has provided funds to Northrop and Lockheed to begin a more detailed look at a possible Navy design. It will participate in ATF source selection, with suitability of design for NATF the uppermost consideration.

"We've just gotten the Navy ATF program started," notes Colonel Fain. "But while we've been looking at Navy compatibility for a couple of years, it's been at very high levels. Based on that, we don't see major show-stoppers."

He sees no significant problem with the Navy's use of ATF avionics or engines. The NATF airframe is a different story. The Navy wants a much larger wing that is capable of changing shape for carrier storage. The plane will need heavier landing gear for carrier use, and this will require heavier beams to be added to NATF. This, he says, can be accommodated.

Colonel Fain refuses to speculate on whether the Navy will make a "firm, in-blood commitment" to the NATF—a decision that could reduce ATF procurement costs by as much as $2 billion due to economies of scale and therefore ease the cost pressures on ATF designers.

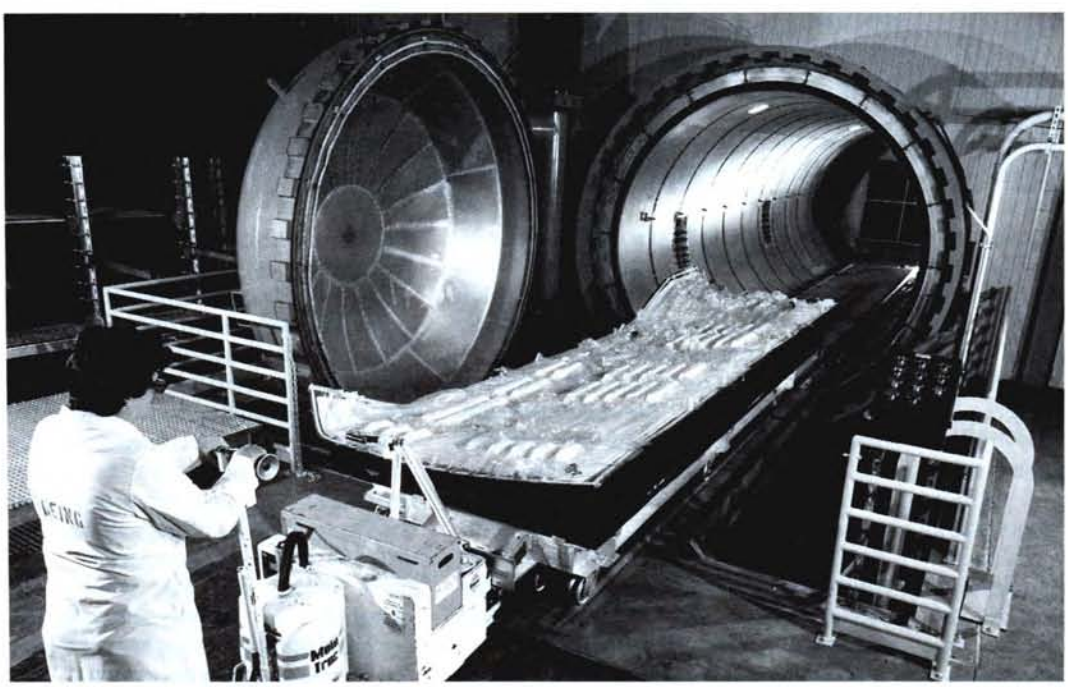
Colonel Fain is taking nothing for granted in this respect. "Let me put it to you this way," the Colonel says. "I have been working up our program without the Navy in there. If the Navy does come in, and all of this [cost reduction] comes to fruition, then we can come in and take advantage of that. But I'm not counting on that right now. If I did, and was wrong, then I've got a program that's not executable."

The fate of NATF aside, Air Force leaders are now establishing formal technological links between their premier fighter program and a number of other USAF projects. The moves are aimed at solidifying the combat strength of future aircraft by ensuring that they benefit from ATF breakthroughs.

The Case of the F-16

The key case in point is the F-16 multirole fighter. Beginning with a directive from Deputy Defense Secretary William H. Taft IV last year that instructed the Air Force to consider ATF technologies for future variants, USAF officials have embraced the concept.

"We'll get a big payoff for the F-16," says General Loh.



Advanced composite materials, similar to the type shown here at the Boeing Vertol Plant in Philadelphia, will be used extensively throughout ATF's airframe to reduce its weight, increase its strength, and lower its cost. The composite sideskin in this photo was developed for the Bell-Boeing V-22 aircraft.

In developing its plan for the "Agile Falcon" makeover of the General Dynamics F-16, the Air Force is eyeing possible incorporation of technologies brought to life by the ATF program. Such advances are considered attractive not only to USAF operators, but to potential European customers as well.

Maj. Gen. Robert Eaglet, director of ASD's F-16 program office, puts it this way: "We need to examine mechanisms to provide for the transfer of technology from ATF to F-16. We've looked at that very aggressively, and we're excited about that."

The ATF technologies would benefit a planned variant of F-16 dubbed the Agile Falcon. Proposed for initial delivery in 1995, the Agile Falcon would feature larger wings, more powerful engines, and newer avionics.

The program is intended to strengthen the F-16 against more powerful Soviet fighters of the next decade. The US also is offering to develop and produce the plane with the Netherlands, Belgium, Norway, and Denmark, original partners in production of the F-16. All four and the US have entered into a two-year predevelopment study agreement ending in 1990. General Dynamics, the F-16's maker, estimates research costs at $600 million.

General Eaglet says that ATF's engine or a derivative could be fitted into Agile Falcon, or it could be used as a design basis for a new ATF-type engine. Also in prospect could be installation of highly advanced low-probability-of-intercept radars and enhanced ATF-type avionics. It is no stretch of the imagination to see some of ATF's low-observable technologies in later versions of the Agile Falcon.

Currently, the Air Force is pursuing modest versions of Agile Falcon for its first phase. Later versions will make heavy use of such ATF concepts as modular avionics architecture. Due to high cost, some of the advanced ATF equipment or components may be unaffordable in the beginning. But officials expect they can be put in later Agile Falcon models and the earliest models can be retrofitted.

"There are lots of [ATF] technologies that already have been flight-demonstrated and can be put into production at roughly the same time as the Agile Falcon," says General Eaglet. "The highly advanced technologies, ones that are being flight-tested and proven for the first time in the ATF program, may be introduced later."

Agile Falcon design already has evolved considerably. First proposed in 1987 by General Dynamics, the new craft was to increase the original F-16's wing surface from 300 square feet to 375 square feet. Now, the figure has grown to 400 square feet. Leading-edge sweep also has been changed. Officers say the bigger planform, bringing higher agility, would be useful in either air-to-air or air-to-ground combat. In fact, says General Eaglet, the aircraft could turn out to be a strike fighter adept in both regimes.

"You'd probably call it an 'F/A-16,' like the Navy calls its plane the F/A-18," he explains. "For the most part, the aerodynamic and engine improvements we're considering for Agile Falcon appear to help the air-to-ground capabilities just as much as they help the air-to-air."

That is fortuitous. The Air Force appears determined to use some form of the F-16 as its replacement in the 1990s for the A-10 close air support aircraft. A Close Air Support Aircraft Design Alternatives study, performed by ASD and presented to Air Force and Pentagon leaders last fall, reinforced the view that the "A-16" would meet Army CAS requirements. The A-16 could be the Agile Falcon itself. The A-16 could also turn out to be a "missionized" version of the standard F-16, optimized with technologies that aid in the ground attack mission.

General Eaglet foresees a virtually endless parade of F-16s coming into production over the next decades. The reason is simple: USAF needs a low-cost, lightweight complement to the ATF for air superiority and for ground attack. None other than the F-16 is in prospect.

In this circumstance, as in others, diffusion of technologies made for the ATF itself shapes up as an increasingly critical necessity. ■