JANUARY 1992/$3

AIR FORCE MAGAZINE

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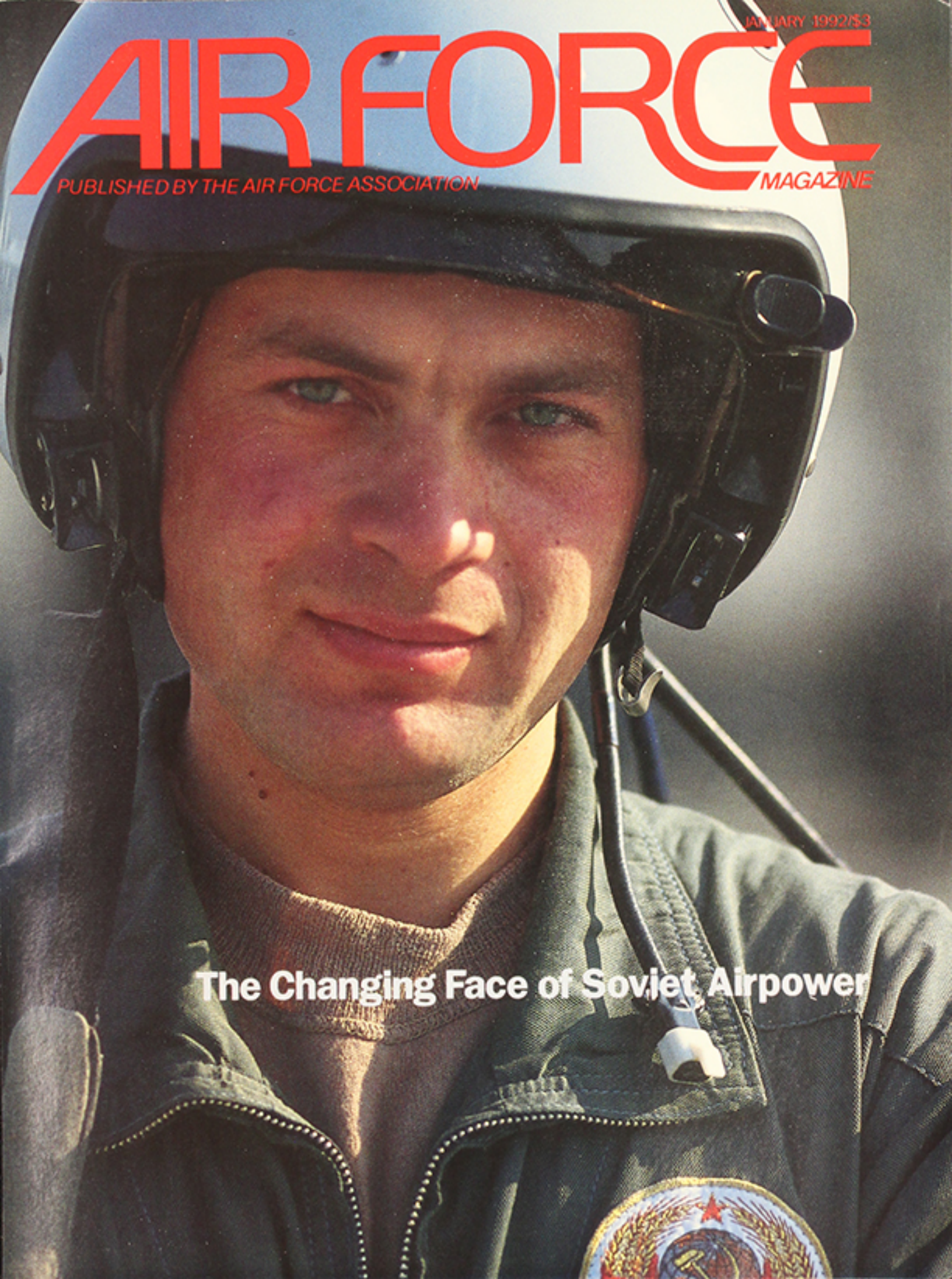
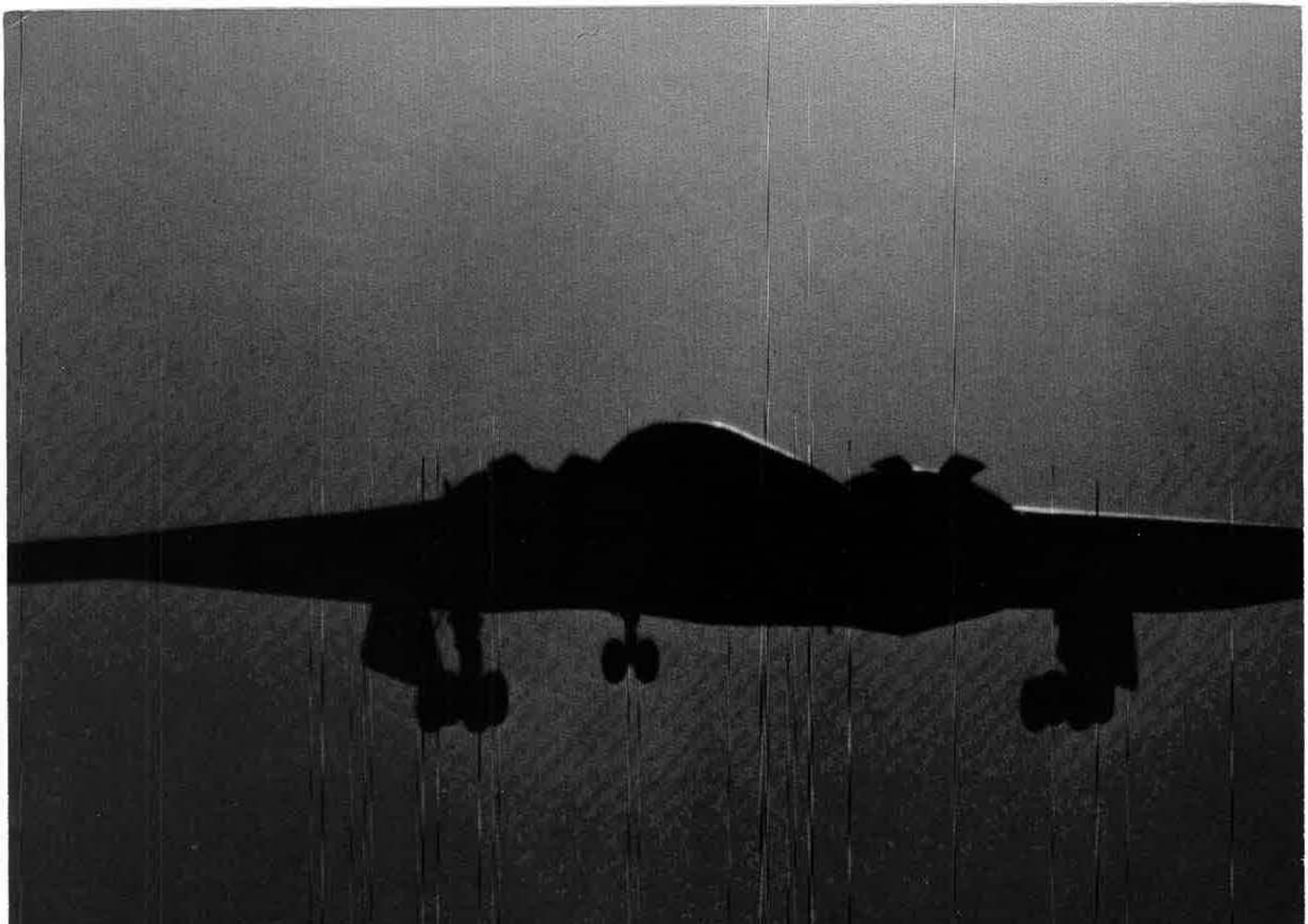


The Changing Face of Soviet Airpower



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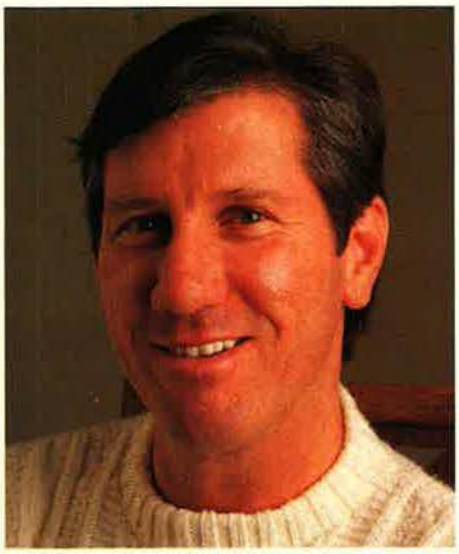

David W. Killam
U.S. Military (Ret.)

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To Be Continued...

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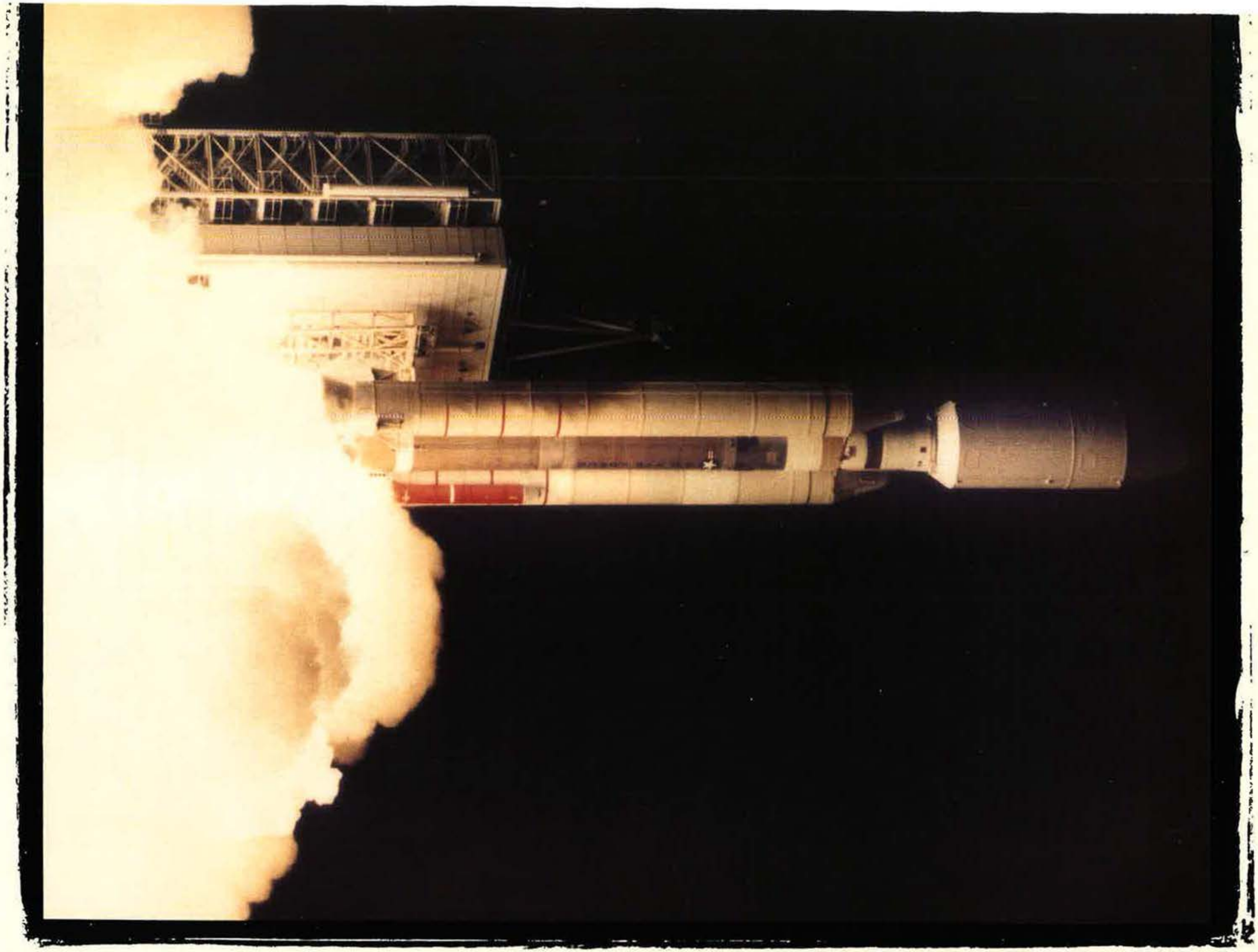
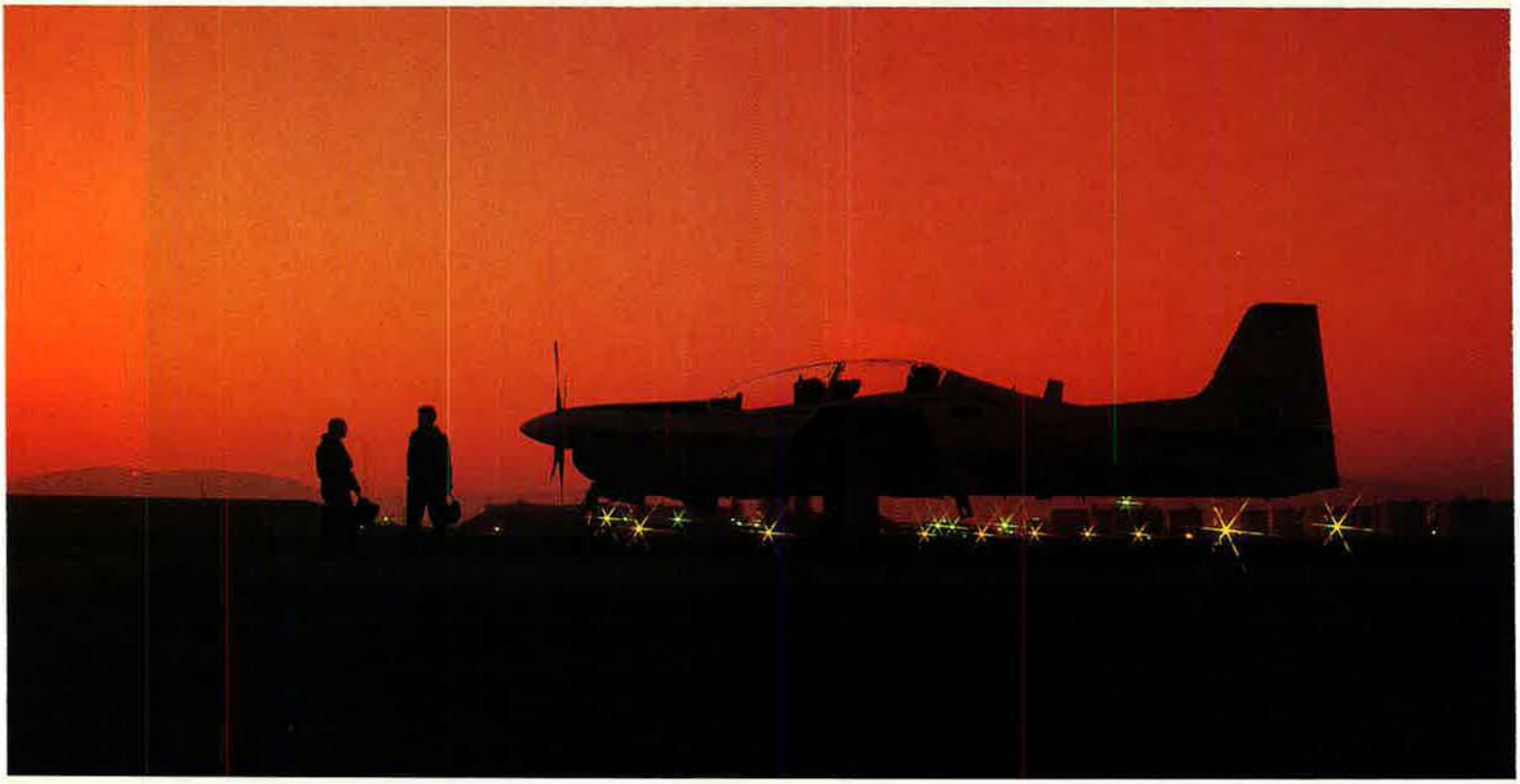


PHOTO COURTESY OF NASA

It takes the right props to train an RAF pilot. Shorts Tucano



If it can win over the Royal Air Force, the Shorts Tucano turbo-prop has got to be a cut above the rest.

Tucano's outstanding achievements in rigorous open international competition ensured its selection by the RAF to replace the Jet Provost basic trainer.

In virtually every respect, Tucano, with its turbo-prop economy, has out-performed its jet-powered predecessor and has established itself as the most advanced trainer in its class. And not just the RAF has taken notice. The Shorts Tucano is now also in service with overseas forces.

But the Tucano is only one of the ways in which Shorts is making its mark in the military contracts field. Shorts manufactures the C-23 Sherpa freighter aircraft in use with the United States forces, and is also an acknowledged pioneer and leader in close-air defence systems. On the civilian side, Shorts is a major force in the commuter aircraft industry and a key supplier of aerostructures for the world's largest aircraft manufacturers.

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January 1992, Vol. 75, No. 1

AIR FORCE MAGAZINE

PUBLISHED BY THE AIR FORCE ASSOCIATION

About the cover: Capt. Sergei Samko, based at Kubinka, flies the Su-27 interceptor both as a regular tactical fighter pilot and as a member of the "Red Knights" demonstration team. For more snapshots of life on this Soviet air base, see p. 30. Photo © Hans Halberstadt/ Arms Communications.

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Editorial

By John T. Correll, Editor in Chief

Shall We Dump Deterrence?

DETERRENCE—the concept of deploying military force to prevent wars—is a comparatively recent innovation. Before the atomic age, nations built their armed forces for direct offensive or defensive purposes. Deterrence was a minor consideration in strategy.

For the past forty years, however, the cornerstone of US doctrine has been to maintain sufficient power, in strategic nuclear forces at least, to deny the adversary any perception that aggression might lead to victory.

This concept of deterrence extended gradually to conventional forces as well. By the 1980s, the primary US objective across the spectrum of conflict was the prevention of war rather than the successful waging of it.

The superficial aspects of deterrence are easy to understand. Those who described it as "a balance of terror" were not completely wrong, but oversimplification often led to mistakes. Even senior government officials, for example, tended to equate deterrence with the reflexive strategy known as "Mutual Assured Destruction," or MAD.

A leading advocate of MAD was Robert S. McNamara, Secretary of Defense from 1961 to 1968, who argued that we could achieve deterrence enough with nuclear weapons, targeted to destroy a fourth of the population and half of the industry in the Soviet Union.

Real military strategists reject MAD, which is deterrence of the worst sort—cheap, inflexible, and nightmarish. According to senior military leaders, it was never put into practice as the basic strategy of the United States. The rational form of deterrence is a range of options that limit, counter, and check an aggressive adversary.

On the whole, deterrence has been an effective strategy. Despite tensions that might have provoked war in earlier times, the world's leading powers have kept peace with each other. The strategy did not always stop military adventurism by smaller nations, but it is not clear whether the failing was in the concept of deterrence or in a belief by the likes of Khomeini, Qaddafi, and Saddam Hussein that they could evade retribution.

The latest fad in the armchair strategy league is to regard deterrence as obsolescent on the grounds that (a) there are no longer any significant threats to deter, (b) the most probable adversaries—particularly in the Third World—may not be deterrable, and (c) if we do need deterrence, we don't need that much.

Armchair strategists say there's nobody to deter but "undeterrable" fanatics.

In the Heritage Foundation *Policy Review,* Jay Kominsky declares that nuclear deterrence always was a "bizarre doctrine" that will henceforth be less central to US defense planning as concepts and technologies of strategic defense mature. In *Foreign Affairs,* Mr. McNamara and his colleagues say the US faces no conceivable threat against which nuclear weapons would be a credible deterrent.

The debunking of deterrence is a hot topic these days for academicians and political aides. This no doubt makes breezy and entertaining chitchat, but let us hope that the actual formulation of strategy remains in more responsible hands.

Unless the United States wants to spend the next twenty years fighting wars large and small, we had better hang onto deterrence and fund it above the shoestring level. The changes sweeping the world have made it possible to achieve deterrence across the spectrum of conflict with less military power, but that has already been factored into the new US defense strategy and a much-reduced defense budget.

Whatever happens in the Soviet Union, somebody in that vast land stands to inherit a lot of nuclear weapons, including the only mobile ICBMs operational anywhere. Over the next several years, a growing number of Third World nations will pose regional threats with weapons of mass destruction. The day is coming when smaller powers will possess intercontinental range.

We should regard improved active defenses as complementing deterrence, not competing with it. The threats can come from too many sources in too many places in ways too unpredictable to repel all of them head-on. Moreover, many of them, especially those looming in the near future, are not the kind a purely defensive strategy can thwart.

As for the "undeterrable fanatic" theory, its plausibility shrinks upon examination. Since Operation Eldorado Canyon in 1986, for example, Qaddafi seems to have been constrained by some consideration other than love for his fellow man. All manner of experts assure us that Saddam Hussein could (and can) be persuaded by economic sanctions. Should we concurrently assume him too irrational to be deterred militarily? The logical explanation for his actions in August 1990 is not that he was undeterrable, but that he miscalculated.

A wise nation will look beyond the "balance of terror" sloganeering and conclude that deterrence—when it is credible—does deter and that it still makes sense to prevent wars if we can rather than fight them. ■

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Letters

ATHS Shortcomings

I would like to comment on "Cooperative Attack" *[November 1991, p. 60]*, which discussed the Automatic Target Handoff System (ATHS). The article suggests that the ATHS will dramatically improve the conduct of close air support (CAS) missions. Speaking as an air liaison officer (ALO) who served for three years in an armored brigade, I disagree.

All of the typical targets mentioned in the article (infantry squads, dispersed armored vehicles, and machine-gun emplacements) are fixed and difficult to see, especially from a fast-moving aircraft. However, if the target position is known to within ten meters, the Army has a wide variety of direct-fire and indirect-fire weapon systems that will effectively neutralize these targets. These include tanks, artillery, guided missiles, and Apache helicopters. The Army also has laser-guided munitions, such as the Copperhead artillery round and Hellfire missile, that do not have to expose the delivery system to (direct) return fire.

Organic Army assets are typically much more plentiful and responsive than CAS. Responsiveness is especially critical in maintaining the tempo of offensive operations, and the greatest limitation of CAS is unresponsiveness.

The application of tactical airpower is more effective when used to strike large, usually mobile, armored concentrations not yet engaged in a direct-fire battle with friendly forces. Intelligence on these forces is usually dated by fifteen minutes or more, and its accuracy is suspect. It was rare in a live exercise to have a target within a kilometer of its reported location.

The problem of target location error is what makes artillery and aircraft complementary rather than interchangeable. While artillery targets a location whether a target is there or not, manned aircraft have the inherent flexibility to adapt to poor intelligence and mobile targets. This is what makes a forward air controller on the ground or in the air successful. A concise and accurate description of the target (of which location is just one aspect) and the relative position of friendly forces are most critical.

A line displayed on a head-up display cannot effectively replace the complex communication usually required for effective CAS. Only in the most "canned" situations did I ever find a nine-line brief adequate for target identification.

The other major problem with the article was the emphasis on integrating Air Force communications into the artillery's Tacfire net. It did not explain how or even why this would be an improvement. In my experience, Tacfire was one of the least important information and command systems. Of more importance were the maneuver unit's command and intelligence nets. Although Tacfire provides distinct advantages for controlling preplanned artillery fires, I always saw the units resort to voice communications when quick decisions and immediate orders were required. Even with Tacfire, in one National Training Center battle, our artillery unit had only three effective missions (within 500 meters of the target) out of forty-two fired. This illustrates the reality of the fog of war, in contrast to the sterile "demonstrations" we tend to evaluate when making doctrinal decisions.

The major advantage to the ALO (and his enlisted troops) of the digital communication system is the ability to communicate securely with higher headquarters in data bursts so short that triangulation by the enemy is unlikely. This was not even addressed in the article.

While the ATHS and associated systems provide distinct advantages, they should not be primarily associated with CAS. The potential for significant impact on the ground battle is much greater in an interdiction mission, such as Scud-hunting or getting targeting information from Joint STARS on enemy convoy movements well beyond the fog of the close battle.

We make our best money by reducing enemy strength and capability before they can become CAS targets. Then the Army can do its job very effectively, as the Persian Gulf War seemed to demonstrate.

Andrew J. Miller
Copperas Cove, Tex.

Cleaning Up

"The Big Toxic Waste Cleanup" *[October 1991, p. 62]* again confirms my impression that all of the military services were totally irresponsible in disposal of waste just because they were exempt from the laws.

It would have cost far less than $200 billion to dispose of waste properly. The idea that military services should be exempt from laws that apply to the rest of the US is absurd.

For years, I watched the Navy operate an incinerator on Treasure Island as I crossed the San Francisco–Oakland Bay Bridge, when such waste disposal was banned throughout the area in an attempt to preserve air quality. The Navy was also free to dump garbage in San Francisco Bay.

Are you or any of your readers really proud of the irresponsibility of our armed services? I'm not.

Lt. Col. Robert Kahn,
AFRES (Ret.)
Lafayette, Calif.

Thanks for mentioning the Air Force Institute of Technology's (AFIT) programs to provide environmental education in support of the Air Force's hazardous waste site cleanup efforts.

In addition to the Installation Restoration Program course and the Center for Environmental Restoration Education mentioned in the article, AFIT

Do you have a comment about a current issue? Write to "Letters," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be concise, timely, and preferably typed. We cannot acknowledge receipt of letters. We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Photographs cannot be used or returned.—THE EDITORS

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Letters

has developed an environmental education system at both the professional continuing education and master's degree levels. These programs will help ensure that USAF military and civilian professionals have the education to accomplish the mission in an environmentally sound manner. Our Department of Environmental Management was established in 1990 to coordinate these programs.

At the professional continuing education level, AFIT will be offering nearly fifty "short courses" in environmental management to students ranging from new environmental employees, both officer and civilian, to senior officers in command positions. At the graduate level, the first class of students attending the Institute's fifteen-month master's degree program in Engineering and Environmental Management will graduate in September 1992. This unique graduate program provides students the skills they need to integrate science and policy issues into a decision-making framework for enhanced management of the environment. It has been lauded by the Environmental Protection Agency's Director of Pollution Prevention as "a model . . . program to meet the current and future educational and training needs of environmental managers."

In addition to teaching, AFIT faculty members are involved in environmental research and consulting. A research project involving AFIT faculty in the Departments of Environmental Management and Mathematics and Statistics is currently under way to investigate better methods of hazardous waste site cleanup. In addition, AFIT faculty consultations have helped bases throughout the world deal with environmental problems. We at AFIT consider ourselves at the forefront of environmental management education.

Col. Steven C. Mugg,
USAF
Wright-Patterson AFB, Ohio

Israeli Patriots

Imagine my surprise, when reading "Israeli Airpower on the Rise" *[November 1991, p. 46],* to learn that the Patriot missiles used against the Scuds attacking Israel belonged to the IAF.

I suppose a mistake was made by the American press when it reported that American crews manned the missiles. The TV shots showing Americans were probably faked, too.

William J. McCormick
Albuquerque, N. M.

• *Mr. Katz's reporting was correct. Though some Patriots in Israel were manned by Americans training Israeli forces, all of the missiles were Israeli-owned.*—THE EDITORS

GPS Standard Time

"Zulu Time" *[October 1991, p. 78]* perceptively presented the role of navigation in the evolution of timing standards. However, by only briefly alluding to space resources, Mr. Calander omitted today's shining example of this relationship—the Navstar Global Positioning System (GPS).

The current GPS constellation of sixteen satellites (to reach twenty-four satellites by 1993) continuously provides a timing signal accurate to an average eight-billionths of a second to properly equipped users anywhere in the world. This capability is essentially a by-product of the constellation's primary mission of providing precise (within sixteen meters) positioning information.

The phenomenal performance of this system clearly deserves a place in any historical account of timing standard techniques.

Capt. Bruce H. Acker,
USAF
Falcon AFB, Colo.

Who Moved the Satellite?

Contrary to TSgt. Raymond Brant's letter "Satellites Over the Gulf" *[November 1991, p. 12],* AFSATCOM satellites don't exist. US Navy's FLTSATCOM satellites with add-on AFSATCOM packages do.

AFSATCOM's Master Control Center did not move the satellites. It is the responsibility of the Air Force Satellite Control Facilities, through Air Force Space Command's 2d Space Wing at Falcon AFB, Colo., to command and control satellites.

The order to move the satellites came from the Joint Chiefs of Staff after discussion and concurrence with National Command Authorities.

Bill Larson
Fort Walton Beach, Fla.

Wade's Service

In reference to the obituary of Maj. Gen. Leigh Wade, USAF (Ret.), on p. 28 of the November 1991 "Aerospace World," he was in the Army Air Service, not the Army Air Corps, when he took off in one of four Douglas Cruiser biplanes on the 1924 around-the-world flight. The Army Air Corps was so designated on July 2, 1926.

Lt. Col. Bert McDowell, Jr.,
USAF (Ret.)
Irving, Tex.

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A Pilot's View

John Bobel, a pilot from Fort Walton Beach, Florida, wrote to me a while back. Here's what he had to say about just one of his experiences with Quest.

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Washington Watch

By James W. Canan, Senior Editor

ABMs on the Ascendant

The US moves to erect defenses against ballistic missiles in the face of the spreading nuclear menace.

For the US, erecting defenses against ballistic missiles has suddenly become mandatory in the face of a spreading nuclear menace. Strategic deterrence—the threat of nuclear retaliation with bombers and ICBMs—is no longer sufficient protection against nuclear attack. The nation urgently needs antiballistic missile (ABM) systems as its first line of defense.

This message resounded on Capitol Hill as 1991 came to a close. Congress switched from opposing to supporting the deployment of ABMs, endorsing the earthbound elements of a Bush Administration program called Global Protection Against Limited Strikes (GPALS).

The lawmakers restricted ballistic missile defense (BMD) sites and weapons to those that comply with the 1972 ABM Treaty with the Soviet Union. It permits the development and testing of land-based ABM defenses and the deployment of up to 100 ABM interceptors in one area of each nation. The Soviets deployed such a system around Moscow long ago. The US developed an ABM site at Grand Forks AFB, N. D., but never armed it.

Urged on by Congress, the Administration's Strategic Defense Initiative Organization (SDIO) is hustling to reactivate the Grand Forks site and get it into operation by FY 1996. SDIO is also moving to build treaty-compliant, land-based ABM systems to defend US overseas forces and allies.

The Administration wants to deploy five more ground-based systems in the US and a space-based system of rockets called Brilliant Pebbles but is thwarted by the ABM Treaty. It forbids nationwide ABM systems and the testing and deployment of any sort of space weapon.

Brilliant Pebbles weapons are out of the picture for now but maybe not forever. Most of the $390 million that Congress appropriated for the continued development of space-based weapons goes to Brilliant Pebbles. Some is earmarked for high-energy lasers, which currently look like losers but have not been counted out. Rockets are likelier in space, and Brilliant Pebbles may yet come to the fore if the ABM Treaty is amended to permit them.

The going will remain rough for them in the political world. Space weapons have always been sore points on Capitol Hill. They symbolize "Star Wars," the movie title that became a derisive nickname for the Reagan Administration's highly expensive and technologically ambitious Strategic Defense Initiative (SDI) program. With plans for such weapons in abeyance, many members of Congress who stood fast against SDI saw their way clear to meet the Administration halfway on a comparatively modest BMD system of exclusively land-based weapons, a system that the sorely beset Soviet Union, or what is left of it, is more likely to adopt than attack.

The original GPALS plan was dubbed "Star Wars Lite." The no-space-weapons version approved by Congress "knocked the 'star' out of 'Star Wars' altogether," one official noted.

After many years of frustration, ABM advocates will take what they can get. Air Force Secretary Donald B. Rice saw congressional approval of the truncated GPALS as "a great breakthrough—we now have bipartisan support in both houses of Congress for a well-designed ballistic missile defense program."

The Air Force has never had anything against ABMs so long as they are kept in perspective. The original SDI goal of a leakproof, multilayered defense against a massive Soviet nuclear attack induced a certain wariness in blue-suit circles. President Reagan grandly envisioned SDI as the precursor of "a world without nuclear weapons." Some Air Force officers privately expressed concern that such exaggerated emphasis on strategic defense would detract from the tried-and-true doctrine of strategic deterrence and would undermine programs for the ICBMs and bombers that make that doctrine come to life.

Is there any such danger to deterrence in the new political consensus for deploying ABMs?

"Quite the contrary," Dr. Rice replies. "Having a viable level of defensive capability enhances deterrence." He defines deterrence as "persuading [an enemy] that he will regret the day he decides to start anything," and he sees "defensive and offensive components working together" in that role—one to "deny [the enemy] his objectives," the other to serve notice of certain retaliation in the event of attack.

There are others in positions of leadership who may see things the same way but who indicate otherwise, starting with President Bush. He never echoed his predecessor's world-beater claims for SDI, has scaled it down to seemingly manageable size, and seems to have a sense of proportion in all things strategic. Yet he left the impression, in remarks at Raytheon's Patriot missile plant, that he was disparaging deterrence.

Declared the President, "Thank God that when the Scuds came, the people of Israel and Saudi Arabia and the brave forces of our coalition had more to protect their lives than some abstract theory of deterrence. Thank God for the Patriot missile."

SDIO picked up on that theme in a document titled "The President's New Focus for SDI: GPALS." It warned that twenty-four nations will likely possess ballistic missiles, some with intercontinental range, by the turn of the century. This means, declared SDIO, that "today and for the future we cannot rely solely on deterrence. The use of Iraqi Scuds in the Persian Gulf War illustrates the risks of a deterrence strategy based solely on the threat of retaliation."

The deadly game of Patriots vs.

Scuds in the Gulf War was a television thriller in the US and had a great deal to do with forging the new political consensus for missile defenses. It underscored the life-or-death importance of being able to intercept and destroy even the most unsophisticated ballistic missiles in modern war.

ABMs forthwith took center stage on Capitol Hill. The conference report accompanying the FY 1992 military authorization bill declares, "It is a goal of the United States to deploy an antiballistic missile system . . . capable of providing a highly effective defense [of the US] against limited attacks of ballistic missiles, including accidental or unauthorized launches or Third World attacks."

Congress backed its rhetoric with earnest money. It appropriated $4.15 billion for strategic and theater defense—$1 billion more than in FY 1991 and more than the Administration once had any right to expect. It also exhorted SDIO to "accelerate the normal acquisition processes and procedures" for US and theater ABM systems "in light of the very high priority of these objectives."

The historical significance of the surprisingly strong political support for strategic defense was not lost on long-suffering ABM advocates. Among them, Rep. William Dickinson of Alabama, senior Republican on the House Armed Services Committee, called the congressional action "a watershed national security decision" and claimed that ABM systems have become "Congress's top defense program."

Rep. Les Aspin (D-Wis.), chairman of the House Armed Services Committee, notable among many lawmakers of both parties newly in favor of ABMs, explained that "enormous changes in the military dangers we face are forcing a basic realignment in the way we think about defenses."

Representative Aspin declared, "We are increasingly likely to face adversaries who are not deterred by the possibility of terrible retaliation. That means ballistic missile defenses look more attractive in this new world. . . . The question is no longer whether we should defend ourselves, but how."

He also said that "the doctrine of deterrence . . . worked for two generations, but it is no longer sufficient in itself in this new era. We have lived with nuclear overkill for decades. We could stand to err on the side of overprotection in the future."

Two big questions remain: Should the US continue to honor the 1972 ABM Treaty if the Soviets cannot or will not agree to ease its restrictions? How quickly should the US move to develop and test space-based interceptors against the day that the treaty permits them to be deployed or is no longer honored?

Those issues seem less thorny than before. The Kremlin has indicated its willingness to renegotiate the ABM Treaty and even to team with the US in developing up-to-date ABMs. The USSR may well have the greater need for ABMs. It is situated in a much nastier neighborhood of the planet, one in which ballistic missiles already abound and where nuclear weapons may proliferate like Saturday night specials do on urban streets.

Congress encouraged the Administration to keep after the USSR to agree to revise the ABM Treaty in Moscow's own best interests. It could well happen. Last July in London, Soviet President Mikhail Gorbachev proposed to his fellow heads of state the "development of joint ABM early warning systems to prevent unauthorized or terrorist-operated launches of ballistic missiles." This was seen as consistent with the GPALS plan that President Bush had brought forth in his State of the Union speech six months earlier—barely ahead of the first Scud attack.

The President proposed scaling down and redirecting the SDI program for a multilayered defense against a massive Soviet missile launch. Research and development of the SDI program's many and complex elements—including space-based lasers, particle beams, and software-intensive battle management and command, control, and communications networks—had already soaked up nearly $25 billion. Cost estimates for a fully deployed SDI system ranged into the hundreds of billions.

The GPALS plan was priced at a comparatively modest $46 billion and came in three parts: space-based Brilliant Pebbles rockets designed to smash into and destroy ICBMs shortly after they are launched, rockets based on US soil to intercept ICBMs approaching the US, and theater missile defense (TMD) systems consisting of various kinds of rockets to protect US overseas forces and allies.

Congress bought most of the package. Although Brilliant Pebbles space weapons, originally priced at $11 billion, are on hold, space-based sensors are still very much in the cards. The truncated GPALS network approved by Congress will embody a surveillance satellite—Brilliant Eyes—to spot and track missiles approaching North America from afar.

SDIO emphasizes that GPALS needs the Brilliant Eyes satellite with or without the Brilliant Pebbles weapons. "An effective US ground-based system is critically dependent on development and deployment of Brilliant Eyes," SDIO Director Henry F. Cooper declares.

Air Force Systems Command's Space Systems Division oversees Brilliant Eyes development. Air Force Space Command would launch the satellite and operate it for US Space Command. Secretary Rice explains that "the Air Force has the space portion of GPALS—the battle management and control mission and the space-based components. Anything that comes along down the road in the way of space-based interceptors would be Air Force responsibilities as well."

Army Strategic Defense Command is SDIO's agent for land-based systems and has done a lot of work on them in the SDI program. The ABM system slated for Grand Forks will consist of 100 rockets together with fixed-site battle management radars and, as Congress specified, "other sensor systems that are not prohibited by the ABM Treaty."

Among such systems are the quick-launch, "pop-up" Ground-Based Surveillance and Tracking System (GSTS) rockets with sensors for tracking incoming missiles and distinguishing between the real things and decoys. Designed to complement Brilliant Eyes, the GSTS sensors would fly high but not in space, and would function for only a half hour or so.

For the ABM system at Grand Forks AFB, Congress authorized deployment of an Endo/exoatmospheric Interceptor (E^2I) designed to intercept nuclear reentry vehicles both inside and outside the atmosphere. But SDIO expects to save money and speed things up by going with a simpler system for starters. It plans to deploy at Grand Forks the Ground-Based Interceptor (GBI) missile, an offshoot of the Lockheed exoatmospheric reentry vehicle interceptor system (ERIS), to intercept RVs in the final stage of their midcourse spaceflight. SDIO's multicontractor Lightweight Exoatmospheric Projectile (LEAP) technology program is part of the picture. The deployment of lower-flying missiles designed to destroy RVs descending into the upper atmosphere—missiles like the McDonnell Douglas High Endoatmospheric Defense Interceptor (HEDI)—will have to wait.

Standing alone, the Grand Forks ABM network will ensure protection against fewer RVs than the 200 or so that the original GPALS, complete with Brilliant Pebbles, was designed to intercept. The Grand Forks ABMs are expected to reach 1,500 to 2,000 miles downrange. Their geographical scope of coverage will depend on such variables as ICBM trajectories and warning time. Their ability to protect both coasts is problematic, and they will do nothing for Alaska and Hawaii.

To expand coverage, the Administration would like to deploy ABM systems at five additional sites in the US and end up with 750 interceptor rockets in all. Congress instructed SDIO to submit a plan for such expansion in case the ABM Treaty is revised to allow it or is abandoned amid the breakup of the Soviet Union.

In the GPALS setup, theater missile defense comes into play first. Sized for airlifting into war zones, TMD systems include upgraded Patriot missiles, Israel-designed Arrow missiles, LTV's Extended-Range Interceptor (ERINT) missiles, and Theater High-Altitude Area Defense (THAAD) missiles now in development. Contractor teams led by Hughes, Lockheed, and McDonnell Douglas are competing for THAAD production contracts. The schedule calls for upgraded Patriots to be ready for action in FY 1993, ERINTs in FY 1994, and Arrows and THAAD missiles by FY 1996.

ERINTs and Patriots make a team. ERINTs will be faster and smaller than Patriots—sixteen ERINTs will fit into a launcher built for four Patriots—and will protect up to four times as much territory. They will destroy missiles by ramming them. Patriots explode on target, sometimes—as in the Gulf War—with messy consequences below.

THAAD missiles are designed to fly higher and farther than the others, striking targets 200 kilometers downrange at altitudes up to 150 kilometers. Such prowess makes the system the best of the bunch for destroying at safe distances missiles armed with chemical and biological warheads.

That prowess is a problem as well. THAAD missiles run afoul of the ABM Treaty. They can be used against strategic ballistic missiles as well as against theater-limited tactical ballistic missiles. Thus the US cannot test the THAAD system, much less deploy it, without violating the treaty.

Ditto for Brilliant Pebbles. The Administration will continue to push for political and diplomatic acceptance of those space rockets—it hopes to deploy 1,000 of them—as indispensable partners of land-based missiles, which they would resemble in most respects.

SDIO's Dr. Cooper claims that "only space-based defenses permit multiple shots against ballistic missiles during the early stages of flight, before multiple warheads are released. This is important in the case of an accidental or unauthorized launch of missiles with up to ten warheads each."

He also maintains that Brilliant Pebbles, in constituting "global defense," would "overcome the difficulty of anticipating where ballistic missiles may be used" and of deciding where and how many land-based interceptors would be required to defend against them.

Some opponents of Brilliant Pebbles argue that the space rockets would be incapable of intercepting short-range ballistic missiles flying low on depressed trajectories because they would lose their way deep down in the atmosphere. Dr. Cooper acknowledges that land-based ABMs are the answer but adds that "the trend is toward Third World missiles of increasing range" and that there will never be enough land-based systems to cover all potential targets, not even in the US itself.

Laser enthusiasts claim that space-based lasers, given their tremendous speed and range, would be the best weapons by far for defending against all kinds of ballistic missiles anywhere in the world. Laser buffs also claim that costs of building, launching, and operating high-energy lasers are dropping sharply because the weapons can be made lighter, less complex, and more durable than before.

Why? Because so-called "uncooled mirrors" can now be built into laser weapons to direct the beams that burst forth from the lasing cavities. Such mirrors are coated with new substances that are all but impervious to heat, thus making it possible to dispense with the elaborate and costly liquid cooling mechanisms formerly needed to keep the heat of the beams from distorting the mirrors over time. Those mechanisms, including channels for circulating the coolants, increase pressure and can cause lasers to jitter—a serious problem.

Dr. Cooper emphasized that SDIO "will maintain robust technology development programs for directed-energy systems," such as lasers, but that it has "no plans to move any into the formal demonstration/validation phase." ■

A new and better way of testing missile target seekers is possible, now that an Air Force laboratory simulation system will use an advanced infrared image projector. This tactical infrared projection system (TIPS) was developed by Hughes Aircraft Company. It is based on Hughes' liquid crystal light valve technology. TIPS projects TV-like images of changing infrared scenes, testing the target detection and tracking performance of seeker sensor systems. The high spatial and temperature resolution of these images provides capabilities not possible with current simulation systems. Using laboratory simulations rather than launching test missiles to test target seekers is expected to save the Air Force considerable money.

The F/A-18 Hornet has surpassed one million lifetime flight hours. This milestone reflects the F/A-18's utility, flexibility, and readiness, which is partly due to its reliable APG-65 radar, built by Hughes. The "one million" milestone combines flying hours for all the McDonnell Douglas-built F/A-18s, including operations with the U.S. Navy, Marine Corps, the Canadian Forces, Royal Australian Air Force, Spanish Air Force, and NASA's high-angle-attack research. Currently 900 planes use the APG-65 radar systems. The historic flight took place during operations from the aircraft carrier USS Eisenhower in the Mediterranean Sea.

The 23rd nation in 25 years will benefit from a Hughes-built air defense system. This advanced, state-of-the-art system will provide Iceland and the surrounding Nato-protected North Atlantic with improved air defense command, control, and communications capability. Hughes will use a new generation of technology to build Iceland's system, which has an overall open system architecture that allows for additional hardware and growth. Its data processing equipment is based on the Digital Equipment Corporation's line of commercial computers, and it is the world's first major air defense system using Ada software language.

Improved TOW 2 antitank missiles, developed by Hughes, will give the U.S. Army additional capability. The latest version of Tube-launched, Optically tracked, Wire-Guided (TOW) missiles, TOW 2B is a top attack version of the TOW, while all others are direct attack. The new missile flies over a tank and, with the aid of a sensor, fires its warheads into the lightly armored top of the vehicle. Enhanced lethality and the ability to attack targets which are not fully exposed are significant advantages.

Germany has upgraded portions of its air traffic control systems with a new state-of-the-art system built by Hughes. These TracView systems give air traffic controllers a real-time, full-color digitized display of aircraft detected by multiple radars that feed into air towers and centers. Installed in former West and East German sites, TracView provides automated identification and beacon code correlation and networked beacon code allocation. The systems draw sensor data from a wide range of old and new radars built by Western and Eastern Bloc companies.

For more information write to: P.O. Box 80032, Los Angeles, CA 90080-0032

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Aerospace World

By Frank Oliveri, Associate Editor

F-22 Flight Tests

Flight testing of the YF-22 Advanced Tactical Fighter prototype resumed October 30 after a ten-month hiatus. Lockheed, the F-22's prime contractor, said the test flight lasted some two hours. This and subsequent flights are intended to help the contractor team of Lockheed, Boeing, and General Dynamics refine its data and complete the F-22's design.

Lockheed's Tom Morgenfield, chief test pilot for this phase of the fighter program, lifted off and completed one aerial refueling before returning to base. This was the first mission flown by the aircraft since December 1990, when contractors were nearing the conclusion of USAF's demonstration/validation phase of the new fighter program. The F-22 has since entered engineering and manufacturing development.

Lockheed announced that the YF-22, in the October flight, met each of a number of test objectives, which included making functional checks of the aircraft's systems, conducting aircraft handling qualities tests, gathering aerodynamic load data, and performing throttle transient trials with the airplane's two Pratt & Whitney YF119 engines.

This phase of the F-22 test program is scheduled to require some 100 flight hours. In preparation for the upcoming tests, the YF-22 was fitted with strain gauges that measure aerodynamics loads in flight. The gauges were calibrated by subjecting the aircraft to distributed static loads while the YF-22 was in a ground test rig.

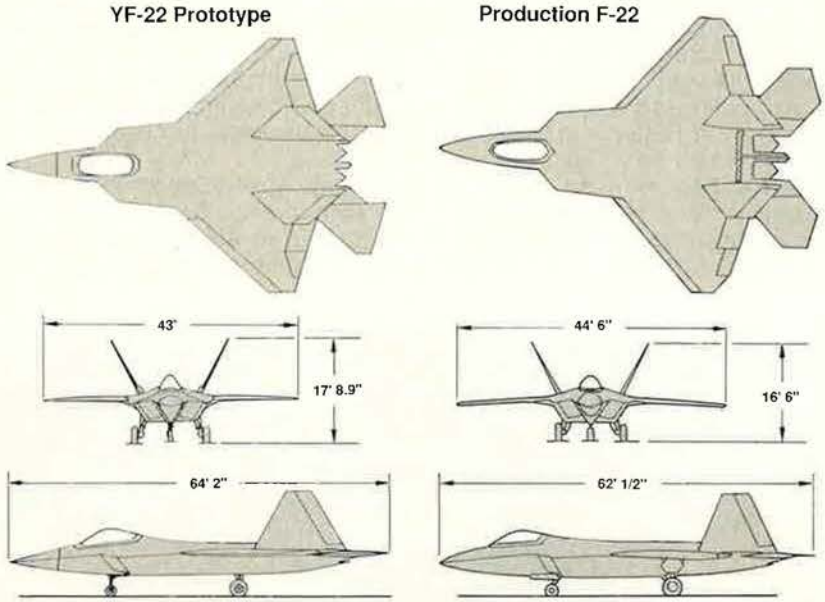
Saudis Seek More F-15s

The Kingdom of Saudi Arabia is seeking to buy seventy-two more F-15 fighters from the US, setting the stage for an arms sale that not only would provide McDonnell Douglas $4 billion in revenue but also would permit the firm to keep its F-15 line open two years beyond the currently planned closing date. The Royal Saudi Air Force already has acquired forty-two F-15s and has more of the front-line jets on order.

In an unusual move, McDonnell Douglas unveiled the Saudi plan at the Dubai International Aerospace and Defense Exhibition in November —before the plan was formally announced by either the US or the Saudi government. Bob Trice, the aircraft manufacturer's vice president for business development, said the aircraft sale, if approved by Congress, would save about 7,000 jobs at McDonnell Douglas's Saint Louis plant. Without additional orders, the F-15 line will close in 1993.

Saudi Arabia formally transmitted its request to the US on November 1. On two recent occasions, Congress has blocked military sales to the kingdom. In addition, as a result of political pressure from Congress, President Bush recently withdrew a proposed $15 billion arms sale to Riyadh.

The US has no plans to sell the highly advanced F-15E strike fighter variant of the aircraft to the Saudis, but apparently there is Saudi interest not only in the F-15C but also in the F-15F, which would be an upgraded version of the already sophisticated air-superiority fighter.



Here the production F-22 is compared with the YF-22 prototype. The F-22 sports a different nose, empennage, and wing. Wingsweep and vertical fin area were changed. The cockpit was moved forward slightly, and the engine inlet moved aft. The aircraft as a whole is two feet shorter, with rounder exhaust nozzles.

Medal to Include Guard, Reserve

Recent presidential action has made it possible for members of the National Guard and Reserve to receive the National Defense Service Medal. In October, President Bush approved DoD's request to expand eligibility requirements for the award.

In a formal statement, DoD said, "By executive order, the President authorized award of the medal for all members of the National Guard and Reserve who were part of the Selected Reserve in good standing during the period from August 2, 1990, to a date to be determined. This medal was previously awarded only to those members who served on active duty, other than for training, during periods for which active military service merited special recognition."

The expanded eligibility is retroactive to August 2, 1990, the day that Iraq invaded Kuwait and set in motion Operations Desert Shield and Desert Storm, the largest US military operations in a generation. US Guard and Reserve members by the thousands served in those operations.

B-2 Redesign Option

If the Air Force can't fix the B-2's radar cross section problems, the service may face the need for a costly redesign of the stealth bomber, according to a late October Defense Science Board memo to Defense Secretary Dick Cheney. The DSB, however, did not recommend that the Air Force redesign the plane at this time.

The B-2 failed to pass one radar cross section test last July. Since then, the Air Force has been studying a variety of potential "fixes" to the airplane in its current platform. In his memo to Secretary Cheney, DSB Chairman John Foster said that one alternative would be to return to the original B-2 baseline plan. The B-2 underwent a major redesign in 1983, at a cost of about $1 billion, to beef up the aircraft for low-level flight. It is this original baseline to which Dr. Foster refers in his discussion of alternatives, says the Air Force.

Air Force Secretary Donald Rice said the B-2's problems occur in one frequency, but he also indicated there were problems in the plane's leading edge and surface treatments. He cited poor predictive computer modeling as a possible reason for the B-2's difficulties in the test last summer. Dr. Foster said the B-2 was making progress in achieving signature reduction in most areas of the spectrum, but he mentioned that there were problems in one area.

In explaining why the DSB had not recommended a redesign, Dr. Foster pointed to cost, complexity, and the possibly marginal benefit of such an action. His memo further cited the view of the DSB members that "the Air Force and its contractors are proceeding with a well-structured program."

Pentagon spokesman Pete Williams said it was too early to give the cost of the fixes. He said there was reason to believe the DSB memo implied that the Air Force should reconsider stealth requirements for the bomber. However, he quickly added that no decision had been made on that issue.

Senate Armed Services Committee Chairman Sen. Sam Nunn (D-Ga.) said after an Air Force B-2 briefing that it would take from three to nine months to fix the problem. Secretary Rice has described the B-2's problems as "nitty" and requiring only "tuning and tweaking."

Staff photo by Guy Aceto

Two A-10 Thunderbolt IIs from the Air National Guard's 175th Tactical Fighter Group, which won the Gunsmoke '91 competition, take off at Nellis AFB, Nev. The 175th, based in Baltimore, Md., compiled 8,524 points in the air-to-ground competition, just ten points better than the 944th TFG, Luke AFB, Ariz., which flies F-16s.

C-17 Load Testing

The first of two "nonflying" C-17 test aircraft was being prepared to start ground testing in late December at McDonnell Douglas's Long Beach, Calif., facilities. After placing the aircraft within a massive steel frame-like fixture, contractor technicians will subject the C-17 to a load that is 1.5 times the maximum it is expected to experience, according to Roland Cassar, business unit manager for C-17 structural testing. Static testing is expected to be completed in 1993.

Mr. Cassar said that loads applied to the aircraft structure by hydraulic actuators will determine if the C-17 can withstand these loadings without failure. The second ground test aircraft will begin durability tests during the first quarter of 1992. The aircraft will be tested to see if the C-17 can endure loads over the equivalent of two service lifetimes.

Guard Unit Wins Gunsmoke '91

The Air National Guard's 175th Tactical Fighter Group, an A-10 Thunderbolt II unit, won USAF's Gunsmoke '91 competition at Nellis AFB, Nev., in October. The Baltimore ANG group piled up 8,524 points in the air-to-ground meet, finishing just ten points ahead of the 944th Tactical Fighter Group, Luke AFB, Ariz., an AFRES unit that flies F-16s.

The competition's "Top Gun" award went to Lt. Col. Roger Disrud, an Air Force Reserve pilot of the 442d Tactical Fighter Wing, Richards-Gebaur AFB, Mo. Colonel Disrud, flying an A-10, scored 2,203 out of a possible 2,350 points. The second-place finisher, the 175th TFG's Lt. Col. Ronald Ball, missed first place by a single point.

DoD Taps War Reserve Fund

The Department of Defense said in November it would draw $2.8 billion from a $15 billion Desert Storm war reserve to pay for operational costs beyond the $48.2 billion pledged by US allies. The actual cost of the conflict is set at $51 billion.

In-kind contributions from coalition nations so far have totaled about $45 billion.

DoD spokesman Pete Williams said a General Accounting Office (GAO) report, released in September, erroneously implied that the US would have money left over once war expenses were deducted from allied contributions. He said that DoD has paid out $3.1 billion in war-related funds, the result of unexpected personnel costs. When that figure is combined with the $2.8 billion soon to be withdrawn, DoD will have paid out $5.9 billion for the Persian Gulf War.

Mr. Williams said those figures do not include $1.2 billion that will be spent to replace items destroyed or consumed during the war or $3.7 billion in combat pay and benefits.

The GAO maintained that the White House's Office of Management and

Budget (OMB) had estimated that Desert Storm and Desert Shield would cost $47.5 billion—some $700 million less than was contributed by US allies—and that OMB actually had overestimated the war's cost.

GD Chairman Says Market Distorted

Defense industry teaming has helped distort the marketplace and has inhibited economic restructuring, claims General Dynamics Chairman William Anders.

Speaking at a Defense Week conference in Saint Louis last October, Mr. Anders also said that, because of the defense industry's generally negative experience in diversification to commercial business, General Dynamics backed away from earlier plans to push strongly into the commercial sector.

Mr. Anders said GD had won a number of contracts since he took over in January 1991. These successes gave him confidence that GD could remain a healthy player in the defense market. By moving away from commercial business, GD has been able to consolidate its funds in defense.

The company's backlog was expected to total $27 billion by the end of 1991, approximately $8 billion more than projected.

Mr. Anders explained he felt comfortable in divesting GD of Cessna, a general aviation firm, despite its status as GD's most profitable division. He said managers can now devote all their time to defense programs.

CBO Reports on Nuclear Reductions

The Congressional Budget Office, in a study released in October, maintained that the US could cut its military spending by as much as $17 billion each year for the next fifteen years by radically cutting nuclear offensive and defensive programs and forces.

To achieve savings on such a scale, said CBO, Washington would have to chop its inventory of strategic nuclear warheads from 12,900 to 1,000, eliminate its entire force of some 10,000 theater nuclear warheads, and dramatically scale back current plans for building a limited defense against nuclear attack.

This particular arms-reduction scenario was the most extreme of four outlined in the 175-page report titled "Study on the Future of Nuclear Deterrence Beyond START." The report was commissioned by Sen. Joseph Biden (D-Del.), a member of the Senate Foreign Relations Committee.

President Bush currently plans to reduce the number of US strategic nuclear warheads to 11,500 by the turn of the century. Once the START treaty was ratified, the US would lower its warhead total to 10,500. CBO outlined three other, less dramatic reduction plans but did not endorse any level of nuclear reduction.

CBO also performed an analysis for Sen. James Sasser (D-Tenn.), the Senate Budget Committee chairman, who wanted to know the potential effect of reducing defense spending by $250 billion between 1992 and 1997. CBO indicated that such a move would seriously jeopardize the US industrial base's ability to produce weapons in large quantities in the late 1990s and beyond.

GE F110X Ground Tests

General Electric's F110X demonstrator engine successfully achieved 36,000 pounds of thrust in ground tests conducted at Edwards AFB, Calif., the company reported in November.

Created from the F110-GE-129 Increased Performance Engine, rated at 29,000 pounds of thrust, the F110X incorporates a higher-flow fan and other recently developed components. The fan was adapted for the F118 engine, which is used in the B-2 bomber. GE sees applications for the F110X in the F-16, the F-14, and the future multirole fighter.

GE also will incorporate technologies from its YF120 engine, which lost the Advanced Tactical Fighter competition to the Pratt & Whitney F119 engine. That application should enhance system performance and reduce support costs.

GE to Eliminate 1,500 Jobs

In an effort to cut $450 million in costs, General Electric Aircraft Engines plans to eliminate 1,500 jobs by the end of 1992, the firm announced in October.

GE said the move was prompted by the national economic slowdown and its impact on the airline industry, as well as cuts in the Pentagon's budget. Corporate officials said that, though the company attempted to save money in the past year through improved inventory management, reduced travel expenses, and gains in productivity, those measures proved insufficient.

P-7A Ruling

Lockheed will not be required immediately to pay back $124 million in P-7A patrol plane progress payments, according to the October ruling of a federal judge.

The judge supported Lockheed's contention that the Navy unfairly denied it the same treatment given General Dynamics and McDonnell Douglas on the A-12 program. Those companies have about two years to repay $1.35 billion that the Pentagon says they owe because of defects in their work on the Navy fighter. The Navy terminated the antisubmarine warfare plane in 1990 for default. Lockheed asked the Navy to delay demanding repayment of disputed progress payments until the Armed Services Board of Appeal settled the firm's request that the finding of a termination for default be changed to termination for convenience of the government.

A-X Study Competition

Rockwell has entered the A-X fray with Lockheed, becoming the fifth firm to join the A-X study competition. Meanwhile, Northrop will join McDonnell Douglas and General Dynamics. The firms made their

Nash Heads West

With this issue, the staff of AIR FORCE Magazine says goodbye and good luck to Associate Editor Colleen Nash, an award-winning journalist and editor who has moved to Hawaii.

Since joining our staff in 1985, Ms. Nash coordinated some of the most difficult and demanding sections in the magazine. She was responsible for acquiring and assembling mountains of data for the Soviet Aerospace Almanac, published annually in March, and the US Air Force Almanac, published annually in May. She also prepared "The Chart Page," one of the magazine's best-read monthly features.

In 1991, Ms. Nash was honored by the Aviation/Space Writers Association with two national awards, for the articles "Solar Max" and "Stinger Proves Its Point." She was one of the principal authors of *Lifeline Adrift: The Defense Industrial Base in the 1990s*, an AFA report published in September.

Many of Ms. Nash's most vital efforts were of the behind-the-scenes type. She was largely responsible for our valuable systems checklists—for example, this issue's "Checklist of Aeronautical Systems"—yet she never got a by-line for this work.

For all these and other reasons, Ms. Nash was one of the magazine's most valuable assets. We wish her luck as she and her husband Paul head west.

announcements in October and November, respectively.

The Rockwell-led team will propose a "clean-sheet" aircraft that is expected to capitalize on experience gained from the X-31 Enhanced Fighter Maneuverability program, according to Rockwell officials. Lockheed is already a member of two other A-X teams.

Northrop also joined General Dynamics and McDonnell Douglas to bid on the A-X program. Northrop was called on late in the A-12 program to assist in solving problems the other two firms were experiencing with stealth.

The Navy will fund five A-X studies at a cost of about $20 million. The teams are Lockheed, General Dynamics, and Boeing; Grumman, Boeing, and Lockheed; McDonnell Douglas and LTV; General Dynamics, McDonnell Douglas, and Northrop; and Rockwell and Lockheed.

Paisley Sentenced

Former Assistant Secretary of the Navy Melvyn Paisley was sentenced to forty-eight months in jail and fined $50,000 for his conviction on charges of improperly helping certain defense contractors win Navy contracts.

The sentence and fine, handed down in October, were the longest and highest, respectively, seen in any case growing out of the Ill Wind investigation, which has been proceeding for more than three years. The probe has netted convictions or guilty pleas from forty-six individuals for defrauding the government. In addition, the probe has led to the guilty pleas of six corporations.

South Korean Fighter Agreement

The Republic of Korea and the US Department of Defense signed a Letter of Offer and Acceptance for Seoul's order of 120 General Dynamics F-16 aircraft, GD announced in October. The total program cost is estimated to be $5 billion, with initial deliveries to begin in 1994.

South Korea selected the F-16 in a competition last March. The program is a combination of foreign military sales (FMS), commercial, and licensed production. GD will deliver twelve aircraft as part of the FMS portion of the contract, and thirty-six aircraft kits will be delivered under FMS and assembled under license in South Korea. The remaining seventy-two aircraft will be produced in South Korea under license from GD, Pratt & Whitney, and other members of the F-16 team.

In a separate agreement, GD and Samsung Aerospace Co. signed an industrial agreement for the commercial and license production portion of the sale.

Proposed Apache Sales

The Pentagon proposed in October to sell $505 million worth of AH-64 Apache attack helicopters and Hellfire missiles to Greece, a move that would mark the first foreign military sale of the Army aircraft to a European nation.

Under the deal, Greece would receive twenty Apaches, 446 Hellfires, eight spare launchers, two target/night vision systems, three spare General Electric T700-701 engines, 5,520 rockets, chaff and dispensers, integrated helmet and display sight systems, forward area refueling equipment, training, field service, and logistics support.

Also proposed by DoD was the sale of 175 Advanced Medium-Range Air-to-Air Missiles to Germany at a cost of $81 million. The missiles are likely to be deployed on German F-4Fs and the future European Fighter Aircraft, according to DoD.

Another sale would involve Japan, which would receive twenty-four Standard missiles and logistics support for $20 million and two Ocean Surveillance Information Systems at a cost of $40 million.

M1 Upgrades

It would cost around $600 million yearly for nine years to upgrade 2,160 M1 Abrams main battle tanks to an M1A2 variant, according to a cost assessment completed in September by the Army and General Dynamics, makers of the M1.

The numbers showed significant improvement over earlier cost assessments, according to George Psihas, vice president and general manager of the General Dynamics Land Systems Division, in a letter to Army Secretary Michael Stone. There is some disparity between the Army's and GD's assessments. The Army assessment found that the upgrade would cost $574 million yearly, while GD set yearly costs at $624 million.

GD estimated a cost of $2.5 million per tank, about $200,000 more than the Army's per-tank estimate. A brand new M1A2 tank would cost more than $3.5 million, making the upgrade of older tanks considerably cheaper.

News Notes

• Unable to reach agreement with Riyadh about leaving some preposi-

Senior Staff Changes

RETIREMENT: B/G Barbara A. **Goodwin.**

CHANGES: B/G (M/G selectee) Hiram H. Burr, Jr., from Dep. Dir., Ops., NMCC, J-3, Jt. Staff, Washington, D. C., to Cmdr., 13th AF, PACAF, and Cmdr., WESTPACSOUTH Air Defense Region, Andersen AFB, Guam, replacing M/G William A. Studer . . . **B/G Robert W. Drewes,** from DCS/Contracting, Hq. AFSC, Andrews AFB, Md., to Dep. Ass't Sec'y, Contracting, SAF/Acquisition, OSAF, Washington, D. C., replacing M/G John D. Slinkard . . . **B/G Edward F. Grillo, Jr.,** from Chief, Strat. Ops. Div., J-3, Jt. Staff, Washington, D. C., to Dep. Dir., Ops., NMCC, J-3, Jt. Staff, Washington, D. C., replacing B/G (M/G selectee) Hiram H. Burr, Jr. . . . **B/G (M/G selectee) Kenneth L. Hagemann, Sr.,** from Cmdr., 7th AD, SAC, and DCS/Strat. Forces Conventional Application, Hq. USAFE, Ramstein AB, Germany, to Dir., Ops., DNA, Washington, D. C., replacing retired M/G Walter E. Webb III.

M/G Burton R. Moore, from Dir., Ops., J-3, Hq. USCENTCOM, MacDill AFB, Fla., to Spec. Ass't to CINC, Hq. USCENTCOM, MacDill AFB, Fla. . . . **M/G John D. Slinkard,** from Dep. Ass't Sec'y, Contracting, SAF/Acquisition, OSAF, Washington, D. C., to DCS/Contracting, Hq. AFSC, Andrews AFB, Md., replacing B/G Robert W. Drewes . . . **M/G William A. Studer,** from Cmdr., 13th AF, PACAF, and Cmdr., WESTPACSOUTH Air Defense Region, Clark AB, the Philippines, to Dir., Ops., J-3, Hq. USCENTCOM, MacDill AFB, Fla., replacing M/G Burton R. Moore . . . **Col. (B/G selectee) Sue E. Turner,** from Chief, Div. of Nursing, Wilford Hall USAF Med. Ctr., Lackland AFB, Tex., to Dir., Nursing Services, Hq. USAF, Bolling AFB, D. C., replacing retired B/G Barbara A. Goodwin.

SENIOR EXECUTIVE SERVICE (SES) CHANGES: Richard P. Hallion, Jr., from Senior Issues and Policy Analyst, (GM-15), Sec'y of the Air Force's Staff Group, OSAF, Washington, D. C., to Air Force Historian, Hq. USAF, Bolling AFB, D. C., replacing Richard H. Kohn . . . **Richard M. McCormick,** from Consultant to Ass't Sec'y of the Air Force (Space), OSAF, Washington D. C., to Dep. Ass't Sec'y (Space Plans and Policy), Ass't Sec'y of the Air Force (Space), OSAF, Washington, D. C. ■

tioned equipment in Saudi Arabia, the US began shipping out 1,300 tracked and 10,000 other vehicles in October, according to the Pentagon. The US had wanted to leave about a division's worth of materiel in the desert kingdom.

• A Boeing-built AGM-86B air-launched cruise missile launched from a B-52 crashed during a test flight over a Utah test and training range on October 8, according to Strategic Air Command. The missile was one hour and forty-seven minutes into the test when it crashed. The incident is under investigation.

• The Longbow Apache program passed a critical design review in late October, the Army said. The move is significant because McDonnell Douglas Helicopter Co. may now begin production planning.

• The last Intelsat 6 communication satellite was launched in late October, bringing the total number of deployed satellites to seventeen. The fifth of its kind, the International Telecommunications Satellite Organization satellite was launched on an Ariane 4.

• Bell-Boeing will design a flex ring that will help to mate the V-22 Osprey's wing and fuselage by the end of the year. The improvement will trim about 300 pounds from the aircraft and save about $300,000 per aircraft, according to the company.

• The Israeli-US Arrow ballistic missile defense interceptor failed to complete a test in October, when it malfunctioned and deviated from its planned course, said the US Strategic Defense Initiative Organization (SDIO). Arrow is being codeveloped to intercept medium-range ballistic missiles.

• The second Red Tigress suborbital launch was successfully conducted in October by Orbital Sciences Corp. for SDIO. Red Tigress is part of a sensor research and development program. The first launch of the Red Tigress series was terminated in August when the vehicle departed from its planned course and was destroyed by safety officials.

• The Light Armored Vehicle 105 (LAV-105) completed initial contractor firings in October. The Cadillac Gage Textron system successfully demonstrated weapon compatibility with the LAV. Following company trials, the systems will be delivered to the Marine Corps for development and operational testing.

• Phillips Laboratory completed its conceptual design review of the Altair Strategic Defense Initiative program. Altair will attempt to acquire and track a rocket in the boost stage, then accurately point and stabilize a low-power laser on the rocket body. The preliminary design review is scheduled for February 1992.

• In October, the President signed an appropriations bill that provides $2 billion for the space station Freedom as a part of an $81 billion measure. The space station was nearly canceled in congressional deliberation.

• Air Force Systems Command's Aeronautical Systems Division delivered the first of four modified MC-130H Combat Talon IIs to Air Force Special Operations Command in October. The aircraft will be able to fly at very low levels and in poor weather and will be used to drop troops and weapons in hostile territory.

• Marine Corps Commandant Gen. Carl E. Mundy, Jr., said in October that the current military drawdown will cost the service three to five active-duty aircraft squadrons. Two F/A-18A squadrons will be transferred to the Reserve, and another two may follow. In addition, one AV-8B squadron will

be disbanded and its planes transferred to other active-duty units.

• The Army has been able to duplicate the premature detonation of the Kinetic Kill Vehicle Integrated Experiment (KITE-2), which led to the destruction of a test vehicle in September, but still has not determined the cause. KITE-2 is a part of the Army's High Endoatmospheric Defense Interceptor program. The project's prime contractor is McDonnell Douglas. Two KITE tests have failed. A third KITE-2A will be tested no earlier than April 1992.

• The Navy successfully launched a Block 1D Harpoon antiship missile in the first test of its kind from a guided missile cruiser in October. The first two Harpoon test launches were from A-6E aircraft.

• In October, Britain's Defence Procurement Minister Alan Clark said it would be "crazy" to abandon the Eurofighter program after all the resources London has put into it. Some German politicians have questioned the program's usefulness in light of the diminished Soviet threat.

• The Japanese National Aerospace Development Agency blamed the explosion of the H-2 booster program's LH7 (not "LE-7" as reported in the November 1991 issue) rocket engine, which killed a researcher in August, on a faulty weld in a high-pressure turbine fuel pump manifold. LH7 is to power the H-2 rocket and is scheduled to begin commercial launches in early 1993. The H-2 program has had several failures in the past few years.

A Hughes Aircraft Co. engineer inspects a Maverick missile sporting a millimeter-wave, high-frequency radar seeker that allows the missile to acquire a target autonomously. The new Maverick, which will begin testing soon, is being developed under USAF's Balanced Technology Initiative.

In November, while serving at Luke AFB, Ariz., Capt. William N. "Goose" Gosselin became the 1,000th pilot to log 1,000 flight hours in the F-16. Capt. Gosselin is now serving in Bahrain, assisting the Bahrain Air Force in training its F-16 pilots. He previously flew the F-16 while assigned to Misawa AB, Japan.

• The fifth JAS-39 Gripen prototype flew for the first time in late October. The Saab-built Swedish fighter, the closest the prototypes have come to a production model aircraft, will be used to test radar, weapon systems, communications, vibration, hydraulics, reconnaissance, and warning systems. Saab said the flight of the fifth prototype will help increase the pace of the flight test program.

• Delta Air Lines will replace Pan Am in the Civil Reserve Air Fleet and pay the Air Force $25 million in cash and credits, the service said in October. Pan Am is no longer able to honor its obligations because of bankruptcy proceedings.

• The Air Force successfully completed the first launch of the Autonomous Guidance for Conventional Weapons program in early October. The low-level release over Eglin AFB, Fla., was the first of six free-flight tests. The program integrates an autonomous guidance kit for air-to-surface weapons.

• An Air Force noncommissioned officer was killed in Ankara, Turkey, when a bomb destroyed his car in late October. Islamic Jihad, a Lebanese terrorist group, claimed responsibility for the bombing. The group linked the attack to the opening of the US-backed Middle East Peace Conference in Madrid, Spain.

• The Navy successfully launched an improved Standoff Land-Attack Missile (SLAM) in October from the wing of an F/A-18C Hornet. The McDonnell Douglas missile was improved by adding flight software that incorporates energy management guidance, which increases the allowable altitude and ambient temperature for SLAM flights. This was the fourteenth successful test flight of SLAM.

• Slingsby Aviation of Britain and Northrop World Aircraft Services, Inc., of the US have teamed to offer the Slingsby T67M-260 Firefly military training aircraft for the Air Force Enhanced Flight Screener program, Slingsby announced in November. Slingsby will provide the parts, and Northrop will assemble and test the piston-engine trainer in the US.

• McDonnell Douglas will split its Long Beach, Calif., operation in half to keep its planned development of a next-generation commercial jetliner

separate from its C-17 work. The firm said the move will make the operation more efficient.

• General Dynamics and McDonnell Douglas resumed deliveries of the advanced cruise missile to the Air Force in November, following the conclusion of work to correct problems with the wing deployment actuators, water intrusion, checkout procedures, and fuel and vapor leaks.

• McDonnell Douglas plans to market a commercial version of the C-17 to small package carriers, according to the firm. The C-17 offered will be stripped of military equipment. The firm hopes to cut the unit cost to $100 million.

• Lockheed has begun final assembly of the 2,000th C-130H Hercules transport, the firm said in October. The aircraft will be delivered to the Kentucky ANG by early 1992. Development of the C-130 began in 1952.

This all-composite, full-scale replica of the North American P-51 Mustang fighter weighs between 3,200 and 3,500 pounds empty; metal Mustangs can weigh from 7,800 to 11,000 pounds. The P-51 DH will be considerably faster than the original aircraft, with a top speed of around 500 mph.

Honors

Vice President Dan Quayle awarded the 1991 Malcolm Baldridge National Quality Award to Solectron Corp., San Jose, Calif.; Zytec Corp., Eden Prairie, Minn.; and Marlow Industries, Dallas, Tex. All three are electronics firms.

Dr. Richard Soref, a research scientist with the Photonic Components Branch at Rome Laboratory's Electromagnetics and Reliability Directorate, Hanscom AFB, Mass., was presented with the 1991 Air Force Basic Research Award in October. Dr. Soref was honored for his pioneering work in electro-optic components and devices.

Dr. Leslie Cohen was awarded the 1992 J. H. "Jud" Hall Composites Manufacturing Award. Dr. Cohen is the program manager for Advanced Systems and Advanced Product Development and Technology for McDonnell Douglas Space Systems Co.

Purchases

The Air Force awarded Lockheed Corp. a $6.9 million increase to a cost plus award fee contract for funding of an award fee for the F-22 Advanced Tactical Fighter airframe program. Expected completion: January 2000.

The Air Force awarded Pratt & Whitney Government Engines Business Group a $5.5 million face-value increase to a cost plus award fee contract for funding of an award fee for the F-22 engine program. Expected completion: October 1999.

The Air Force awarded Harris Corp. a $10.5 million cost plus incentive fee contract for the development of the Advanced Medium-Range Air-to-Air Missile warhead replacement tactical telemetry system. Expected completion: February 1993.

The Navy awarded TRW a $5.2 million contract for a superconductive infrared focal plane array sensor. Expected completion: October 9, 1994.

The Navy awarded Sikorsky Aircraft Division an $18.6 million contract for incorporation of the T64-GE-419 engine into the MH-53E Sea Dragon helicopter. Expected completion: December 1995.

Obituaries

Hanson W. Baldwin, a Pulitzer Prize–winning war correspondent, defense reporter, author, and editor, died of heart ailments on November 13 at his home in Roxbury, Conn. He was eighty-eight. Mr. Baldwin, whose work spanned the 1930s, 1940s, 1950s, and most of the 1960s, was a former military editor of the New York *Times* and author or editor of a score of books on military and defense issues. Mr. Baldwin won his Pulitzer Prize for coverage of World War II operations in the Pacific. In addition, Mr. Baldwin covered World War II campaigns in North Africa and Europe. Mr. Baldwin retired from the *Times* in 1968 after forty years with that publication. He is survived by his wife, two daughters, seven grandchildren, and three great-grandchildren. ■

Index to Advertisers

Combat aircraft of the future are being shaped by today's work on propulsion, materials, flight dynamics—and even airplane tires.

The Long Reach of Wright Lab

By Frank Oliveri, Associate Editor

FOR decades to come, Air Force fighters and other combat aircraft will be reaping the benefit of developments taking place at workbenches throughout the Air Force's Wright Laboratory—from powerful new engines permitting Mach 3+ speeds to superlight structures, from nonflammable hydraulic fluids to artificial intelligence avionics that "think" for themselves.

Even minor details are getting attention. For example, a new, extended-life, radial-type tire is being developed to replace the current nonradial variety. The tires on Block 40 F-16s last only for about four to eight landings. The newer radials are expected to last significantly longer and, in the process, save about $10 million yearly in tire expense for F-16s, F-15s, and A-10s.

Wright Laboratory, the research arm of USAF's Aeronautical Systems Division (ASD), Wright-Patterson AFB, Ohio, is hard at work on the three-phase Integrated High-Performance Turbine Engine Technology (IHPTET) initiative, which is expected to provide the Air Force with the technology for "revolutionary" advancement in aircraft propulsion performance and operational capability.

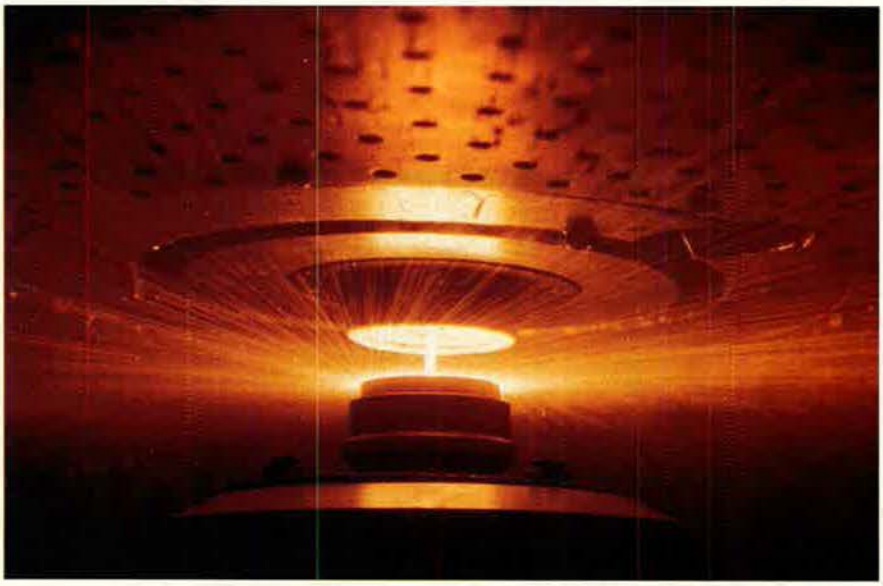
New structural materials are certain to be used extensively in the forthcoming F-22 Advanced Tactical Fighter and perhaps in some existing fighters as well. They include new thermoplastic and thermoset composite materials, which greatly reduce aircraft weight. Advances are being made in structural metallic materials, such as aluminum, titanium, and magnesium structural alloys and metal matrix composites.

In flight dynamics, the Advanced Fighter Technology Integration/F-16 (AFTI/F-16) program is set to begin testing of technologies associated with close air support operations. The short takeoff, landing, and maneuvering technology demonstrator (S/MTD) F-15 has shown high maneuverability, in-flight thrust reversing, and reductions of thirty-five percent in takeoff distance and sixty-five percent in landing distance. The S/MTD also demonstrated the ability to land autonomously at night and in poor weather.

This C-130 flight station, the first of its kind to be tested on a military transport, uses color active-matrix liquid crystal display technology. The LCDs, being tested here by Frank Hadden (left), director of flying operations for Lockheed Aeronautical Systems Co., and Lockheed test pilot Bob Hall, replace more than sixty electromechanical instruments, standard with current production model C-130s.

Gone are the days when the goal was performance for its own sake. The Air Force is changing the meaning of "performance" and using the F-22 Advanced Tactical Fighter program as the model of what it seeks.

Says Maj. Gen. James Fain, Jr., the F-22 program director, "What we mean by 'improved performance' is 'I want to do it right the first time. I don't want to have to do it right the second or third time.' It's not performance in terms of Mach number or Gs. It's performance in terms of executing a program to deliver a product that will give the user what he needs. We believe that starts in the design phase."



Wright Lab's Materials Directorate is working closely with the Aeropropulsion Directorate on high-temperature materials, such as ceramic matrix composites, carbon-carbon composites, and intermetallics (here, rapid solidification rate power metallurgy research), for gas turbine engines and hypersonic vehicle structures.

Emphasis on Engines

Engines form one major technology thrust. The IHPTET program is projected to have an impact like few programs now in development. Under the Aeropropulsion Directorate, IHPTET will benefit not only fighter/attack aircraft but also rotorcraft engines, cruise missile engines, and subsonic patrol and transport aircraft engines.

It is expected to increase fighter engine thrust-to-weight ratios by 100 percent while decreasing fuel consumption by forty percent. Rotorcraft engines will increase power-to-weight ratios by 120 percent while decreasing fuel consumption by forty percent. Technologies developed in the IHPTET program will also decrease fuel consumption of strategic missile engines by forty percent and increase thrust-to-airflow ratios for tactical missiles by 100 percent.

The payoff is an aircraft the size of an F-15 that will be able to fly at speeds of Mach 3+, with greater range and payload, and perhaps be able to make vertical and short takeoffs and landings. A helicopter the size of a CH-47 will increase range and payload by 100 percent.

The program will be broken into three phases. Phase One of IHPTET is itself broken into three parts: the technology base, components, and technology demonstrators. In the first part, materials, structures, and aerothermodynamics (the study of heat flow as it relates to aerodynamics) will be analyzed. In the second part, compression systems, combustors and augmentors, turbine systems, exhaust nozzles, control systems, and mechanical systems will be studied. Finally, the demonstrators will be divided into three fundamentally different types of gas turbine engines: turbofan/turbojet, turboshaft/turboprop, and expendable missile turbine engines. Phases Two and Three of IHPTET are still taking shape.

Already, work in the IHPTET program has produced knowledge that has added to the technology base for the development of the F100 and F110 Increased Performance Engines that will soon enter the force. In addition, it will provide an engine technology base for the B-2, F-22, and other aircraft.

A key component of IHPTET will be the development of multifunctional (both pitch and yaw), lightweight engine exhaust nozzles. Such technologies led to the installation of a first-generation pitch thrust-vectoring system on the F-22, which helps the aircraft achieve extreme high alphas (high angles of attack). IHPTET will also address the use of high-temperature materials and structures, advanced nozzle-cooling techniques, and special nozzle features associated with low-observable aircraft.

Weight Watchers

In developing an aircraft, or even modifying one, designers must constantly watch its weight. Strenuous efforts are under way to reduce the size and weight of certain components. The use of composite structures would reduce the designer's current reliance on heavier metals, a move that might not necessarily reduce the size of the structures but would certainly eliminate weight.

Thermoplastic is one of the more mature composites, says Dr. Charles Browning, head of one of the Materials Directorate's structural materials branches. The beauty of thermoplastics is that they can be heated, formed, and reheated and reformed if need be. Dr. Browning says the temperature needed to form thermoplastics is some 500° hotter than the temperature at which they are used.

Thermoplastics are useful for doors on fighters and have already been used for the underbelly of a C-130, on the rudders of the F-117, and on doors for the F/A-18, F-16, and F-15.

Though thermoplastic is a mature technology, the idea of making a "full-composite" aircraft is not widely accepted because the manufacturing risks are perceived as very high. Dr. Browning says companies are afraid of the up-front investment required to use thermoplastic to its full potential. Above

The Pratt & Whitney YF119 engine, to be employed on the F-22, will have vectored thrust capability. This timed-exposure photo shows the maximum positive and negative twenty degrees of thrust of the YF-22 nozzle as the engine undergoes ground testing at Edwards AFB, Calif.

all, Dr. Browning says, thermoplastics need a production history to allay contractor fears.

Moreover, the benefit of using thermoplastics on existing aircraft to replace metallic structures is low, inasmuch as the composite structures need to be formed in the way metallic structures are formed to fit the aircraft. "The way you stiffen or support a metal is not the way you stiffen or support thermoplastics," Dr. Browning says.

Wright Lab's Materials Directorate is working closely with the Aeropropulsion Directorate on high-temperature materials, such as ceramic matrix composites, carbon-carbon composites, and intermetallics for application in future gas turbine engines and in hypersonic vehicle structures.

Many other materials programs could play a significant role in development and improvement of USAF fighter aircraft. Lois Gschwender, a material research engineer at the Materials Directorate, says that a nonflammable hydraulic fluid has been developed for use at temperatures ranging from −54° Celsius to 175° Celsius. Hydraulic fluids used today are highly inflammable. A nonflammable fluid would make future aircraft more survivable, Ms. Gschwender says.

In addition, a new low-cost, nontoxic coolant is being tested on the B-1B bomber. Use of the new coolant is expected to save about $947 million over the life cycle of the aircraft, after an investment of only $100,000.

USAF's current tactical fighter force will benefit from technologies coming out of Wright Lab. For example, TAC pilots who flew the S/MTD recommended putting its autonomous landing guidance system in F-15Es (above) now in use.

S/MTD Payoffs

The Flight Dynamics Directorate recently concluded the F-15 S/MTD program, which turned out to be one of the more successful initiatives the lab has ever undertaken. In 138 test flights, the program developed, flight-demonstrated, and validated systems in numerous major technology areas critical to providing STOL capability and enhanced maneuverability to fighters.

One of the key technologies is the autonomous landing guidance system. Tactical Air Command pilots who flew the S/MTD recommended putting the system in all F-15Es now in the tactical force.

Other technologies demonstrated in the S/MTD program:

- Two-dimensional thrust vectoring (to be used in later versions of the F-22).

• A fully integrated, digital, multivariable, fly-by-wire, integrated flight/propulsion control (IFPC) system.

• Rough/soft-field landing gear with IFPC-controlled differential braking, nose wheel steering, and self-regulated antiskid autobraking.

• Numerous pilot/vehicle interface enhancements (with autonomous landing guidance and position aids).

• Use of close-coupled canards and wing flaperons and ailerons.

Assisted by thrust vectoring, the aircraft's pitch maneuverability at high alpha was demonstrated to be 110 percent better than similar aircraft with conventional controls. In addition, the aircraft demonstrated the ability to land at a distance one-third that of a normal fighter.

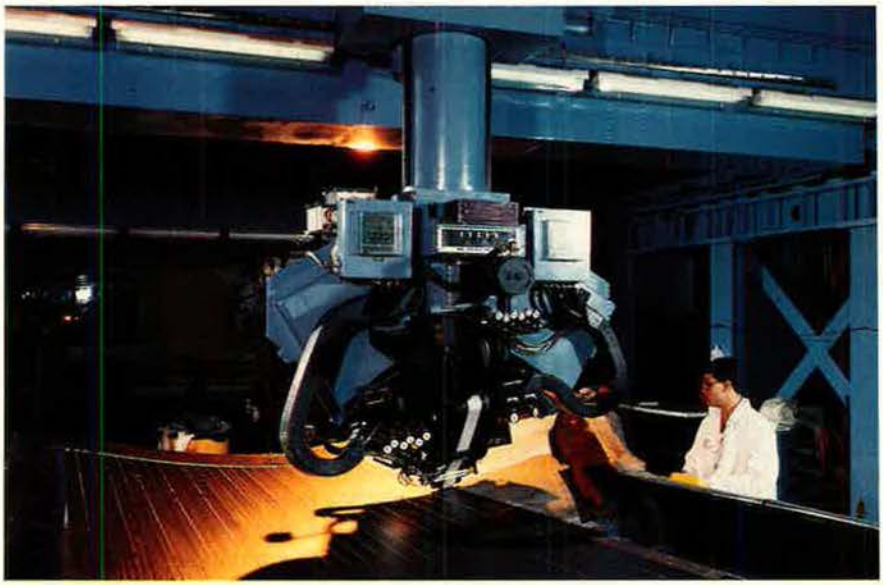
Another key Flight Dynamics Directorate program is the AFTI/F-16, now modified to demonstrate new technologies for next-generation close air support/battlefield air interdiction (CAS/BAI) aircraft.

The program is designed to demonstrate technologies that enhance an aircraft's ability to locate and destroy enemy ground targets in poor weather and at night. Low-altitude maneuverability and reductions in electromagnetic emissions to increase survivability against surface-to-air missiles will also be studied in the program.

Lt. Col. Ted Church, who manages the AFTI/F-16 CAS/BAI program, says the program will attempt to improve single-pass attack and the pilot's tactical awareness through a digital data link system. In addition, he says, the All-Terrain Ground Collision Avoidance System will be demonstrated. That system has the ability to incorporate real-time data from a forward-looking sensor with digital terrain data to improve performance. It would provide a safety net for night-time, under-the-weather operations. Colonel Church says many of the advanced technologies to be demonstrated may be used by future F-16 CAS/BAI fighters.

Other technologies to be demonstrated in the AFTI/F-16 are systems for maneuvering, terrain following, terrain avoidance, and threat avoidance. They would allow manual and automated five-G maneuvering flight and be coupled with an ejection-safe, integrated helmet system, which combines image intensifying tubes, forward-looking infrared (FLIR) images of the pilot's view, and overlays of head-up display information. The bomb delivery systems will be modified to allow for curvilinear flight path delivery over all terrain.

An advanced targeting FLIR system will also be integrated with bombing and flight-control computers, permitting automatic weapons delivery on more than one target. A covert radar altimeter was installed and integrated with the digital terrain navigation system, which will help mask electromagnetic emissions at low altitudes.



New materials developed at Wright Lab are employed in advanced-development programs. The use of composite structures reduces the designer's current reliance on heavier metals, making for a lighter and more capable aircraft. Here, an LTV engineer lays tape on a composite structure for the B-2 bomber.

Avionics Advances Continue

Remarkable advances in avionics still are being made at Wright Laboratory. As more and more capabilities are developed for military aircraft, more powerful and more sophisticated systems will be required to handle them.

The watchword is integration. Older, proven development programs like Integrated Electronic Warfare Systems (INEWS), Integrated Communication Navigation Identification Avionics (ICNIA), and Ultra Reliable Radar (URR) have produced systems that are being integrated under Pave Pillar–style avionics architecture. These Pave Pillar–based systems are primarily being developed for application in the F-22, but some technologies will likely be used as upgrades to F-15 and F-16 fighters, among other potential customers.

The newer, next-generation program, Pave Pace, will introduce a number of leading-edge technologies into new fighters. Those technologies include wafer-scale integration of functions now performed by individual semiconductors, parallel processing techniques, photonics, neural networks, and artificial intelligence.

While Pave Pace is still an immature program, it is geared to upgrade such systems as the F-22, the B-2 bomber, and future National Aerospace Plane derivatives.

The Avionics Directorate is looking to stack the deck in favor of future US air-superiority fighters by developing the Integrated Control and Avionics for Air Superiority (ICAAS) program. ICAAS is intended to demonstrate technologies to kill and survive when outnumbered in air combat, with a goal of winning aerial engagements when outnumbered by as much as four to one. The primary emphasis is on a beyond-visual-range, multiple target attack capability, with the ability to switch to close combat.

The ICAAS system would be divided into five functions, each of

which aids the pilot in making air combat decisions. They include attack management, tactics, attack guidance, management of defensive assets, and monitoring of performance.

Attack management will provide the pilot situational awareness. The tactics function would provide an assessment of the situation in the air. The attack guidance function would give data on how to achieve the greatest positional advantage. The defensive assets manager is activated by a threat missile launch and presents the pilot with options to defeat the missile. The performance monitor helps the pilot exploit aircraft performance advantages by achieving the best energy state for executing specific attack or defensive maneuvers.

Computers are being used to design and redesign cockpits to improve interface between pilot and aircraft. Cockpit improvements will give pilots greater situational awareness and will increase the overall capability of the aircraft.

Chopping the Work Load

This type of system greatly reduces the work load of a pilot. Currently, pilots must extract information from numerous sources in the cockpit and then make decisions on actions they should take. ICAAS will compute much of the information and then tell the pilot his options. The system will also give pilots tactical situation data, greatly enhancing their situational awareness. A synergistic combination of subfunctions translates into a higher level of pilot and total system performance. The Air Force is unlikely to insert the ICAAS system as a whole into an operational aircraft, but many of its integrated technologies will make the transition.

The presentation of all this electronic data is a subject of increasing importance at Wright Laboratory. ASD is addressing that problem by using active-matrix, color, liquid crystal displays (LCDs), already in the F-22 prototype and slated for production for that aircraft.

Existing fighters use cathode-ray tubes, which are heavy and large and require a great deal of power—producing a lot of heat. LCDs are lightweight, operate on small amounts of power, are very reliable, and are only about one inch thick. F-22 test pilots say LCDs present a clearer image.

Initially, the cost of the LCDs would be higher because companies must build up a manufacturing infrastructure, according to Jerry Covert, group leader of the display technology group in the Joint Cockpit Office. "I would say the principal thing that we are concentrating on is in making them domestically producible," Mr. Covert says.

Production of LCDs would require a clean-room facility and very expensive manufacturing equipment to handle large-plate silicon devices of the size needed for aircraft displays. Mr. Covert says LCDs would have the same silicon-processing requirements as the Very-High-Speed Integrated Circuit (VHSIC) program.

The Air Force is currently developing an LCD to replace the radarscope for the F-15 and an LCD for the horizontal situation indicator in the F-15, C-135, and E-3 Airborne Warning and Control System aircraft.

The Air Force has not always emphasized manufacturing technologies, but that is changing. At Wright Lab, manufacturing technology is now included from the outset in the design process. "What you're balancing is reliability, maintainability, supportability, trainability, manufacturability, all those issues against each other, and you're balancing them all in a cost environment," says General Fain.

One of the programs sponsored by the Manufacturing Technology Directorate (MANTECH) is the Automated Airframe Assembly Program. The program will develop, integrate, and apply above-the-shop-floor technology. The Air Force wants the ability to analyze a design, implement alternatives efficiently, and generate a common product definition for above-the-shop-floor and product requirements, among other things.

This program applies to airframe assembly. Another, similar framework would be developed for smaller components.

MANTECH officials are currently working to find a cost-effective way to produce the individual transmit/receive antenna modules for the URR program. The URR is a solid-state, electronically scanned, phased-array radar that uses gallium arsenide devices in active circuits. URR would employ 2,000 of the individual devices in one system. When MANTECH began working the problem, the cost per module was about $12,000 each. To date, that price has been cut by more than half, but the goal is to get costs down to $400 per module.

Sometimes the simplest ideas can produce significant rewards. One example: Wright Laboratory's development of cockpit solar shields, similar to those used in cars. They are now being developed for aircraft and may save up to $400 million a year by protecting instruments from sun heat damage. ■

Here are scenes of daily life and mission preparedness at a Soviet Air Forces base, as seen by an American photographer.

The Changing Face of Soviet Airpower

A photo report by **Hans Halberstadt**

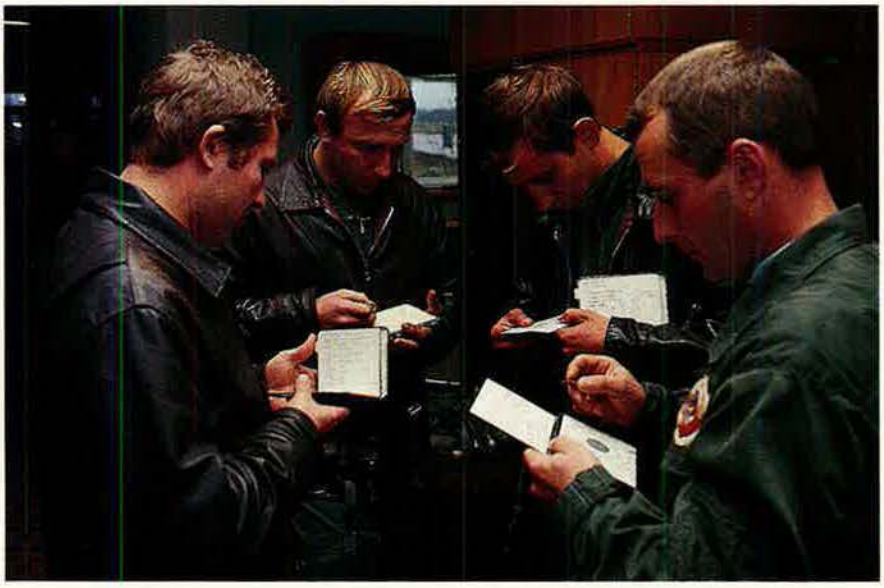
Above: Capt. Sergei Samko is a tactical and demonstration pilot for the Su-27 "Flanker" interceptor, an agile air-to-air combatant. Opposite: This young crew chief is, like his USAF counterpart, dedicated, energetic, and highly trained and skilled. He takes great pride in "his" aircraft's design and condition. Unlike USAF crew chiefs, he is a commissioned officer rather than a sergeant.

Just outside Moscow is Kubinka, a Soviet Air Forces base that, until recently, was a prime target for NATO war planners. It is sometimes—wrongly—called a "showbase," because it hosts visiting foreign delegations and because the MiG and Sukhoi aerobatic teams are based there. Away from the demonstration area, Kubinka is like most other Soviet air bases: austere in some ways, lovely in others, with a flight line that can be hectic and residential areas full of families.

I spent nine days at Kubinka in October. Each day was full of revelations. The Soviets know a lot about us and our aircraft—more than we know about them. I saw a lot of energetic, professional, intelligent people. Most were friendly; many expressed admiration for the United States; a few were reserved.

There were far fewer restrictions on movement and photography than at an American base. They let me photograph things never before photographed. When I asked why, they said, "We want you to tell the truth about us, good and bad, to the American public and especially to the US Air Force." ■

The Su-24 "Fencer" pilots begin debriefing at planeside (above), and they almost never remove their helmets. The ground-attack aircraft are turned quickly by the ground crews (right), who swarm over them as soon as they return from a flight. The heavily armed Su-24, like the other Soviet aircraft at Kubinka, seems built for go, not for show: rugged, efficient, reliable—with crews to match.



Two crews confer after a preflight briefing. In thirty minutes they will be airborne in their MiG-29 "Fulcrums" and headed for a week's visit to a Swedish Air Force base. Since the collapse of the Warsaw Pact alliance, these goodwill visits have become commonplace, and the Soviet pilots are eager to begin exchange tours with American units. They have already increased participation at US air shows, including the sale of fifteen-minute flights in MiG-29s.

Kubinka dates back before World War II and has many elements of a city park, a lovely place for a young officer and his family to take a walk. In a country where housing is tight, commissioned officers and their families are assigned small apartments within walking distance of the flight line.

The Soviets have some excellent military museums. The Su-22 "Fitter" above is part of a large Soviet military aviation display near downtown Moscow. Not far away at the Army museum (right), MiGs and Sukhois compete with tanks and guns for the attention of crowds of history-minded fathers and sons.

The premission brief is the same ritual in the Soviet Air Forces as it is in the US Air Force. For this one, the master of ceremonies is Lt. Col. Vladimir Basov, deputy commander of the air division and leader of the "Red Knights" demonstration team, which flies Su-27s. Portions of the brief are delivered by members of the flight.

The pilots' lunch is normally served at 3:00 p.m., in this elegant room, by a neatly attired waitress. She serves soup, bread, a light malt beverage called kvass, and fried fish or meat, sumptuous fare in a society where shoppers wait in line for hours at state-sponsored stores for scant pickings. The dining facility is in the operations building, adjacent to the flight line.

When it is time for business at Kubinka, the crews whip into action. Most of the preparation is done by the crew chief lieutenants. The pilot straps in, fires up, and is at the end of the runway while a US pilot would still be working on his walkaround. The MiGs and Su-27s are airborne in a few hundred feet, five minutes after engine start.

Heat-seeking AA-11 "Archers" (right) are part of the MiGs' and Su-27s' bag of tricks. The Archer is a highly maneuverable close-in weapon, usually carried in groups of four along with a pair of AA-10 "Alamos" for engagements with enemy aircraft at longer range. After recent poor performances by their air-to-air combat aircraft, the Soviets are making progress toward a more competitive force.

The MiGs and Sukhois normally park in dispersal areas and individual revetments. When flight time comes, they are towed out to the ramp. Away from the demonstration hangars and headquarters building, Kubinka seems more like an austere forward base with minimal facilities.

The Soviet policy of making crew chiefs commissioned officers ensures that they and their training and experience will be around for the long haul. With a strong team spirit and an efficient, businesslike attitude on the flight line, the crews launch and recover aircraft extremely quickly.

Col. Alexander Kutuzov is deputy commander of the air regiment (equivalent to an air wing) and leader of the "Swifts" demonstration team, which flies MiG-29s. To the usual set of deputy commander's concerns, he must add a new set of political, military, and economic uncertainties, plus the possible threat from former republics of the Soviet Union.

Maj. Alexander Dyatlov flies what NATO calls the Flanker, but he wishes his Su-27 had an official Russian nickname. The NATO appellation has been added to his helmet perhaps because he participates in flight demonstrations in Europe and North America.

No matter how well the Air Force handles it, the reductions will be hard on men and women in uniform.

Drawdown and Pain

By Bruce D. Callander

WHEN Merrill A. McPeak came to active duty in 1957, it was peacetime, Eisenhower was president, the budget was balanced, and he was joining an Air Force of almost 920,000 members.

Today, as the Chief of Staff of the Air Force, General McPeak is presiding over a planned force drawdown that will leave his service, by 1995, with less than one-half its 1957 strength. Moreover, the 415,000-strong force that was seen last year as a rock-bottom minimum for 1995 now is closer to reality, and congressional pressure is mounting for deeper cuts beyond 1995. The pressure foreshadows a drawdown of greater magnitude.

"Will it be painful?" General McPeak asks. "Yes, but I hope we will come out of it with a leaner, tougher, and even stronger Air Force."

So far, the pain has been felt largely by a small number of Air Force members forced to retire earlier than they had planned. The Air Force has lowered its "high-year-of-tenure" points for top noncommissioned officers by two to three years. E-8s now must leave at twenty-six years; E-7s at twenty-three; and E-6s, like E-5s, at twenty years. Chiefs still can stay for up to thirty years but no longer can be selected to go beyond that point.

On the officer side, the Air Force has set up Selective Early Retirement Boards (SERBs) to "select out" retirement-eligible field-grade officers. Some colonels and lieutenant colonels who were not picked by earlier SERBs and thought themselves "safe" for another five years will be reconsidered by a new board in early 1992 along with a new group of eligibles.

The only involuntary separations from the career force thus far have been those triggered by traditional up-or-out mechanisms for officers and selective reenlistment limitations on enlisted members. The Air Force has added a more recent "quality check" to force out E-4s who have not made E-5 after ten years of service. Beyond that point, however, staff sergeants generally are good for twenty years.

Losses under these programs will be substantial in 1992. Personnel officials predict that the new SERBs will select about 900 senior officers to retire and point out that they could, legally, pick several hundred more. The lower tenure points for top NCOs are expected to produce about 2,900 losses, and another 1,500 E-4s are expected to leave the service under the ten-year tenure rule. Another 800 airmen will be denied selective reenlistment.

The Real Pain

Though these actions are hard on individuals, they will account for only a fraction of the losses needed

Staff photo by Guy Aceto

to meet the Air Force's drawdown requirements. The real pain will come if USAF has to resort to an involuntary reduction in force (RIF).

To avoid or at least delay such a forced reduction, General McPeak and Air Force Secretary Donald Rice have opted to meet the reduction schedule through 1992—and as far beyond as possible—by making sharp cuts in the level of enlisted recruiting and in new officer accessions.

"We have to be loyal to the people who have been loyal to the Air Force," General McPeak says. "Besides, it makes no sense to RIF a tech sergeant who has been trained and served and wants to stay just to take in a new, untrained person. We may have to consider some force-outs later on, but, for now, we're doing all we can to avoid them."

Reducing the number of accessions has its dark side, however. The Air Force currently is taking in only about 30,000 nonprior-service airmen per year. That is enough to meet the Air Force's current needs but barely enough to give it an adequate retention pool when today's first-termers become career-eligible airmen. As one Air Force Military Personnel Center (AFMPC) official puts it, "We're pushing recruiting cuts to the limit for 1992."

For officers, new accessions are linked in a long pipeline, and even the reduction of the number of new officers presents a problem. The difficulties are compounded by the fact that many new officers cannot be used where they most want to serve —in the cockpit.

The Air Force is cutting the rate of undergraduate pilot training to about 800 per year, less than half the production of recent years. Up to sixty-five percent of new UPT graduates are being sent to nonrated jobs, and new Air Force Reserve Officer Training Corps graduates who want pilot training have to wait for openings.

For some time, there will be fewer openings even for experienced pilots. Tactical Air Command (and its successor, Air Combat Command) will lose ten tactical fighter wings over the next five years, and other commands will take comparable hits. Whole squadrons will be phased out, leaving many pilots without jobs. Even traditional instructor jobs that have been havens for displaced pilots in the past are growing scarcer as UPT and the command's own transition training programs are cut back *[see "The Fighter Training Shortfall," December 1991 issue, p. 22].*

While the Air Force is trying to hold on to pilots it will need in future years, it faces another problem. The commercial airlines are not hiring at the rates they once were, but they still represent a tempting alternative to pilots who want to continue flying and see little hope of doing so in the service. The temptation may grow as more pilots face long periods out of the cockpit. Under the "gates" system, they must spend specific percentages of their career in rated positions to remain qualified for flight pay. Failing to meet a gate can be costly.

"We're keeping a close eye on that problem," General McPeak says, "and we'll ask Congress for relief if necessary. The 'gates' system was devised to meet an earlier need, and the need has changed. We may have to look for a new approach."

A Little Help From Their Friends

In fact, the Air Force may need congressional help on a number of fronts to ride out the drawdown and forestall the dreaded RIF. Despite some lawmakers' promise to gut defense in favor of domestic programs, General McPeak thinks Congress in general will be supportive. "We have had a good relationship with the Hill so far, and I think they will work with us to meet the problems," says General McPeak.

How supportive Congress will be remains unclear. In a seeming contradiction, the Air Force's wish list includes incentives both to induce needed members to stay in and to encourage those in less-needed specialties to get out.

In the retention area, the 4.2 percent pay raise scheduled to kick in this month should help, but General McPeak also sees a need for other standard-of-living improvements, including housing. In today's force, three-quarters of all officers and two-thirds of all airmen are married, and both percentages are rising. The Air Force has never been able to supply more than a fraction of USAF families with base housing, and what is available is outdated and not up to contemporary standards.

"Today's families, many of them with two spouses working, expect something better, and they deserve it," General McPeak says. "We need either to build better housing or to provide realistic allowances so people can live in local communities."

In today's harsh budget climate, a major building program seems inconceivable, particularly when the services are about to close a number of bases into which they have poured housing dollars. As an alternative, the Air Force hopes Congress will raise housing allowances, which have fallen well behind rental rates. The service is working with Pentagon officials on proposals that may make it to Congress next year.

General McPeak and Air Force personnel officials concede that it will not be easy to convince an economy-minded Congress to raise quarters allowances and make other improvements, but they see the cost as the price of keeping the force viable. As one AFMPC official put it, "It's going to be important, as the force draws down and part of the budget goes away, that we try to reinvest at least a piece of the savings in fixing the things that are wrong. If we are going to keep the best people, the average cost per person probably is going to go up."

Selling that idea may be even harder as the Air Force presses for another monetary item, one designed to encourage separations.

Incentives to Leave

As part of the Air Force's effort to avoid RIFs, it wants to offer members in less critical skills substantial payments to leave short of retirement. A voluntary separation incentive was proposed to the last session of Congress. It would give the "early outs" less than retired pay but more than the severance pay allowed for involuntary separation. The idea was to stimulate enough voluntary exits to reduce the need for force-outs.

Officials hope for a receptive congressional hearing in 1992. While general cuts in defense spending are politically attractive, many lawmakers seem less eager to disrupt the lives of career service members, particularly in an election year. Some of those likely to be forced out are the same troops whom Congress praised so lavishly for their service in Operation Desert Storm. Nor do the lawmakers want to see the services dump hordes of troops into a depressed job market with no more than severance pay.

Whether by RIF or voluntary early outs, thousands of members will be leaving the force in coming years. Against that prospect, General McPeak has ordered a study of the transition program started in 1990 to help departing members. That review was one of the last chores given Lt. Gen. Thomas Hickey as deputy chief of staff for Personnel.

While the Air Force continues its drawdown and hopes for what one official termed the "small miracle" that will help it weather the experience without a major RIF, officials are assessing other areas of battle damage. Surprisingly, they are finding less than expected.

In past force cuts, for example, the services have taken heavy losses in the lower grades and been left with surpluses at the top levels that slowed or even halted promotions. That is not the case this time because the Air Force already had a self-leveling mechanism built into its career programs.

The new high-year-of-tenure rules and early retirement boards have tended to thin the upper ranks proportionately and have kept the shrinking force from becoming top-heavy. As a result, AFMPC officials say, promotion "pin-on" points for colonel, lieutenant colonel, and the top three NCO grades actually may be a little earlier than in the past.

The outlook is not as optimistic in some of the middle grades, where the year groups are larger and there are fewer provisions for reducing them. Promotions to major and to staff and technical sergeant may come slower. Even here, however, officials say that there is no danger of major stagnation. At worst, delays should be no more than a year, and perhaps less.

Temporary Relief?

Even that modest slowdown could be avoided if Congress approves the voluntary separation incentive, officials say. If it doesn't, the Defense Department could ease matters, at least on the enlisted side, by granting temporary relief from the rule that no more than 51.1 percent of enlisted strength may be in the top five grades.

The Air Force says it will not force out some members just to keep promotions coming for others. However, if a RIF of midcareer members is necessary for other reasons, it will have beneficial side effects on the promotion chances of those remaining.

Apart from the influence that the drawdown will have on their careers and promotion chances, the major concern for many members during the drawdown will be finding and keeping jobs with good career prospects. General McPeak says that he and Secretary Rice are keeping that concern in mind as they manage the cuts. Rather than take the easy way out and eliminate a proportionate number of jobs across the board, he says, they have opted for a more active approach. To save as many good jobs as possible, they will eliminate headquarters and overhead and maintain Air Force combat strength.

Putting people into those "good jobs" without wasting scarce dollars on needless permanent changes of station (PCSs) is another of the drawdown's major challenges. Col. Lyal Gordon, the deputy director of assignments at AFMPC, notes that the challenge is complicated by the basing of this year's PCS budget on estimates made some eighteen months before the budget was approved. "Many changes have occurred since those estimates, and we must adjust our internal priorities to accommodate those," says Colonel Gordon. "It's part of our juggling act."

More than budget austerity is involved. Under Pentagon rules, at least thirty-six months on station must elapse between continental US moves and twenty-four months must elapse before members apply for overseas. Waivers require approval at the general officer level, and, says Colonel Gordon, these don't come easy.

Those rules remain in effect even though the Air Force is shuffling its forces. So do the requirements to fill short, unaccompanied tours overseas even as the Stateside assignment base shrinks. Despite these constraints and realities, Colonel Gordon says, the Air Force will be able to continue most of the assignment-choice programs that it started in less hectic times. In fact, it has even made some improvements.

Improved Assignment-Choice Programs

The biggest gain can be seen for the officer corps. The Air Force has launched a new system for posting job openings on an electronic bulletin board that operates through the worldwide computer network. Colonel Gordon says that about 3,000 rated and nonrated officer jobs will be displayed. At many bases, officers can read the bulletin board at squadron level. At others, they will have to check it at their base personnel office. Either way, however, they can check the available job options and register their preferences with AFMPC by telephone, letter, or fax.

On the enlisted side, the number of assignments is too massive to make an electronic bulletin board practical, but Colonel Gordon says a similar improvement is in the works for airmen—at least for overseas returnees.

Traditionally, AFMPC has worked overseas returns in six two-month cycles per year. Now it is moving to four quarterly cycles. This will buy assignment officials added time to send job listings to base personnel offices showing which positions AFMPC will be working in that particular cycle. For the first round, Colonel Gordon says, the lists will show some 9,000 jobs.

He explains the change this way: "In the past, say an administrative clerk was due to come home from Germany. He filled out his assignment preference form knowing that admin clerks are used in Washington state and Texas. He didn't know, however, whether we would be assigning admin clerks to those openings during that particular time period.

"Now he will be able to look at the job listings for his rotation cycle and see exactly what assignments will be worked for his grade and career field for that cycle. He'll have far better information on which to base his preference statement and tell us which of the assignments he would like."

Better information will become even more important as bases close and overseas withdrawals begin. Although actual closings are a year or so away, Colonel Gordon says, AFMPC is already limiting assignments to bases it expects to shut down. Closer to the closing dates, it will send teams to give briefings on the phaseout plans. The teams will return later to work the actual assignment actions.

Not surprisingly, the public drawdown order and rumors of additional cuts have left many members nervous. However, officials say, neither recruiting nor retention figures so far suggest any major disillusionment with Air Force career opportunities.

On the recruiting front, USAF has had little trouble meeting most goals, particularly in the nonprior-service airman area. Those goals are far lower than in the past, but officials find the sustained high quality of applicants surprising. The only serious recruiting shortfalls, they say, have been among physicians, nurses, and some specialties in the Biomedical Sciences Corps. Retention rates are not the best they have seen, officials say, but these too are better than might otherwise be expected.

General McPeak concedes that the no-RIF approach may create future retention problems as the pool of career-eligibles shrinks, but he says that the Air Force has a good record for holding needed people. He is convinced that, given adequate incentives, it still can meet its needs.

It is already evident, however, that the Air Force will rely more on its civilian and reserve forces. Some cuts are forecast among civilian employees in depots and similar facilities, but they probably will not be as heavy as those in the uniformed services, and most will be made by attrition. The Air Force Reserve and Air National Guard will take some hits, but these also will be lighter than those experienced by the active-duty force. In fact, General McPeak says, the Guard and Reserve, already carrying a heavy load in such areas as airlift, will make up a larger fraction of the total force and take on an even bigger part of the overall job. After Operation Desert Storm, Guardsmen and Reservists should be aware that they will play an active role in any future crisis.

Managing a shrinking force may not have been General McPeak's dream when he entered the service thirty-five years ago. He does, however, have one consolation: It could be worse. He takes note of the similar drawdown in the armed forces of the Soviet Union and concludes, "Their job is a lot tougher. I was there recently talking to their people. I wouldn't trade jobs with them for anything." ■

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A Checklist of Major Aeronautical Systems

Aeronautical works in progress at the Air Force's major program offices, Aeronautical Systems Division, and Wright Laboratory, Wright-Patterson AFB, Ohio

Advanced Cruise Missile System Program Office

AGM-129A Advanced Cruise Missile
Program to develop a second-generation strategic ALCM with increased range, accuracy, and stealth features. Designed for use by B-52 and B-1B bombers. **Contractors:** General Dynamics (GD), Williams, McDonnell Douglas (MD). **Status:** Production.

Aeronautical Equipment System Program Office

Air Base Operability
Development and production of equipment to enhance survivability of air bases: camouflage, concealment, deception, decoys, and contingency airfield lighting. **Contractors:** Many. **Status:** R&D, production.

Avionics Modernization Decision Process
Structured technical and management review to recommend lead acquisition organization for Class IV–V modifications to initiate major weapon system improvements more effectively. **Contractor:** In-house. **Status:** Continuing.

Avionics Subsystems
Acquisition of avionics systems common to many aircraft; standard components. **Contractors:** Many. **Status:** R&D, production.

Common Support Equipment
Production of ground-support equipment capable of supporting many types of aircraft, ground power generator system, and advanced X-ray system. **Contractors:** Many. **Status:** R&D, production.

Embedded Computer Standardization Program
Program to develop and acquire software support tools (*e.g.*, compilers, linkers, debuggers) for weapon system acquisitions that use MIL-STD-1815A Ada language and MIL-STD-1750 computer instruction set architecture. **Contractor:** Boeing Military Airplane Co. **Status:** Development.

Fasteners, Actuators, Connectors, Tools, Subsystems
Development and production of improved FACTS parts to enhance weapon system and subsystem performance, reliability, and service life. **Contractors:** Many. **Status:** R&D, production.

Modular Automatic Test Equipment System
Management system to govern procedures, architecture, hardware, and software in systems that use automatic test equipment. **Contractors:** Many. **Status:** Continuing.

Productivity, Reliability, Availability, and Maintainability Program
Program to increase combat power and reduce support costs of the Air Force by improving equipment efficiency and exploiting lower lifetime cost alternatives. **Contractors:** Many. **Status:** Continuing.

Reliability and Maintainability Technology Insertion Program
Program to develop and accelerate incorporation of promising new technology into current and future systems. **Contractors:** Many. **Status:** Continuing.

B-2 System Program Office

B-2A Bomber
Development of a four-engine, low-observable, flying-wing type of strategic penetrating bomber, designed specifically to elude enemy air defenses. Supplements, then supplants, B-1 in penetrating role. Plans call for building 75 two-place intercontinental-range B-2s. B-2 design and manufacturing program has made extensive use of computer-aided design and manufacturing. Initial operational capability scheduled for the mid-1990s. **Contractors:** Northrop, Boeing, LTV, GE, Hughes, Link. **Status:** FSD/low-rate initial production.

C-17 System Program Office

C-17A Aircraft
Development and production of new airlifter to augment C-5, C-141, and C-130. Will be used for rapid intertheater deployment of Army and other units directly to overseas areas and airlift of outsize cargo over both intertheater and intratheater ranges with the ability to take off and land at small, austere airfields. **Contractors:** MD, Pratt & Whitney (P&W). **Status:** FSD, initial production.

EC/Reconnaissance System Program Office

Advanced Strategic and Tactical Expendables
Program to develop near-term and longer-term infrared expendables for a variety of USAF aircraft. **Contractor:** None. **Status:** Pre-FSD.

Advanced Tactical Air Reconnaissance System
Development of electro-optical and infrared sensors, digital recorders, and management system for reconnaissance aircraft, UAVs, and fighter aircraft pods. **Contractor:** Martin Marietta. **Status:** FSD.

Air Force Electronic Warfare Evaluation Simulator
Hybrid digital/RF simulator that provides a terminal engagement environment for testing electronic combat systems. Program is being transferred to Air Force Development Test Center (AFDTC), Eglin AFB, Fla. **Contractor:** GD. **Status:** FSD.

Airlift Defensive System
Class V installation of threat warning and countermeasures dispenser systems for MAC aircraft. **Contractor:** None. **Status:** FSD.

EF-111A System Improvement Program
Upgrades the EF-111A Tactical Jamming System (TJS), ALQ-99E, to maintain its capability against the growing number and sophistication of threat radars and to improve its operational availability. **Contractor:** Grumman. **Status:** FSD.

Follow-On Wild Weasel
Investigation of alternatives for replacement of F-4G. **Contractor:** None. **Status:** Concept exploration.

Real-Time Electromagnetic Digitally Controlled Analyzer and Processor
Program to develop hybrid digital/RF simulator that provides an Integrated Air Defense System (IADS) environment for testing electronic combat systems. Program is being transferred to AFDTC. **Contractor:** Arvin Calspan Corp. **Status:** FSD.

Seek Spartan
Initiative to examine the application of threat warning capabilities on USAF, Navy, and Army aircraft using Integrated Electronic Warfare System technology. **Contractor:** None. **Status:** Pre-FSD.

SOF Defensive Avionics System
Development, prototype, and test of an infrared countermeasures system for Special Operations Forces/Airlift aircraft. **Contractor:** None. **Status:** Pre-FSD.

Tactical Countermeasures Dispenser Upgrade (AN/ALE-47)
USAF-Navy program to provide dispenser that can operate together with radar warning receivers and missile warning systems. **Contractor:** Tracor. **Status:** FSD.

TR-1 Ground Station
System to receive and process data collected by TR-1 sensors. **Contractor:** Loral. **Status:** FSD.

F-15 System Program Office

F-15 Radio Frequency Compatibility Program
An effort to improve interoperability of tactical electronic warfare system (TEWS) with F-15 radar, weapons, and avionics. **Contractors:** MD, Loral, Northrop. **Status:** Development.

F-15E Dual-Role Fighter
Two-seat upgraded version of F-15 to provide long-range, day/night, fair/foul weather delivery of air-to-ground munitions as well as air-to-air capability. Includes advanced cockpit technology, LANTIRN, ring-laser gyro guidance, conformal fuel tanks, reconfigured engine bay, Increased Performance Engines, and upgraded TEWS. Weapons integration efforts include PGM, HARM, and AMRAAM. **Contractors:** MD, P&W. **Status:** Development, production, deployment, modifications.

Memory/Radar Module Test Station
New depot test systems to support the F-15's new APG-70 radar and F-15E avionics. **Contractor:** MD. **Status:** Production.

Mobile Electronic Test Set
Initiative to enhance supportability and mobility of the F-15E Avionics Intermediate Shop. **Contractor:** MD. **Status:** Production.

Program Loader Verifier
Used to load and verify operational flight programs (OFPs) and preflight messages (PFMs) at the flight line. **Contractor:** MD. **Status:** Production.

Tactical Electronic Warfare System Intermediate Support System
Program to provide test system to support all configurations of F-15 TEWS. **Contractor:** MD. **Status:** Production.

Tactical Electronic Warfare System P^{3}I
Program to improve ALR-56C radar warning receiver, ALQ-135 internal countermeasures set, and ALE-45 countermeasures dispenser on F-15. **Contractors:** Loral, Northrop, Tracor. **Status:** Development, production, deployment, modification.

F-16 System Program Office

F-16 Multimission Fighter
A single-engine, lightweight, high-performance, tactical fighter with an air-to-air and air-to-surface multirole capability that can be deployed from the continental US to any possible trouble spot in the world with minimum en-route support, high reliability, and simplified maintenance procedures to ensure successful operation under austere conditions. The program involves 17 foreign nations, more than 50 distinct aircraft configurations, and extensive foreign coproduction, making it the largest, most complex acquisition program in the Department of Defense. **Contractors:** GD, P&W, GE, SABCA (Belgium), Fokker (Netherlands), Fabrique Nationale (Belgium), Norsk Forsvarsteknologi (Norway), Philips (Netherlands), TAI (Turkey). **Status:** Development, production, deployment.

F-22 System Program Office

F-22 Advanced Tactical Fighter
Development of the Air Force's next-generation air-superiority fighter. Flight testing of the engineering and manufacturing development (EMD) aircraft will begin in 1995, and the F-22 will begin operational service in 2002. The F-22 will include advanced propulsion, flight controls, and fire controls; significant avionics integration; advanced system survivability features; designed supportability characteristics; low-observable technologies; superior subsonic and supersonic maneuverability; supersonic persistence without use of afterburners; and greatly increased combat radius. Powered by two F119-PW-100 advanced technology fighter engines. **Contractors:** Lockheed/Boeing/GD, P&W. **Status:** EMD.

Flight Training System Program Office

Enhanced Flight Screener
Acquisition of 125 aerobatic piston aircraft to support the Pilot Selection and Classification System. **Contractor:** None. **Status:** RFP preparation.

Joint Primary Aircraft Training System
Program to acquire "missionized," nondevelopmental aircraft and associated ground-based components to replace USAF T-37B and Navy T-34C training system components. **Contractor:** None. **Status:** Acquisition strategy planning.

T-1A Training System
Program to acquire 180 Beech 400T aircraft (T-1A Jayhawk), 11 simulators and other training devices, and courseware to support specialized undergraduate pilot training. To be used by ATC to train student pilots in skills essential for flying military tanker and transport aircraft. **Contractors:** MD Training Systems, Beech, Quintron. **Status:** Courseware—development; aircraft and simulator—production.

LANTIRN System Program Office

LANTIRN System
Production of two-pod navigation/targeting system for night, under-the-weather ground attack by F-15E and F-16C/D aircraft. Navigation pod with FLIR provides a video display of terrain in an aircraft's flight path on the HUD, and a terrain-following radar (TFR) provides the pilot with flight cues as warnings of obstacles. Targeting pod with FLIR provides aircrews with infrared target detection and tracking and laser designation/range-finding. It is used for precision munitions deliveries. LANTIRN Mobility Shelter Set (LMSS) provides intermediate-level maintenance capability. The Paperless LANTIRN Automated Depot (PLAD) provides computer integrated repair (CIR) and data collection in a paperless environment. **Contractor:** Martin Marietta. **Status:** Production.

National Aerospace Plane Joint Program Office

National Aerospace Plane
DoD-NASA research program aimed at developing and demonstrating

single-stage-to-orbit (SSTO) and hypersonic flight technologies for a new generation of aerospacecraft capable of flying in the atmosphere and low Earth orbit. Development and flight test of a technology demonstrator, the X-30, in horizontal takeoff, hypersonic flight, and SSTO flight. **Contractors:** NASP National Team, comprising GD, MD, North American Aircraft, P&W, and Rocketdyne. **Status:** Technology development.

Propulsion System Program Office

Engine Component Improvement Program
Continuing engineering support for all air-breathing engines used in manned USAF aircraft. **Contractors:** All major engine firms. **Status:** Continuing.

F100-PW-229 Engine for F-15 and F-16
Increased Performance Engine (IPE) version of the existing F100 being developed for the F-15 and F-16 in the 1990s. Greater thrust and reliability. **Contractor:** P&W. **Status:** Production.

F110-GE-129 Engine for F-15 and F-16
IPE version of the existing F110 also being developed for the F-15 and F-16. Will compete with P&W in engine buys of the 1990s. **Contractor:** GE. **Status:** Production.

F112-WR-100 Engine for Advanced Cruise Missile
Production of a small turbofan engine for the second-generation strategic cruise missile. **Contractor:** Williams. **Status:** Production.

F117-PW-100 Engine for C-17
Development and acquisition of a version of the commercial PW-2040 turbofan engine, with 40,000 pounds of thrust, to power the C-17A aircraft. **Contractor:** P&W. **Status:** FSD.

Propulsion Technology Modernization
Insertion of state-of-the-art technologies in engine manufacturing systems to increase productivity and efficiency. **Contractors:** GE, P&W, Garrett, Williams, Teledyne, Allison. **Status:** Continuing.

Special Operations Forces System Program Office

AC-130U Gunship
Development of side-firing gunships with highly accurate gun suite and new ECM systems. Replacement for aging AC-130As in inventory. **Contractor:** Rockwell. **Status:** FSD.

C-130H Aircraft
Acquisition of C-130H aircraft for all US military and foreign military sales (FMS) customers. Averages 28 aircraft per year for such customers as Air National Guard, Air Force Reserve, US Navy Reserve, US Marine Corps Reserve, and Japan Air Self-Defense Force. **Contractor:** Lockheed. **Status:** Production.

Integrated Avionics Testers
Acquisition of automatic test equipment for support of various SOF aircraft (AC-130U, AC-130H, and MC-130H, initially). **Contractor:** TBD. **Status:** Working toward contract awards in 1992.

Joint Vertical Lift Aircraft (CV-22A)
Development of tiltrotor V/STOL aircraft combining the versatility of a helicopter with the speed of a high-performance turboprop airplane. Will significantly enhance SOF long-range infiltration/exfiltration capability. **Contractor:** Bell-Boeing Tiltrotor Team. **Status:** FSD.

MC-130H Aircraft
Acquisition of 24 aircraft with integrated avionics, improved navigation, terrain-following radar, and ECM. Will augment Combat Talon I SOF aircraft. **Contractors:** Lockheed, IBM. **Status:** Production.

MH-60G Pave Hawk
Acquisition and modification of Army UH-60A helicopters for special operations, rescue, and tactical air control. Contains aerial refueling capability and additional avionics. **Contractor:** Sikorsky. **Status:** Production.

Systems Program Office

Airdrop Development Program
Development, test, and production of improved airdrop systems for C-130 and C-141. **Contractors:** Ver-Val, Douglas. **Status:** Production.

Air Force Infrared Maverick (AGM-65D)
Precision guided, launch-and-leave, air-to-ground weapon to counter armored vehicles and fortified structures. **Contractors:** Hughes, Raytheon. **Status:** Production.

Air Force Infrared Maverick (AGM-65G)
Incorporates unique tracking algorithms and a pneumatic actuation system in the standard Maverick. **Contractors:** Hughes, Raytheon. **Status:** Production.

C-21A Aircraft
Modification of 83 Learjet aircraft with Digital Electronic Engine Controls. **Contractor:** Learjet Corp. **Status:** Modification.

C-26B
Acquisition and support of a total of 53 Fairchild Metro III aircraft (if all options are exercised) to provide operational airlift support. **Contractor:** Fairchild Aircraft. **Status:** 23 on contract as of FY 1991 with options for 30 in FY 1992–94.

C-27A Aircraft
Acquisition of ten commercially available STOL aircraft with options for eight others. These will provide US Southern Command with rapid-response intratheater airlift of personnel and cargo to remote locations accessible primarily through unimproved airfields with short, unpaved landing surfaces. **Contractor:** Chrysler Technologies Airborne Systems, Inc. **Status:** Production, delivery.

C-29A Aircraft
Acquisition of six commercial, FAA-certified, business jet aircraft with state-of-the-art flight-inspection systems to provide worldwide, all-weather, certified instrument approaches; traffic control and landing systems equipment; and air-to-ground communications in wartime operations. **Contractor:** LTV Aerospace. **Status:** Production.

Cruise Missile Mission Control Aircraft
Class II modification of two EC-18s to support USAF and USN cruise missile test missions. **Contractor:** Chrysler Technologies Airborne Systems Inc. **Status:** Development.

C-SAM
Acquisition of up to three additional C-20-type aircraft for the 89th Airlift Wing for use by high-ranking government officials. **Contractor:** Gulfstream Aerospace. **Status:** Production.

F/EF-111 Digital Flight-Control System Program
Class IV-A safety modification to develop, test, and produce a digital flight-control computer to replace the current analog flight-control computers. Also replaces the angle-of-attack transmitters and normal accelerometers for improved reliability. **Contractor:** GD. **Status:** Production.

F/RF-111C Digital Flight-Control System
FMS case to provide the F-111 Digital Flight-Control System to the Royal Australian Air Force. **Contractor:** None. **Status:** Proposal evaluation.

KC-10A On-Board Loader
Development and production of an air transportable loader for the KC-10A capable of deployment with the aircraft. Loader will provide upload/download capability for palletized cargo in austere locations. **Contractor:** None. **Status:** Development.

KC-10 Wing Pods
Modification of KC-10A aircraft with two wingtip aerial refueling hose reel pods to provide simultaneous air refueling to Navy/NATO aircraft. **Contractor:** MD. **Status:** Modification.

KC-135 Improved Aerial Refueling System
Development and test of new aerial refueling systems and subsystems. **Contractor:** None. **Status:** Development.

KC-135 Wing Pods
Modification of KC-135 aircraft with two wing-mounted air refueling hose reel pods to provide simultaneous air refueling of probe-equipped aircraft. **Contractor:** TBD. **Status:** Concept validation.

Navy Infrared Maverick (AGM-65F)
Incorporation of a ship-track algorithm and heavyweight penetration/blast warhead into the design, resulting in a Maverick that the Navy can employ against its sea/land target spectrum. **Contractors:** Hughes, Raytheon. **Status:** Limited production.

Navy Laser Maverick (AGM-65E)
Precision guided, close air support weapon with heavyweight penetration/blast warhead homes in on reflected laser radiation generated by either ground or airborne laser designators. **Contractor:** Hughes. **Status:** Limited production.

VC-X
Replacement of seven aging VC-137 aircraft, which support the travel requirements of the Vice President, cabinet members, members of Congress, and other high-ranking dignitaries, with modern, long-range, high-volume aircraft. **Contractor:** None. **Status:** RFP development.

Training Systems Program Office

Air Defense Fighter Training System
Procurement of system for training of air defense crews. **Contractor:** GD. **Status:** Development, acquisition.

B-1B Simulator System
Development and production of system to train all B-1B crews. Includes five weapon system trainers that simulate all four crew positions, two mission trainers that simulate only the offensive/defensive positions, and cockpit procedures trainers. **Contractor:** Boeing. **Status:** Production.

C-5/C-141 Aerial Refueling Part-Task Trainer
Development of one prototype and production of six units to provide visual, audio, and flight-control cues for realistic air-refueling training. **Contractor:** Reflectone. **Status:** Production, deployment.

C-17 Aircrew Training System
Development and production of a total aircrew training system for C-17A aircrews. **Contractor:** MD Training Systems. **Status:** Development, acquisition.

C-17 Maintenance Training Devices
Development and acquisition of five suites of devices to certify C-17A maintenance personnel without using the aircraft. **Contractor:** ECC. **Status:** Development, acquisition.

C-130 Aircrew Training System
Development and acquisition of a totally integrated aircrew training system that encompasses the continuum of training from initial entry through refresher and continuation training. **Contractor:** CAE-Link. **Status:** Production, deployment.

C-141 Aircrew Training System
Development and acquisition of a total aircrew training system for C-141 crew members from initial entry through ongoing continuation training. **Contractor:** Hughes. **Status:** Development, acquisition.

F-15E Weapon System Trainer
Production of four F-15E WSTs for initial entry level through advanced aircrew training. Contains high-resolution sensor displays, electro-optical/infrared weapons delivery, and LANTIRN capability for air-to-ground and low-level training. **Contractor:** Loral. **Status:** Production.

F-16 Weapon System Trainer
Procurement of operational flight trainers, improved digital radar landmass simulators, improved electronic warfare training devices, visual systems, and various LANTIRN simulators. **Contractors:** CAE-Link, GE, AAI, E&S. **Status:** Acquisition.

F-22 Trainer
Comprehensive analysis to develop training system concept to meet requirements for F-22. **Contractor:** Lockheed/GD/Boeing. **Status:** Development, acquisition.

Joint Primary Aircraft Training System (JPATS)
Ground-Based Training System
Development and production of a total aircrew training system for JPATS. **Contractor:** None. **Status:** Pre–concept analysis.

Joint Surveillance Target Attack Radar System (Joint STARS)
Development and acquisition of a total aircrew training system for Joint STARS. **Contractor:** TBD. **Status:** Development.

KC-135 Aircrew Training System
Development and acquisition of a totally integrated aircrew training system that encompasses all training from initial entry through refresher and continuation training. **Contractor:** TBD. **Status:** Source selection.

Light Combat Aircraft
FMS case with government of India for supplying aircraft components for Indian production of the Light Combat Aircraft. **Contractor:** None. **Status:** Concept definition.

Modular Simulator Design Program
Program to explore uses of microcomputers and high-speed data communications in modular flight simulators. **Contractor:** Boeing. **Status:** Development.

Simulator Data Integrity Program (SDIP)
Program to explore ways to improve the flow of source data from the weapon system program to the training system program. **Contractor:** Simtec, Inc. **Status:** Development.

Simulator for Electronic Combat Training (SECT)
Development and acquisition of simulator to train Electronic Warfare Officers. **Contractor:** TBD. **Status:** Development.

Special Operations Forces Aircrew Training System
Development and production of a total aircrew training and mission-rehearsal system for MC-130H/E, AC-130H/U, MH-53J, HC-130H/P/N, MH-60G, and V-22 crew members. **Contractor:** Loral. **Status:** Development, acquisition.

Standard DoD Simulator Digital Database (Project 2851)
Triservice-sponsored and -approved program to develop database standards, production capability, and central library to support training and mission-rehearsal systems for all services. **Contractor:** Planning Research Corp. **Status:** Development.

T-1A Training System (Ground-Based Training System)
Development and production of a total aircrew training system for the T-1A. **Contractors:** MD Training Systems, Quintron. **Status:** Development, acquisition.

Visual Evaluation
Program to evaluate various display technologies for training effectiveness. **Contractor:** TBD. **Status:** Source selection.

Wright Laboratory/Aeropropulsion Directorate

Advanced Turbine Engine Gas Generator
Program to assess new core engine components, advanced structures, and material technologies in a true large-thrust-class engine environment. **Contractors:** Allison, GE, P&W. **Status:** Advanced development.

Air-Breathing Missile Propulsion
Program to develop and demonstrate "wooden round" propulsion concepts for air-to-air and air-to-ground missile applications. **Contractors:** Atlantic Research, Hercules, Hughes, UTC's Chemical Systems Division. **Status:** In-house research, exploratory and advanced development.

Aircraft Power
Demonstration of new-generation conditioning and distribution technologies needed for more electronic power systems for current and future aircraft. **Contractors:** Many. **Status:** In-house research, exploratory and advanced development.

Aviation Fuel and Lubricants
Program to develop fuels, fuel systems, and lubricants for subsonic, supersonic, and hypersonic aircraft and missiles powered by air-breathing engines. Stresses high-heat-sink and endothermic fuels and high-temperature lubricants. **Contractors:** Many. **Status:** In-house research, exploratory and advanced development.

Combustion
Program to provide experimental data and advanced design codes for turbine engine and ramjet combustors. Extensive application of optical diagnostic techniques and computer modeling. **Contractors:** SRI, U. of Dayton Research Institute. **Status:** Research, exploratory development.

High-Speed Propulsion
Program to develop an Air Force capability for manned and unmanned flight at very high speeds using combined cycle air-breathing engines and logistically supportable fuels. **Contractors:** UTRC, CSD, and others. **Status:** Research, exploratory development.

Integrated High-Performance Turbine Engine Technology Initiative
National program to develop and demonstrate revolutionary advances in turbine engine technology that will double current propulsion capability. **Contractors:** Many. **Status:** In-house research, exploratory and advanced development.

Joint Expendable Turbine Engine Concepts
Interservice program to develop demonstrator engines to help define future technology requirements for small, unmanned, limited-life vehicles. **Contractors:** Allison, Garrett, Teledyne, Williams. **Status:** Advanced development.

Joint Technology Demonstrator Engine
Interservice program to develop large-thrust-class demonstrator engines combining advanced high-pressure cores from ATEGG with advanced low-pressure and adaptive components. **Contractors:** GE, P&W. **Status:** Advanced development.

Joint Turbine Advanced Gas Generator
Interservice program to assess new core engine components, advanced structures, and material technologies in a true, small- to medium-thrust-class engine environment. **Contractors:** Lycoming, GE/Garrett. **Status:** Advanced development.

Plasma Physics
Program to investigate the fundamental properties of plasmas for application to thin film deposition, high-power switches, and advanced lasers. **Contractors:** SRI, U. of Chicago, Wright State U. **Status:** Research, exploratory development.

Spacecraft Power Technology
Program planned and executed in conjunction with Phillips Laboratory to provide evolutionary and revolutionary improvements in spacecraft power systems and thermal management technologies. **Contractors:** Many. **Status:** In-house research, exploratory and advanced development.

Special-Purpose Power
Initiative to provide airborne, mobile baseload pulsed power and energy storage technology for special-purpose loads, such as high-power microwaves, electromagnetic launchers, radars, and accelerator systems. **Contractors:** Many. **Status:** In-house research, exploratory and advanced development.

Survivable Solar Power System
Initiative to design, fabricate, and test a survivable solar power and energy storage system for use in space. **Contractor:** Martin Marietta. **Status:** Advanced development.

Wright Laboratory/Avionics Directorate

Advanced Avionics Reconfiguration Technology
Development and application of neural computing methods for RF threat alert. Addresses parametric and intrapulse information domains as well as information correction. **Contractors:** Booz-Allen Hamilton, Georgia Tech Research Institute. **Status:** Development.

Advanced Tracking Algorithm Development
Program will improve tracking accuracies of current and future fire-control sensors through the use of multiple hypothesis tracking techniques. This program will develop a software upgrade for an operational sensor and evaluate system tracking performance in a laboratory evaluation. **Contractor:** Hughes. **Status:** Advanced development.

Airborne Imagery Transmission
Development of a modular, wideband, multisensor, low probability of intercept, jam-resistant, air-to-air data link for transmission of reconnaissance imagery or digital data. **Contractor:** Unisys. **Status:** Development.

Air-to-Air Attack Management
Program to develop an advanced automated fire-control system for beyond-visual-range, air-to-air combat with an automated sensor manager and internetted flight capability. This system is designed for air superiority in a few-vs.-many scenario. **Contractor:** Northrop. **Status:** TAC pilot-in-the-loop simulation.

Air-to-Air Covert Sensor Technology
Definition and design of future covert electro-optical sensor subsystem to enhance situational awareness by providing missile warning, acquisition, tracking, and identification functions. **Contractor:** Honeywell. **Status:** Development.

Automatic Radar Air-to-Ground Target Identification Program
Two-phased effort to design, build, and demonstrate all-weather target identification of ground-mobile targets using synthetic aperture radar imagery, model-based vision techniques, and massively parallel computing techniques. **Contractor:** Martin Marietta. **Status:** Development.

Automatic Radar Target Identification
Three-phased effort to produce and demonstrate an air-to-air identification system using one-dimensional radar signatures. **Contractor:** GD. **Status:** Advanced development.

Automatic Target Recognizer Development Tools
Effort to develop a test-bed for algorithm development, evaluation, and understanding. This test-bed will become an essential part of the program for transition to a real-time ATR. **Contractor:** TBD. **Status:** Advanced development.

Concealed Target Detection Technology Program
Two-phased program to develop and demonstrate airborne radar technology required to detect strategic and tactical targets concealed by foliage and camouflage. **Contractors:** ERIM, Loral. **Status:** Concept definition.

Digital EW Receiver
Development of a wideband EW receiver in which the baseboard frequency is digitized, thus allowing all subsequent receiver functions to be performed digitally. **Contractor:** TBD. **Status:** Development.

Dual Band FLIR
Program to develop an integrated imaging sensor for a single forward-looking infrared (FLIR) for aircraft piloting, reconnaissance, target acquisition, and weapon delivery applications. **Contractors:** Hughes, Martin Marietta, Rockwell. **Status:** Advanced development.

Electronic Combat Multifunction Radar Technology
Program to develop ECCM technology for robust airborne radar performance in post-1995 threat environments. Uses wide, tunable bandwidth and adaptive waveforms. **Contractors:** Hughes, Raytheon. **Status:** Exploratory development.

Embedded Computer Resources Support Improvement Program
Development of software support technologies to reduce costs, improve turnaround capability, and provide software supportability. New technology insertion for support of current, new, and retrofit weapons platforms. **Contractors:** In-house, TRW, Westinghouse, JFTaylor, Hughes, Analytic Sciences Corp. **Status:** Development.

Gallium Arsenide Preprocessor Prototype
Development of a high-performance preprocessor for such applications as infrared missile warning (IRMW), FLIR, and automatic target recognition. **Contractor:** Martin Marietta. **Status:** Development.

High-Power Countermeasures
Definition, development, and flight test of a long-range standoff jamming capability. Elements include very high effective radiated power and fast-switching, narrow-beamwidth, multiple-beam jamming. **Contractor:** Raytheon. **Status:** Completed preliminary flight testing.

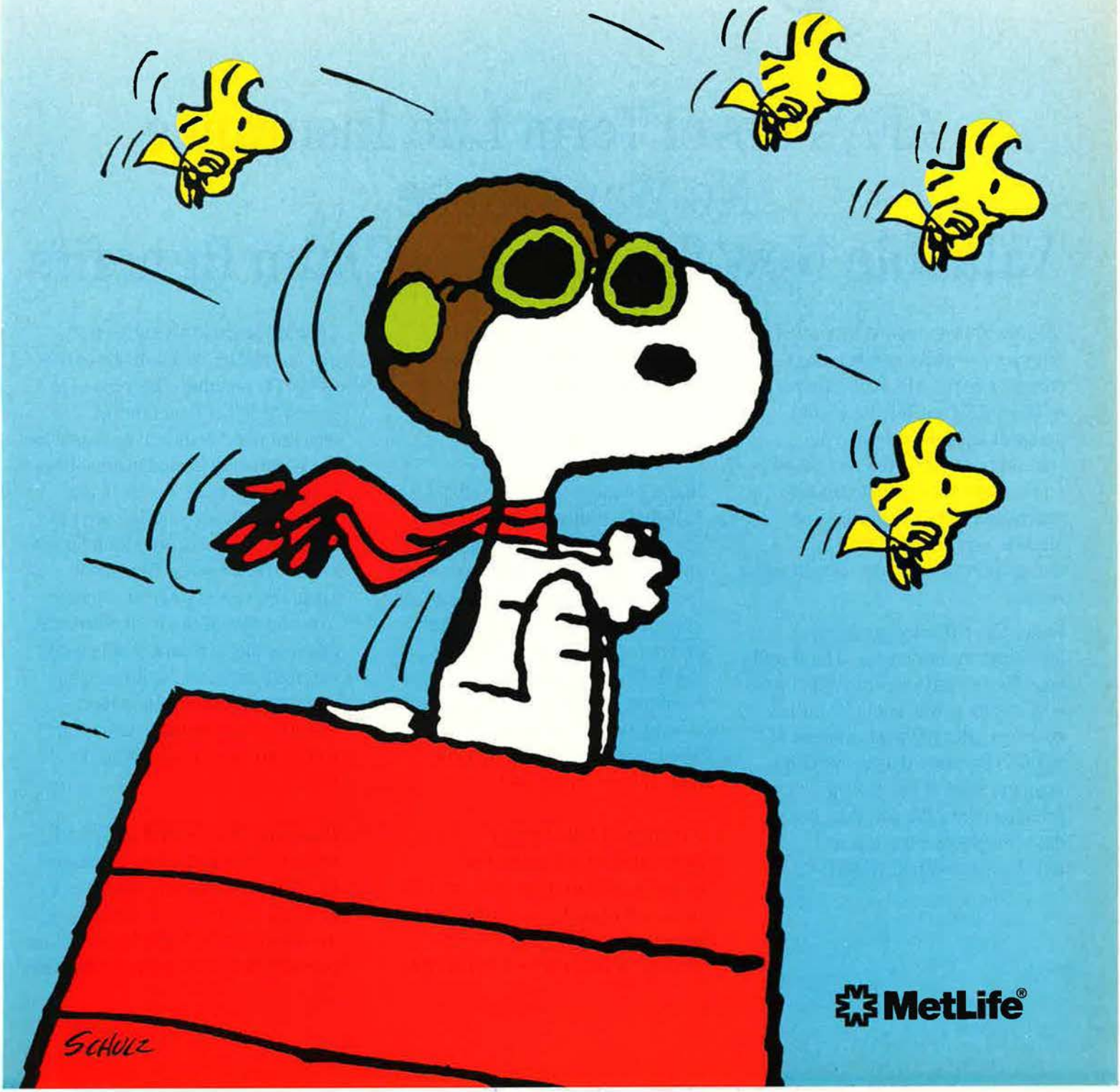
Integrated Electronic Warfare Analysis and Modeling
Program to analyze, evaluate, and model RF/EO/IR countermeasures concepts and EW advanced development prototype hardware. **Contractor:** SAIC. **Status:** Development.

Intra-Flight Data Link
Program to develop and demonstrate a covert, jam-resistant, secure LPI wideband common avionics situational awareness data link for intra- and interflight sharing of multisensor information. **Contractors:** ITT, Unisys/TRW. **Status:** Development.

Laser Warning
Program to analyze, develop, and test technology for threat warning of hostile laser systems. Emphasis on robust, low-cost, reliable techniques and designs. **Contractor:** None. **Status:** Ongoing in-house project.

Low Probability of Intercept Radio Brassboard
Development and demonstration of the feasibility of a cost-effective,

America's Favorite Flying Ace Reports To AFA With MetLife® And Powerful New Security Weapons For Members!



AFA's Level Term Life Insurance No War Clause... Valuable New Service And Claim Benefits

AFA has always stood in support of America's security, and in today's changing world, AFA is also prepared to assist with the defense of your personal financial security. On December 31, 1991 AFA was joined on the front lines of that effort by America's favorite flying ace and MetLife, one of the largest underwriters of life insurance in the world.

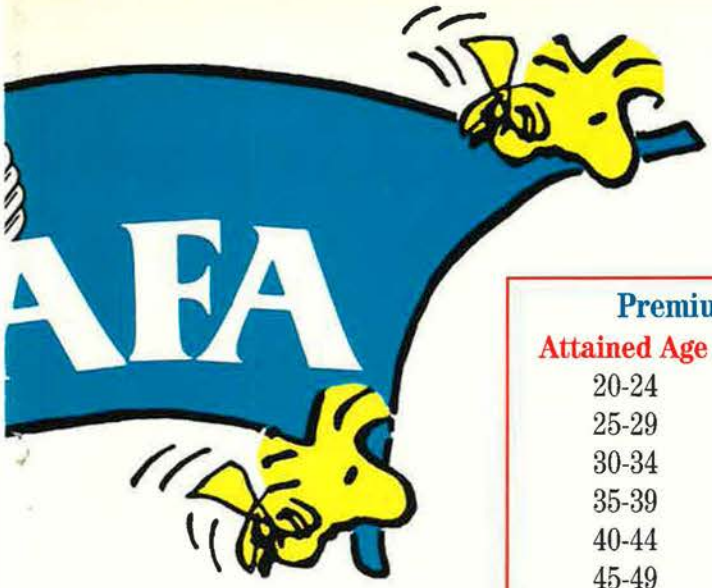
Under this enhanced program of level term insurance, these improved benefits and services are available to AFA members who apply for initial coverage prior to the attainment of age 65. (Coverage may be retained, upon payment of the appropriate premium, until the premium due date coincident with or next following the 80th birthday):

No War Clause: There is no limitation on benefits payable in the event of the death of an insured person as a result of an act of declared or undeclared war.

High Coverage: Coverage of up to $240,000 is available, in units of $20,000. All AFA members under the age of 65 may apply for this coverage (or for increased coverage, if already insured under the program). At the premium due date coincident with or next following the insured person's attainment of age 65, the amount of coverage will drop to the lesser amount of 50 percent of benefits then in force, or $20,000.

Expedited Claim Service: Depending on the amount of coverage, a draft of up to $5,000 can be issued immediately to the insured person's beneficiary on the same day as proof of death is received at AFA. Benefits beyond this initial draft amount will be issued in one of two forms: for remaining benefits of at least $10,000, a Total Control Account checkbook will be issued to the beneficiary to enable him or her to have immediate access to the death benefit without the worry of having to find a secure haven for the funds. The account will bear an attractive rate of interest, accrued from the date of the insured's death, and no delay in payment of benefits will result from this approach. For remaining benefits of less than $10,000, a traditional benefit draft will be provided promptly to the beneficiary.

Disability Waiver Of Premium: If, while insured and under the age of 60, you become totally disabled, coverage will be continued in force upon approval by MetLife. No further premium will be due for the duration



Premium Rate Schedule
Premiums shown are for each $20,000 unit of coverage. Up to twelve (12) units of coverage may be requested.

Premium Rate Schedule (per $20,000 unit of coverage)

Attained Age	Monthly*	Quarterly	Semi-Annual	Annual
20-24	$ 1.16	$ 3.48	$ 6.96	$ 13.92
25-29	1.32	3.96	7.92	15.84
30-34	1.84	5.52	11.04	22.08
35-39	2.52	7.56	15.12	30.24
40-44	4.00	12.00	24.00	48.00
45-49	6.68	20.04	40.08	80.16
50-54	10.00	30.00	60.00	120.00
55-59	14.32	42.96	85.92	171.84
60-64	22.16	66.48	132.96	265.92
65-69	50.00	150.00	300.00	600.00
70-74	80.00	240.00	480.00	960.00
75-79	100.00	300.00	600.00	1,200.00

RENEWAL RATES ONLY

*Only by government allotment or by automatic payments to an AFA/VISA or MasterCard account.

of the disability, or until you reach the limiting age under the plan.

Conversion Privilege: At age 65, when coverage reduces, or at age 80, when it terminates, you may convert this insurance within 31 days of the then-current premium due date to any permanent plan of insurance then being offered by MetLife, regardless of your health at that time. The amount of your coverage may not be greater than the amount of your coverage under the group plan at the time of conversion.

Limitation: Benefits under this policy will not be effective if death results from intentionally self-inflicted injuries, whether the insured person is sane or insane, within one year from the date the insurance on that person becomes effective, or, with respect to increased amounts of insurance only, one year from the effective date of such increase. Additionally, the plan provides a reduced benefit (equal to 50 percent of the level term life insurance benefit in force) for members under age 35 who are killed in an aviation accident while operating the aircraft involved.

Apply Today!

Special Notice To All Insured AFA Members

Effective 12:01 a.m. December 31, 1991, MetLife assumed underwriting responsibilities for all AFA sponsored group insurance programs. Notification of the change and replacement certificates have been sent to all program participants, but in the event they are not received by January 31, 1992, we request that you advise AFA's Insurance Division by phone, at 1-800-727-3337 or 1-703-247-5800; press '1' for insurance.

Application for AFA

AFA LEVEL TERM LIFE INSURANCE

Name (print) Last	First	Middle	[ ] Male [ ] Female	Group # 74571
Address Street	City	State	Zip Code	

Date of Birth Mo. Day Year	Height	Weight	Social Security #	Daytime Phone #	Flying Status ☐ Yes ☐ No

Primary Beneficiary (Name and Relationship) _____

Contingent Beneficiary (Name and Relationship) _____

Requested Amount of Coverage _____ (units) X $20,000 = $ _____ (amount of coverage)

Method and Amount of Payment

☐ **Monthly**

☐ Governmental Allotment (check here but compute quarterly payment (below) and submit with application); Instructions for requesting allotment will be sent with [policy] certificate.

☐ AFA/VISA/MASTERCARD credit card (Send no payment with application) Card # _____ Expire Date _____

☐ **Quarterly**
☐ **Semi-Annually**
☐ **Annually**
} $ _____ { Using the Premium Rate Schedule, indicate the premium rate per unit of coverage based on your current age and requested frequency of payments.

_____ **(units) X $** _____ **(premium rate per unit of coverage—see above) = $** _____ **(premium amount).**

1. Have you been hospitalized during the preceding 90 days? [ ] Yes [ ] No

2. In the past three years, have you received treatment or been told you had
   a) Cancer, Leukemia, Hodgkins Disease, or other associated malignancies? [ ] Yes [ ] No
   b) Heart Disease, stroke, or other related cardiovascular disease? [ ] Yes [ ] No

3. Within the past two years, have you had persistent cough, pneumonia, chest discomfort, muscle weakness, unexplained weight loss of ten pounds or more, swollen glands, patches in mouth, visual disturbance, recurring diarrhea, fever, or infection? [ ] Yes [ ] No

4. Has any application made by you for Life or Health insurance been declined, postponed, or issued other than as applied for? [ ] Yes [ ] No

5. Are you receiving, entitled to receive or would be entitled to receive upon timely application any benefits due to sickness or injury (other than medical expense benefits) under any private policy or plan or governmental program whether insured or non-insured? [ ] Yes [ ] No

If you answered "Yes" to any of the above questions, please give details, dates, diagnosis, treatment, and name and address of the health care provider(s) and hospital(s). Use additional sheet of paper if necessary.

Information in this application, a copy of which shall be attached to and made a part of my certificate when issued, is given to obtain the plan requested and is true and complete to the best of my knowledge and belief. I agree that no insurance will be effective until a certificate has been issued and the initial premium paid. I understand that coverage will not become effective until approved by MetLife.

I understand that if on the Effective Date I am not eligible for such insurance by reason of (i) age or (ii) membership status, insurance will not become effective on my life.

"Hospitalized" means inpatient confinement for: hospital care, hospice care or care in an intermediate or long term care facility. It also includes outpatient hospital care for chemotherapy, radiation therapy, or dialysis treatment.

Authorization to Furnish Medical Information

For underwriting and claim purposes, I hereby authorize any physician or other medical practitioner, hospital, clinic, other medically related facility, insurance company, or other organization to furnish MetLife, on my behalf, with information in his or its possession, including the findings, relating to medical, psychiatric or psychological care, or examination, or surgical treatment given to the undersigned. This authorization shall be valid for two years. A photocopy of this authorization shall be considered as effective and valid as the original.

Member Signature	Date

AFA

Send application with remittance to:
Insurance Division, AFA, 1501 Lee Highway, Arlington, Virginia, 22209-1198.
4571-G1–MetLife

MetLife®

1/92

PLEASE RETAIN THIS MEDICAL INFORMATION FOR YOUR RECORDS

MetLife's Consumer Privacy Notice—Information Practices

The Underwriting Process: MetLife (hereinafter "we") will evaluate the information given by you on this enrollment form and tell you if we cannot give you the coverage you asked for. We will also tell you in general terms the reason for our decision. Upon written request, more specific reasons will be given to you.
Information Collection: This enrollment form is our main source of information. To properly evaluate your request for coverage, we obtain additional medical data from third parties about any person to be insured. For instance, we may ask physicians, hospitals, or medical care providers to confirm or add to the medical data you have given us.
Information Disclosure: In most cases, the information we have about you will be sent to third parties only if you authorize us to do so. In some cases where disclosure is required by law or necessary for the conduct of our business, we may send the information to third parties without your consent.
Access and Correction Information: Upon written request, we will make information we have about you available to you. You have certain access and correction rights with respect to the information about you in our files.
Further Information About Our Practices: Upon written request, we will send you more information about our underwriting process and your access and correction rights. Also, upon your written request, we will give you more information about the circumstances under which we will disclose the information about you to third parties without your authorization. Please write MetLife at the following address about these matters.

Metropolitan Life Insurance Company, One Madison Avenue, New York, NY 10010-3690

multimode, LPI/antijam, secure airborne voice radio system. **Contractor:** QualComm. **Status:** Development.

Machine Intelligence (MI)
Program to use various MI paradigms and architectures to improve avionics system performance in such applications as automatic target recognition, adaptive flight control, communication, navigation, radar warning, and aircrew aiding. **Contractors:** Booz-Allen Hamilton, Martin Marietta, Georgia Tech, Draper. **Status:** Development.

Modular Avionics Maintenance Technology
Development and demonstration of an integrated diagnostics concept to address maintenance issues in JIAWG-type avionics. **Contractor:** TRW. **Status:** Development.

Multifunction CNI/EW Antenna System
Joint USAF-Navy development of broadband (2MHz–6GHz) beam-forming, frequency-sharing antenna system to service CNI/EW functions. **Contractor:** TRW. **Status:** Development.

Multiple Target Attack Program
Program to develop and demonstrate fire-control techniques for maneuvering attack of multiple targets in a single pass using advanced avionics and weapons. **Contractors:** MD, Hughes, Martin Marietta. **Status:** TAC pilot-in-the-loop simulation.

Multisensor Air Target Algorithm Development Test-Bed
Program to develop and test model-based visual target identification techniques for air-to-air applications. It will also explore active sensing (controlling one's own observables while obtaining a target ID). **Contractor:** TBD. **Status:** Advanced development.

Passive Expendables Analysis Measurements
Program to design, develop, and test passive or partially passive expendable/decoy ECM techniques for tactical and strategic applications. **Contractor:** None. **Status:** Ongoing in-house project.

Passive Velocity/Altitude Sensor
Program to design and demonstrate feasibility of a passive sensor to update inertial velocity and altitude errors for strategic bombers and cruise missiles. **Contractor:** Litton. **Status:** Development.

Pave Pace
Design and demonstration of key elements to enhance avionics architecture for the twenty-first century. Exploits potential of emerging technologies in parallel processing, opto-electronics, and integrated sensor architectures. **Contractors:** Boeing, Lockheed, McDonnell Aircraft. **Status:** Design.

Real-Time Artificial Intelligence System
Joint USAF-Army-NASA program to develop and demonstrate a modular computing system for real-time processing of artificial intelligence/expert systems applications for aiding aircrews. **Contractor:** IBM. **Status:** Development.

Silent Attack Warning System
Development of hardware to demonstrate a state-of-the-art infrared detection system for missile and aircraft warning. **Contractors:** GE, Loral, TI. **Status:** Flight testing.

Strapdown Stellar-Inertial System
Joint USAF-Navy-SDIO project to develop and demonstrate low-cost, strapdown star tracker systems for strategic/reconnaissance aircraft, ballistic missiles, and space-based systems. **Contractor:** Northrop. **Status:** Advanced development.

Strategic Targeting Laser Radar (LADAR) Technology
Development and demonstration of critical technologies and components needed to produce a CO_2 laser radar (LADAR) sensor that will permit manned aircraft to recognize and attack critical mobile targets. **Contractors:** Hughes, Rockwell. **Status:** Advanced development.

Superconductivity Application for EW
Evaluation of superconductivity application concepts and resulting payoffs in electronic combat/electronic warfare systems. **Contractors:** TRW, SRI. **Status:** Studies.

Tactical Situation Assessment and Response Strategy
Partial demonstration of benefits and risks associated with application of artificial intelligence technologies to integrated defensive processing in the post-2000 fighter. **Contractor:** Loral. **Status:** Development.

Ultrareliable Digital Avionics
Design and development of high-performance SEM-E data and signal modular processor for such advanced applications as infrared search and track (IRST). **Contractor:** None. **Status:** Development.

Ultrareliable RF Avionics
Project to develop and demonstrate a highly reliable, modular packaging approach for low-power RF application for radar, CNI, and EW avionic systems. APG-68 radar receiver module demonstrated for proof of concept. **Contractor:** Westinghouse. **Status:** Development.

Wright Laboratory/Solid-State Electronics Directorate

Device Research
In-house program of III-V semiconductor technology research. Includes material growth and characterization integrated with device design, fabrication, evaluation, and modeling, emphasizing heterojunction device research and band gap engineering. **Contractor:** None. **Status:** Ongoing.

Microelectronics Manufacturing Science and Technology
DARPA's Microelectronics Technology Office and Wright Laboratory's Manufacturing Technology and Solid-State Electronics Directorates are working on a joint program to implement a new, flexible, low-cost manufacturing concept for semiconductor devices based on modular cluster tools, real-time process controls, and advanced modular, object-oriented, factory control software. **Contractors:** Texas Instruments, Stanford University, University of Iowa. **Status:** Continuing.

Microwave/Millimeter Wave Monolithic Integrated Circuits
DARPA-triservice program to develop affordable gallium arsenide MIMICs for advanced DoD systems. Emphasizes such MIMIC development areas as computer-aided design, chip fabrication, testing procedures, packaging, and manufacturing. **Contractors:** Phase 2: Hughes/GE. Phase 3: AT&T, Avantek, Gateway Modeling, TriQuint. **Status:** Continuing.

Rapid Prototyping System for Custom ASICs and MCMs
In-house program to establish and demonstrate a computer-aided design (CAD) system for the quick-turnaround design of custom application-specific integrated circuits (ASICs) and multichip module (MCM) packages. **Contractor:** None. **Status:** Ongoing.

RF Vacuum Electronics
DARPA-triservice program to develop advanced microwave and millimeter-wave power amplifiers for airborne electronic warfare, radar, and communication transmitter applications. Emphasis is on traveling wave tube design, fabrication, and assembly techniques that yield affordable high-performance thermonic sources. **Contractors:** Hughes Aircraft, Northrop, Raytheon, Varian. **Status:** Continuing.

Strategic Defense Initiative
Multitechnology program involving the development of advanced microwave and electro-optical devices for spaceborne applications. **Contractors:** GTE, Honeywell, Gen Corp-Aero Jet, Microwave Modules, Inc., Microwave Technologies, Inc. **Status:** Continuing.

Wright Laboratory/Flight Dynamics Directorate

Advanced Fighter Technology Integration F-16
Program to develop, integrate, and flight-demonstrate technologies that will improve lethality and survivability of future advanced fighters. Technologies include digital flight-control system, automated maneuvering attack system, digital terrain management and display system, head-steerable FLIR, integrated night vision helmet, Automatic Target Handoff System, and Pave Penny. **Contractor:** GD. **Status:** Aircraft modification, flight tests September 1991, final reports September 1992.

Advanced Technology Redesign of Highly Loaded Structure
Program to apply advanced metallic structures to highly loaded structural components in operational aircraft. **Contractors:** Lockheed, Northrop. **Status:** Candidate structural components identified.

Aircraft Battle-Damage Repair
Program to provide deliverable products that will increase the capability to rapidly return battle-damaged aircraft to operational status in a combat environment. Goal is to return 50 percent of all battle-damaged aircraft to the commander within 24 hours. Will address critical aircraft battle-damage assessment and repair-technology challenges, such as inspection devices to help an assessor find damage in otherwise inaccessible areas; a computerized wiring aid to help find the information needed to repair severed wires; a rapid repair technique for multiple contoured aircraft surfaces; an integral

fuel tank repair using only fast cure, long-shelf-life adhesives; and repairs that maintain the small radar cross section of low-observable aircraft. Project will define battle-damage effects, evaluate state-of-the-art ABDR techniques, identify technology deficiencies, and develop and demonstrate necessary ABDR procedures. **Contractors:** GD, Booz-Allen Hamilton, Sparta. **Status:** Continuing.

Aircraft Structural Integrity
Research and development to provide the methods required by the Aircraft Structural Integrity Program (ASIP) to design, test, and manage aircraft structure. Current emphasis is on extreme temperature structures technology for future hypersonic vehicle and on the structural integrity of aging aircraft. **Contractor:** Aerospace Industry. **Status:** Development.

Aircraft Windshield System Development
Integration of emerging technologies into operationally acceptable transparency systems compatible with evolving military missions. **Contractor:** In-house. **Status:** Continuing.

Airframe Propulsion Integration
Technology development program for advanced fighters and high-speed flight vehicles. Advanced multifunction exhaust nozzles and highly survivable inlets. **Contractor:** MD. **Status:** Continuing in-house exploratory development.

Airframe Weapons Integration
Technology development program for advanced and derivative fighters to increase survivability. **Contractor:** In-house. **Status:** Exploratory and advanced development.

Carbon-Carbon 2-D Exhaust Nozzle Structures
Program to develop the technologies required to design and manufacture advanced engine thrust-vectoring/thrust-reversing nozzle components of carbon-carbon composites. **Contractor:** GE. **Status:** Testing on F110 and YF120 engines completed.

Ceramic Composite Component Demonstration
Development of structural ceramic matrix composites for turbine engine 2-D-exhaust nozzle applications. **Contractor:** P&W. **Status:** Nozzle components being fabricated for 1991 engine test.

Computational Fluid Dynamics
Program to develop, validate, and apply CFD methods for design and analysis of advanced vehicles, aeromechanics technologies development, and vehicle system support. **Contractors:** Many. **Status:** Exploratory development.

Configuration Research
Investigation of ways to shape, arrange, and integrate configuration components for optimum aircraft performance and survivability. **Contractors:** Many. **Status:** Exploratory and advanced development.

Elevated Temperature Aluminum Program
Program to develop and demonstrate elevated temperature aluminum structure for Air Force aircraft. **Contractor:** Lockheed. **Status:** Design complete; details in fabrication.

Hybrid Laminar Flow Control
Joint program (with Flight Dynamics Laboratory, NASA Langley Research Center) to develop and flight-test hybrid laminar flow-control system on Boeing 757. **Contractor:** Boeing. **Status:** Data analysis.

Hypersonics
Program to provide the aerodynamic and thermodynamic technology base for the analysis, design, and development of advanced hypersonic aircraft, aeroconfigured missiles, and reusable launch vehicles. **Contractors:** Many. **Status:** Research.

Integrated Control and Avionics for Air Superiority
Development of key control and avionics technologies that will enable cooperating fighter aircraft to engage and defeat multiple airborne threats. **Contractor:** MD. **Status:** Development, simulation.

Mission Integrated Transparency System
Development of a transparency system for advanced tactical aircraft operating in 1995. **Contractor:** GD. **Status:** Demonstration.

Prototype Flight Cryogenic Cooler
Program to develop, integrate, and test advanced cryogenic cooler technologies capable of producing cooling capacities and temperatures that meet SDI requirements. **Contractors:** Arthur D. Little, Allied-Signal. **Status:** Testing.

Self-Repairing Flight-Control System
Development of reconfiguration and on-board maintenance diagnostic technologies capable of improving reliability and maintainability of a flight-control system. **Contractor:** MD. **Status:** Final report in review.

STOL and Maneuvering Technology Demonstrator (S/MTD)
Program to develop and flight-test advanced technologies on an F-15 testbed to provide future fighters with STOL capabilities from bomb-damaged runways while enhancing maneuverability and cruise performance. Technologies include two-dimensional (rectangular) thrust-vectoring/thrust-reversing engine nozzles, integrated flight and propulsion control system, rough-field landing gear, and advanced pilot-vehicle interface. **Contractor:** MD. **Status:** Flight testing, military utility assessment.

Structural Assessment and Vulnerability Evaluation
Program to define the structural engagement conditions of key USAF aircraft to demonstrate the problem through component level testing and to validate analytical tools for use in future hardening programs. **Contractor:** SAIC. **Status:** Mission analysis and airframe testing.

Subsonic Aerodynamic Research Laboratory
In-house design and development of a large, open-circuit, low-turbulence, subsonic wind tunnel for flow visualization, computational fluid dynamics code calibration, and high-angle-of-attack research. **Contractor:** Fluidyne. **Status:** Operational.

Supportable Hybrid Fighter Structures
Demonstration of the supportability, durability, weight, and life-cycle cost advantages of an advanced hybrid structure compared to conventional hardware used in major airframe structures. **Contractor:** GD. **Status:** Testing and analysis.

Variable Stability In-Flight Simulator Test Aircraft (VISTA/F-16)
Design and production of a high-performance in-flight simulator to replace the NT-33. **Contractors:** GD, Calspan. **Status:** Fabrication.

Vortex Flow Control
Development and flight test validation of a pneumatic system to obtain yaw control at high angles of attack by manipulation of nose vortices. **Contractor:** Grumman. **Status:** X-29 aircraft in modification.

X-29A Advanced Technology Demonstrator
Development and validation of advanced aerodynamic, structural, and flight-control technologies of a forward-swept-wing aircraft. **Contractor:** Grumman. **Status:** Documentation.

Wright Laboratory/Materials Directorate

Advanced Structural Metallic Materials
Comprehensive two-part program to research and conduct exploratory development of aluminum, titanium, and magnesium structural alloys and metal matrix composites. Aims to put into production superior alloys of higher strength, improved resistance to corrosion, and greater resistance to heat. **Contractors:** Lockheed, GE, U. of Va., Metcut, Universal Energy Systems (UES), P&W, Boeing, Lockheed-Calac. **Status:** Research, exploratory development.

Composite Materials Research and Development
Investigation and development of a wide variety of new composite materials for USAF aircraft, spacecraft, missiles, and ICBMs. **Contractors:** Boeing, GD, U. of Dayton Research Institute, others. **Status:** Research, exploratory and advanced development.

Electronic and Optical Materials Research and Development
Programs to develop new and improved materials and processing techniques for II-VI and III-V compound semiconductors, high-temperature superconducting thin films, nonlinear optical materials, and high-performance infrared transparencies for applications in infrared detectors; microwave, microelectronic, and opto-electronic devices; and high-speed missiles and aircraft. **Contractors:** AT&T, GE, Hughes, Rockwell, U. of Dayton Research Institute, Westinghouse, others. **Status:** Research, exploratory development.

Hardened Materials/Airborne and Space Subsystems
Program to develop technology base to be used by systems designers for

protecting tactical and space systems from effects of directed energy and kinetic energy weapons and laser radiation. **Contractors:** TI, MD, Hughes, Rockwell, Acurex, GE, TRW, Barnes, Lockheed, Arthur D. Little, Perkin Elmer, LTV, GA Technologies, SAIC, Martin Marietta, AVCO. **Status:** Advanced development.

High-Temperature Materials
Development of revolutionary high-temperature materials—primarily ceramic matrix composites, carbon-carbon composites, and intermetallics—for application in future gas turbine engines and in hypersonic vehicle structures. **Contractors:** Many. **Status:** Research, exploratory development.

Manufacturing Research
Provides the technology base for early introduction of advanced materials and processes into manufacturing; for significantly reducing new product cycle time and acquisition and life-cycle cost; and for flexible, low-volume, high-quality manufacturing. The research will address the advancement of computer technology as applied to manufacturing. **Contractors:** Many. **Status:** Research.

Materials Processing Modeling
Development of computer analytical models and physical modeling to predict materials' response to processing, enabling the attainment of preferred microstructure and properties the first time and avoiding costly, traditional trial-and-error approach. **Contractors:** UES, Battelle, Shulz Steel. **Status:** Research, exploratory development.

Mechanical Behavior of Advanced Materials
Program to develop understanding of the engineering behavior and life-prediction methodologies necessary to use revolutionary high-temperature materials in both propulsion and airframe applications. Materials include titanium aluminides, intermetallic matrix composites, carbon-carbon composites, and ceramic matrix composites. **Contractors:** Many. **Status:** Exploratory development.

Nondestructive Evaluation/Inspection R&D
Exploratory and advanced development of new, more accurate, more reliable, nondestructive evaluation/inspection (NDE/I) capabilities to support weapon systems quality assurance and reliability and maintainability programs within the Air Force. **Contractors:** Many. **Status:** Exploratory and advanced development.

Nonstructural Materials
Development of a variety of lubricants, seals, coatings, foams, and other critical materials. **Contractors:** Hughes, U. of Dayton, GE, TRW, Ultrasystems, others. **Status:** Exploratory development.

Ultralightweight Structural Materials
Development of advanced carbon-fiber matrix composites, ordered polymers, molecular composites, and other substances for future USAF aircraft, spacecraft, and missiles. **Contractors:** MD, Northrop, Dow Chemical, Foster Miller, others. **Status:** Research, exploratory and advanced development.

Weapon Systems Material Support
Development of advanced composite repair techniques, new NDE/I procedures, and corrosion control coatings and methods. Provides structural and electronic failure analysis and materials-engineering support to acquisition, operational, and logistics commands. **Contractors:** U. of Dayton Research Institute, Universal Technology Corp., Rockwell, Boeing, McDonnell Douglas–McDonnell Aircraft Co. (McAir), others. **Status:** Continuing.

Wright Laboratory/Joint Cockpit Office

3-D Flat Panel Display
Development of a flat-panel color display for cockpit use with the capability to display 3-D stereoscopic information. **Contractor:** Dimension Technologies, Inc. **Status:** Development.

Assault Transport Crew Systems Development
Effort to define and develop crew system concepts for an advanced assault transport. **Contractor:** Douglas Aircraft. **Status:** Development.

Cockpit Display Generator
Development of a VHSIC Hardware Description Language (VHDL) model prior to creation of a brassboard design. **Contractor:** Selection in 1992. **Status:** Continuing.

Defense Production Act Title III
Technical sponsor for the Joint Logistics Commanders' proposal to create a domestic manufacturing capacity for flat-panel cockpit displays. **Contractor:** Continuing selection. **Status:** Continuing.

Graphics Processor Definition
Program to define the requirements, design a detailed architecture, and create a system/segment design document for a graphics processor system for application in an Air Force avionics environment. **Contractors:** Honeywell, MD. **Status:** Development.

High-Definition Systems
Development of technologies to create flat-panel displays for large cockpit areas. Direct view and projection approaches used. **Contractor:** None. **Status:** Planning.

Integrated Cockpit/Avionics for Transports
Development, simulation, and flight demonstration of crew system technologies to improve night/adverse weather tactical transport operations with a minimum crew, concentrating on development of improved mission and information. **Contractor:** None. **Status:** Planning for contract award in 1992.

Multirole Cockpit
Evaluation and demonstration of advanced cockpit technologies for affordable single-set, night/adverse weather operations. **Contractor:** TBD. **Status:** Source selection.

Pilot's Associate
Program to apply artificial intelligence technology to cockpit to assist pilots of advanced aircraft by managing information and helping to improve situational awareness. **Contractor:** Lockheed. **Status:** Development, demonstration.

Wright Laboratory/Manufacturing Technology Directorate

Aircraft Composite Structure Manufacturing
Initiative to provide more efficient production of primary advanced composite components for aircraft. **Contractors:** Boeing, MD, Textron (Bell). **Status:** Manufacturing technology.

Enterprise Integration Program
Initiative to advance the state of the art in technology areas determined critical to enterprise integration. **Contractor:** SofTech. **Status:** Manufacturing technology.

Integrated Product Support Initiative
Initiative for the application of CALS technology to ongoing Air Force programs at each of the Air Logistics Centers (ALCs). CALS technologies initiated at each site will be shared and networked into a common technology information center to assist in shaping national and international standards and specifications. **Contractors:** Northrop, P&W, MD, ICAD, Lockheed, Boeing, D. Appleton & Co., others. **Status:** Manufacturing technology.

Knowledge-Based Integrated Design System (KIDS)
Program to develop an advanced workstation for designing unit fabrication processes that will be demonstrated for the casting process. **Contractor:** UES. **Status:** Manufacturing science.

Large Aircraft Robotic Paint-Stripping System (LARPS)
Program to provide environmentally safe techniques to remove paint from large aircraft such as the C-5A. Anticipated benefits are reductions in hazardous waste and large reductions in paint removal time. **Contractor:** UTC/USBI. **Status:** Manufacturing technology.

Manufacturing Technology for Advanced Propulsion Materials
Initiative to provide production capabilities for moderate- and high-temperature engine components, incorporating advanced materials systems. **Contractors:** GE, P&W, Textron. **Status:** Manufacturing technology.

Manufacturing Technology for Radar Transmit/Receive Modules
Program to establish and demonstrate a low-cost manufacturing capability for large quantities of complex microwave T/R modules for inclusion in active element phased-array radar systems. **Contractors:** Hughes, TI/Westinghouse joint venture. **Status:** Manufacturing technology.

Manufacturing Technology for Silicon on Insulator Wafer
Program to optimize the "separation by implantation of oxygen" (SIMOX) process of manufacturing silicon wafers up to six inches in diameter and establish a US source for same. **Contractor:** TI. **Status:** Manufacturing technology.

Microelectronics Manufacturing Science and Technology
A joint effort among the Wright Laboratory Technology and Solid-State Electronics Directorates and the DARPA Microelectronics Technology Office. This program will demonstrate new, low-cost semiconductor manufacturing techniques using modular, vacuum processing chambers in clusters with reactive ion etching, plasma-enhanced chemical vapor depositions, and in-situ sensors with expert system process control for low-volume, military, semiconductor products. **Contractor:** TI with Stanford University subcontract. **Status:** Ongoing.

Spare Parts Reprocurement and Production Support
Program to automate and integrate the enormous volume of spare parts, technical information, and data required to support advanced weapon systems. **Contractor:** General Atomics. **Status:** Manufacturing technology.

Wright Laboratory/Plans and Programs Directorate

Enhanced Surface-to-Air Missile Simulation
Simulation model of interaction between a single airborne target and a specified surface-to-air missile fired from a designated location. **Contractors:** Many. **Status:** Development.

Fighter Airframe/Propulsion Integration Predesign (FAPIP) Studies
Assessment of the benefits and penalties of individual technologies and integration concepts for future multimission fighter aircraft as well as upgrades to and derivatives of current aircraft. Efforts include planning of development and demonstrations required for transition to full-scale development. Areas of interest: advanced aerodynamic controls; thrust-vectoring nozzles; signature control; acquisition and operations cost; reliability, maintainability, and supportability; and weapons integration. **Contractors:** Boeing, GD, GE, MD, P&W, Rockwell; subcontractors. **Status:** Continuing.

Fighter Avionics/Cockpit Integration Predesign (FACIP) Studies
Program to search for high-payoff ways to optimize pilot–weapon system interface technology for future multimission fighter aircraft and define avionics/cockpit needs and demonstration levels. **Contractors:** Northrop, Martin Marietta, others. **Status:** Two contract awards September 1991, others pending.

Future Theater Airlift Studies (FTAS)
Joint program to address design and technology issues for a posited twenty-first century theater airlifter. **Contractors:** Many. **Status:** Research, exploratory and advanced development.

Multirole Fighter (MRF) Technology Transition
Assessment of high-value technologies needing development for MRF. Identification of technology application windows and needed technology maturity. Development of technology transition strategy. **Contractor:** None. **Status:** Continuing.

Special Operations Aircraft Study
Long-term planning project to support development of system requirements and technology for future Special Operations Forces airlift aircraft. **Contractor:** None. **Status:** Continuing.

ASD Deputate/Development Planning

Abductive Modeling and Mode-Based Vision Applied to Relocatable Target Recognition
A program to develop a prototype system for detecting and identifying strategic and tactical relocatable targets (RTs). **Contractor:** Abtech Corp. **Status:** Continuing.

AC-130 SOF Gunship Standoff Weapons
Study to identify increased standoff and effectiveness enhancements to the AC-130, ranging from guided/unguided 105-mm options to a Hellfire missile option. **Contractors:** AAI Corp., Loral Defense Systems, Martin Marietta, Nichols Research, Rockwell. **Status:** Concept evaluation.

Advanced Aerial Refueling Capability
Program to assess current aerial refueling capabilities and future requirements and to develop a comprehensive plan to meet future needs through current force modification and new acquisitions options. **Contractor:** In-house. **Status:** Pre–Milestone 0.

Advanced Multirole Combat Aircraft Design Analysis
Development of configuration alternatives for a future lightweight, multirole aircraft with emphasis on the integration of advanced weapons and reduced signatures. **Contractor:** In-house. **Status:** Continuing.

Advanced Weather Gulded Weapon Concept Exploration
Cost-effectiveness evaluation of adverse weather seeker alternatives. **Contractor:** In-house. **Status:** Continuing.

Agile Responsive Effectiveness Support (ARES)
Flight test evaluation of GAU-12 (25-mm) gun on small, all-composite aircraft. **Contractors:** SAIC, Scaled Composites, Inc. **Status:** Continuing.

Air Force Mission Area Roadmaps
Annual publication of Technical Oversight Center (TOC) Mission Area Roadmaps for air-to-surface, air-superiority, special operations, training, and mobility mission areas. This is a cooperative effort among mission area planners, Majcoms, program offices, and laboratories. Focus is on cost and operationally effective technology transition to current and future systems. **Contractor:** In-house. **Status:** Continuing.

Air Force Weapons Roadmaps
Annual publication of air-to-air, air-to-surface, and special operations twenty-year master plans that are cooperative efforts among users, planners, and technologists. **Contractor:** In-house. **Status:** Continuing.

Air Interdiction Design Analysis
Analyzes operational capabilities and design alternatives for future USAF interdiction aircraft. **Contractor:** In-house. **Status:** Continuing.

Avionics Integration in Design
Project to develop concepts that consider the interaction of avionics with the airframe and armament elements to ensure a balanced, effective design. **Contractor:** In-house. **Status:** Continuing.

Bomber-Fighter Training System
Development of concepts for a basic pilot training system that will prepare students for eventual duty in bomber or fighter aircraft. Study will help define requirements for replacement of or upgrades to the T-38. **Contractor:** TBD. **Status:** Pre–concept definition.

Critical Mobile Targets Program Office
Program to demonstrate technologies that will detect, identify, and strike mobile targets. Employs a non-platform-specific, building-block approach to combine mature and emerging technologies. Emphasis on manned bombers, off-board scouts, overhead systems, sensors, automatic target cuing, and automatic target recognition algorithms as well as high-speed processors. Office is ASD point of contact for counterforce aspects of Theater Missile Defense (TMD). **Contractors:** Many. **Status:** Continuing.

Extended Coverage Antimateriel Submunition
Development of preliminary concepts and effectiveness analysis for an improved antimateriel submunition that can be used as a payload for either guided standoff weapons or unguided weapons. **Contractor:** In-house. **Status:** Continuing.

Extraction Parachute Jettison Device
Failure modes and effects analysis to evaluate options for emergency release of extraction parachutes when a malfunction prevents the airdrop load from departing the aircraft. **Contractor:** TBD. **Status:** Concept development.

Foreign Comparative Testing
Evaluation of foreign developed penetrating warheads/submunitions, multifunctional fuzes, and gunship ammunitions for USAF applications. **Contractors:** Rafael, Matra, Thorn EMI, Bofors. **Status:** Continuing.

Future Systems Cost Analysis and Structuring
Development of cost-estimating relationships and estimates for high-technology materials subsystems and systems. Will also formulate cost-estimating techniques for new emerging system concepts. **Contractor:** Axion Corp. **Status:** Continuing.

Future Theater Airlift Studies
Development of comprehensive database, performance trades, and sensitivity analyses to support MAC definition of next-generation theater airlifter. **Contractors:** In-house, Ball Systems, Douglas, Lockheed, Boeing. **Status:** Pre–Milestone 0.

High-Temperature Superconductivity Delay Lines and Filter Banks
Program consists of two development demonstrations: a delay line assem-

bly and a switchable, band reject filter bank. The delay line demonstration will lead to improvements in EW systems through increased bandwidth and reduced size, weight, and insertion loss. The switchable, band reject filter bank unit will reduce signal overload and false alarm rate in radar warning receivers. **Contractor:** Superconductor Technologies, Inc. **Status:** Concept definition.

Hypervelocity Missile Design Integration
Studies identifying integrated design options for both air-to-ground and air-to-air applications to maximize combat utility. **Contractor:** In-house. **Status:** Continuing.

Infrared/Electro-Optical Sensor Trends and Requirements
Investigation to provide an assessment of performance capability and availability of specific IR and EO technology. **Contractor:** MacAulay-Brown, Inc. **Status:** Continuing.

Joint Primary Aircraft Training System Study
Cost and Operational Effectiveness Study in support of Milestone 1 to refine requirements for pilot training system to replace the Air Force T-37 and Navy T-34C. **Contractor:** TBD. **Status:** Concept development.

Lighter-Than-Air Technology
Effort defines USAF and non-USAF, including commercial, missions that may be performed effectively and with reduced resources by a small, remotely piloted CycloCrane. **Contractor:** Mission Research Corp. **Status:** Continuing.

Low Probability of Intercept/Detection Data Link Technology Evaluation
Study will evaluate needs and potential concepts for jam-resistant LPI/LPD data links to enhance intraformation communication and data sharing. **Contractors:** In-house, potential contractor support. **Status:** Pre–concept definition.

Mission/Flight Systems Integration
Development of functional capability requirements (FCRs) for future aircraft electronic/avionics systems in a variety of vehicles and missions. Specific FCRs developed for weapon integration and JIAWG compliant avionics for MRF. **Contractors:** Illinois Institute of Technology, McAir, and GD–Fort Worth Div. **Status:** Efforts completed. Reports in processing.

Mobile Target (MT) Analysis
Program to develop UAV scout concepts to aid bombers searching for MTs in the 1995–2000+ time frame for both nuclear and nonnuclear scenarios. **Contractor:** Frontier Technology, Inc. **Status:** Continuing.

Multirole Fighter Mission Needs Analysis
Analysis is being conducted for Hq. TAC to provide the quantitative basis for a Mission Needs Statement leading to a Milestone 0 decision on the Air Forces' next Multirole Tactical Fighter. **Contractors:** In-house, major airframers through RFI. **Status:** Pre–Milestone 0.

Planning for Hypersonic Weapons and Aerospace Vehicles
Prepare mission area/mission needs analyses, concept assessment packages, cost estimates, schedule estimates, and other pre- and post–Milestone 0 hypersonic systems development planning for major command mission needs for space launch, global force projection, and quick response. **Contractors:** In-house, various. **Status:** Continuing.

Requirements for an Automated HMPT Planning Tool
Investigation to determine requirements for an automated human factors, manpower, personnel, and training planning tool to use in meeting human resources–related requirements early in the acquisition cycle. **Contractor:** Vector Research Inc. **Status:** Continuing.

Special Operations Aircraft
Definition of long-range survivable system concepts and needed capabilities for a new special operations airlift vehicle. **Contractor:** In-house. **Status:** Pre–Milestone 0.

STOVL Design Analysis
Evaluation of design concepts for short takeoff and vertical landing air vehicles. **Contractor:** In-house. **Status:** Continuing.

Study of Unmanned Air Vehicles
Project to identify promising applications of unmanned air vehicles for TMD, define UAV concepts, and provide recommendations for use of UAVs to eliminate force deficiencies. **Contractor:** SAIC. **Status:** Continuing.

Systems Analysis Quality Metrics
A program to develop an extensive set of quality metrics for the evaluation of IDEF-model quality. **Contractor:** Androit Systems, Inc. **Status:** Continuing.

T-38X
Application of technologies to enhance the T-38 to meet Bomber-Fighter Training System (BFTS) mission needs. **Contractor:** Eidetics Int'l, Inc. **Status:** Ongoing.

Transatmospheric Aeronautical Systems
Preliminary design analysis to identify requirements and capabilities of transatmospheric systems. **Contractor:** In-house. **Status:** Pre–concept definition.

Weapons for Multirole Fighter
Concept design of aeronautical systems that have airframe, propulsion, avionics, and armament as free variables for air-to-air and air-to-surface weapons tailored to the multirole fighter concept. **Contractor:** In-house. **Status:** Continuing.

Weapons Planning Information Management System (WEPIMS)
The primary objective of WEPIMS is to provide the Technical Oversight Centers a capability to readily access, display, and analyze data for long-range munitions procurement planning. **Contractor:** TASC. **Status:** Development.

ASD Deputate/Integrated Engineering and Technical Management

Aircraft Structural Integrity Program
Program to link all aspects of structural design, analysis, test, and operational use of aircraft to establish service life and track it constantly. **Contractor:** None. **Status:** Continuing.

Avionics Integrity Program
Provides a disciplined engineering process for the development of avionics to enhance system reliability and safety. **Contractor:** In-house. **Status:** Continuing.

Engine Structural Integrity Program
Provides organized approach to structural design, analysis, test, and life-cycle management of gas turbine engines. **Contractor:** None. **Status:** Continuing.

Industrial Modernization Incentive Program
Program to provide incentives for contractors to bring together advanced productivity-enhancing technologies and the investments necessary to modernize their organizations and facilities. **Contractors:** Many. **Status:** Ongoing.

Integrated Product Development
Initiative in support of "concurrent engineering," a method to combine development and qualification of all system elements. Integrates design, manufacturing, support, and training. **Contractors:** Many. **Status:** Ongoing.

Mechanical Subsystems and Equipment Structural Integrity Program
Program to adapt integrity-assurance process to air and ground mechanical systems and such equipment as hydraulic, pneumatic, and secondary power systems. **Contractor:** None. **Status:** Continuing.

MIL-PRIME Program
Initiative to streamline acquisition by improving quality of specifications and standards placed on contract and to eliminate overspecification of program requirements. **Contractor:** None. **Status:** Continuing.

Senior Engineering Technology Assessment Review
Program for review and assessment of objectives, approach, and possible payoffs of advanced technology development programs. **Contractor:** None. **Status:** Continuing.

Software Development Integrity Program
Initiative to improve operational capability and supportability of aeronautical weapon system software. **Contractor:** None. **Status:** Continuing.

Value Engineering
Program to reduce acquisition and support costs while maintaining or improving performance by implementing high-payoff changes to such system features as design and production processes. **Contractor:** None. **Status:** Continuing. ■

Can the military-industrial complex lay off two million workers, convert production lines, gain efficiency, and somehow accelerate technology and R&D?

Soviet Industry Gropes Ahead

By Reuben F. Johnson

THE abortive August putsch in the USSR will go down in history as the beginning of the end for the gigantic military-industrial complex that for decades utterly dominated Soviet economic life. It is worth examining what this breakup means for the future of the USSR and its military forces.

I was in the Soviet Union with a delegation of Westerners at the time of the attempted coup and witnessed it firsthand. I was able to tour defense facilities and speak with a variety of senior Soviet officials, including the present Defense Minister, Marshal Yevgeni Shaposhnikov. Their message was only too clear: The Soviet military and defense industry are about to undergo a rapid—and possibly agonizing—transformation.

For decades, the armed forces and their defense industries have been enclaves of privilege, abundant resources, and disregard for cost or efficiency. All of this is now changing.

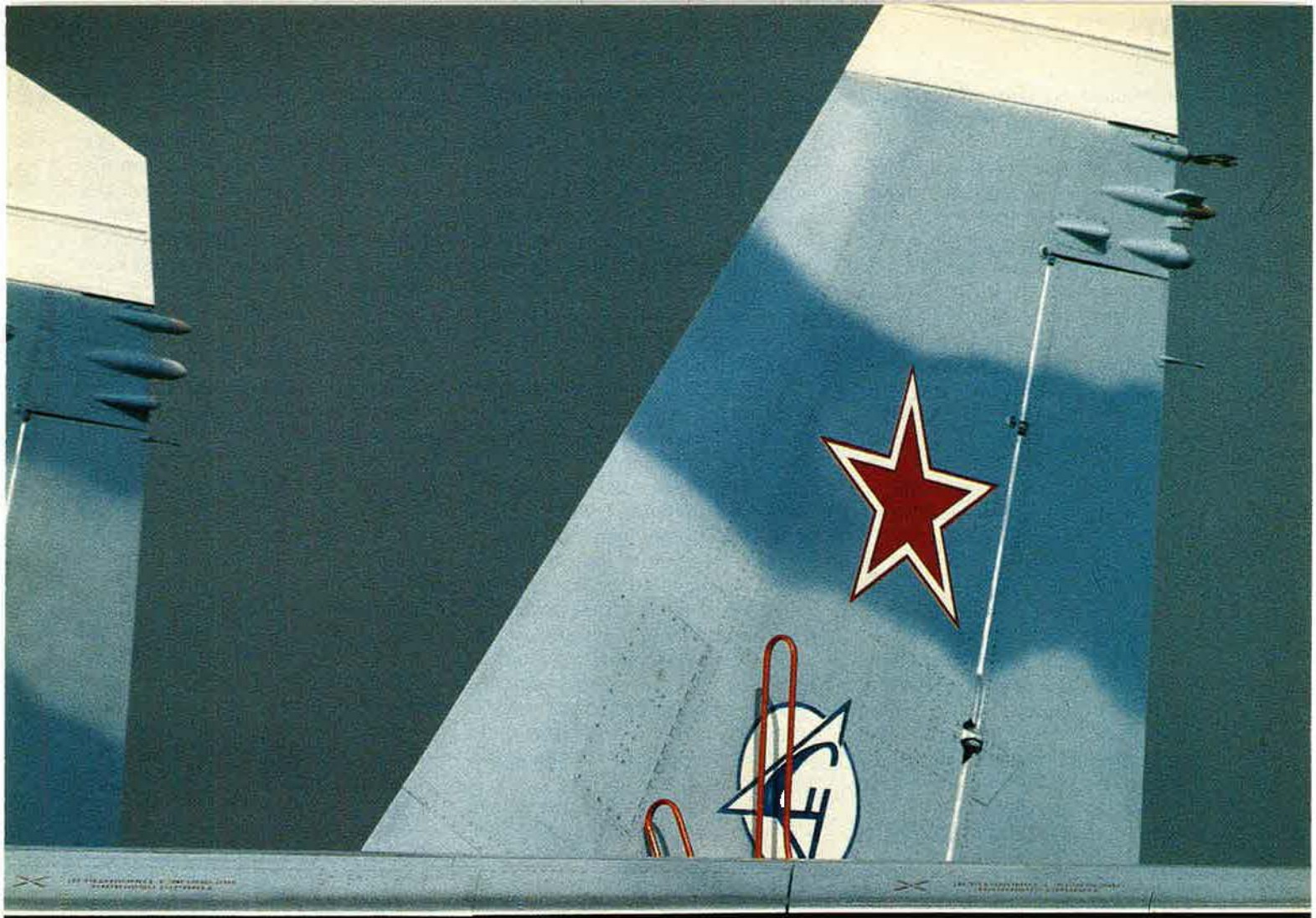
The ponderous Soviet military-industrial system ignored economic realities for decades and now is in deep trouble. It is not too difficult to understand why if you spend any time talking to those who hold positions within the USSR's defense industry. The manner in which it has been administered is seen as another example of meddling by incompetent bureaucrats.

Such popular sentiments are reinforced by Moscow's numerous social ills that have been ignored for many years. Even in the city's better neighborhoods, scores of pathetic people, including some without a place to live, beg in the entranceways of subway stations and outside churches—two places they are likely to intercept Western tourists.

The country is everywhere perceived as a place that does not work. This assessment could be applied to almost every industrial enterprise in the USSR, both civilian and defense. Most Soviet production facilities are simply unsuited to the demands of today's rapidly changing

Staff photo by Guy Aceto

With the Soviet military retrenching and defense industries at excess capacity, major reductions are in order. The USSR's belt-tightening plans call for limiting its Air Forces to one continuously produced model of fighter aircraft: the Su-27. It would be built in different variants to fulfill all required Air Forces missions.



world, based on swift advances in microelectronics and telecommunications.

Eliminating this grand-scale inefficiency is perhaps the most important challenge that the Soviet military and its industries face. The only way to keep the military machine up-to-date is by creating a modernized, cost-effective Soviet military-industrial research, development, and production base.

However, efficiency alone will not solve all the ills of the USSR's defense industry. Many of the country's defense plants can no longer afford to stay in the arms business. With the Soviet military retrenching and defense industries at excess capacity, major reductions are in order.

"Frying Pan Conversion"

In the drive to keep these plants open and their workers employed, many have claimed that the nation can "convert" these military industries to production of civilian goods. Previous efforts on this score have been almost complete failures, exposing the absence of management expertise within the Soviet defense industry.

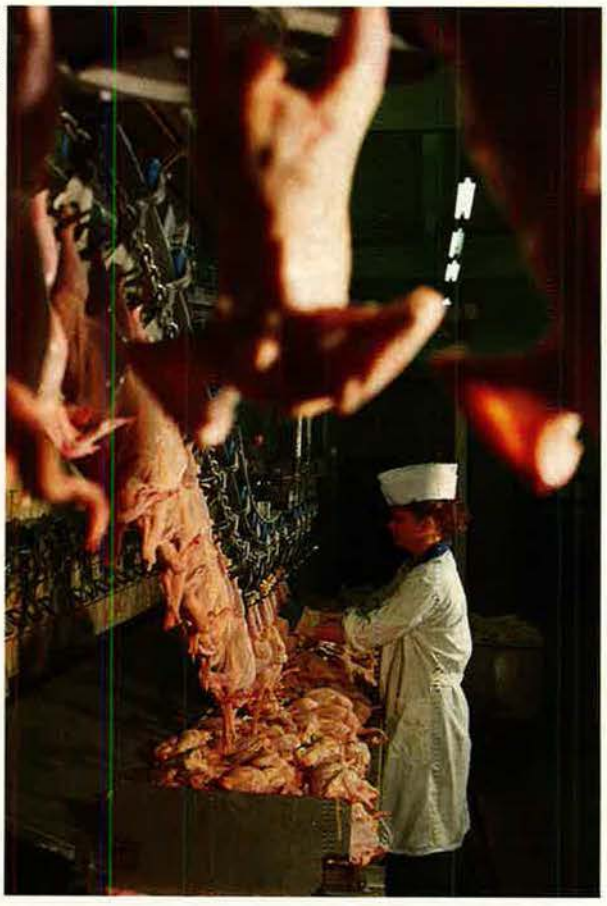
In recent years, untold sums of money have been wasted to help factories produce simple consumer items using high-priced materials. Aircraft plants' production of rakes and other garden implements out of aircraft-grade titanium is one of many horror stories openly discussed and criticized by embittered defense industrialists.

The failure of "frying pan conversion," as it has been pejoratively labeled by Russian Republic President Boris Yeltsin, has become a major concern in such places as the Ministry of Aviation Industry. Budgeting and procurement realities are about to hit defense industries, and their impact could be devastating.

The latest figures from Soviet defense industry officials indicate that up to two million workers could be laid off from various Soviet defense plants over the next year, unless some way is found to convert these facilities properly to civilian goods production.

No one believes that the Soviet Union is going out of the arms business, but financial and political circumstances put its defense industries in a precarious position. The Soviets must learn how to trim the size of the military, divert resources from military to consumer goods production, and develop new commercial product lines that will keep workers gainfully employed. At the same time, they must develop new weapon systems comparable to modern US systems, increase the pay of their R&D specialists to keep their scientific talent and design teams together, and modernize their facilities. All of this, of course, must be done in record time and with less money than they had to work with when they did nothing but build weapons.

TASS/Sovfoto



The USSR must trim the size of its military and divert resources from military to consumer goods production. Though many have claimed that military plants can be converted to production of civilian goods, previous efforts have been almost complete failures for lack of management expertise.

Long Term vs. Short Term

To accomplish these tasks and make a true recovery, Soviet officials have developed short- and long-term plans.

Over the short term, the USSR will sharply pare the number of systems that it builds, the better to cut production costs. Marshal Shaposhnikov underlined this strategy just a few days before he became the new Minister of Defense. In his meeting with us, he emphasized the Soviet need to produce smaller numbers and fewer models of aircraft.

This plan calls for limiting the Soviet Air Forces to just one continuously produced model of fighter aircraft: the Su-27. This aircraft would be built in different variants to fulfill all the required Air Forces missions.

At the same time, the Soviet Union would discontinue production of the MiG-29 for use by the Soviet Air Forces, though the USSR might continue building it to fill export orders. Aircraft Plant No. 30 in Moscow, one of the main MiG-29 production facilities, has already announced that it will close down its entire MiG-29 assembly line and begin building the Ilyushin Il-114, a twin-turboprop civilian commuter aircraft.

MiG-31 production will continue in a new advanced variant, but for specialized missions and in smaller numbers than the Su-27. Other recently developed aircraft—most prominently, the Yak-141 V/STOL fighter—will probably never see production.

Using just one aircraft for every mission clearly is not the optimal situation for an air force planner, but Marshal Shaposhnikov and others have made it clear that such decisions are unavoidable and are being driven by cost. "We are being pushed toward multirole aircraft because of defense cutbacks," Marshal Shaposhnikov told our group.

However, reducing the number of aircraft models to one allows the Soviet Air Forces freedom to accomplish objectives that are more critical than preserving a diverse air fleet. This move will greatly reduce the funds consumed by the military in production expenditures, giving military aviation planners the flexibility to fully fund the aircraft design bureaus and research institutes.

The Soviet General Staff fears that the scientific and technical base of the defense industry will atrophy, or even fall apart, if it is not well funded. These senior uniformed leaders are alarmed by the legions of talented young designers and scientists leaving design bureaus and institutes in search of better opportunities in the budding Soviet private sector. The generals understand that full funding of the design bureaus is the only way to stem this brain drain.

The other benefit of cutting back the number of production models is the ability to use funds freed by closing down military production lines to accelerate the development of high-priority projects. The USSR has been aggressively pursuing programs in stealth technology and precision guided munitions. Essentially, multiple aircraft product lines will be sacrificed to build an R&D infrastructure and acquire proficiency in state-of-the-art defense technologies for beyond the turn of the century—a more strategic objective.

©Pete Diner/Black Star

The USSR's short-term plans call for discontinuing production of the MiG-29 for Soviet use, though it might still be built to fill export orders. The Mikoyan design bureau, anxious to stay in the fighter aircraft business, will seek as many overseas customers for the MiG-29 as it can get. Here is one in German livery.

The Soviets continue to stress the development of these advanced technologies because they have seen the future of military conflict. The results of Israel's 1982 engagements with Syrian aircraft and air defense forces and the outcome of Operation Desert Storm have demonstrated how devastating new-generation weapons can be against an opponent whose technology is only a few years behind.

The Critical Soviet Weakness

Marshal Shaposhnikov sees the Soviet inability to produce the high-technology weapons needed to survive in a modern battlefield as a critical weakness that must be addressed. Such warfare requires not only high-technology systems but also precision management of all assets, including coordination with space reconnaissance.

Meeting with US industry officials on a recent tour of Soviet aerospace facilities, Vladimir F. Laptev, the Deputy Minister of Aviation Industry for Military Aircraft, stated that the Soviet Union had no option but to continue to pursue new technological advances. Research and development account for about fifty percent of Soviet military expenditures, he said. He doubted that this figure would be reduced.

Mr. Laptev's statements, and the remarks of other Soviet officials, reflect a growing concern about the

TASS/Sovfoto

New commercial product lines must be developed to keep former Soviet defense workers gainfully employed, or some two million may lose their jobs this year. The Ilyushin design bureau has begun collaborating with Aeroflot on civilian passenger aircraft like this Il-96-300 jumbo jet and the twin-turboprop Il-114 commuter plane.

The Soviet Air Forces will rely heavily on the Sukhoi Su-27 "Flanker" for years to come. Its flight-control system software has been extensively modified, and new technologies are being tested on it. Some may be used in the Soviet counterpart to USAF's F-22 Advanced Tactical Fighter.

technological lead held by the US in key areas, particularly in stealth technology. The success of the F-117A in Operation Desert Storm is said to have caused the Soviet leadership to accelerate the nation's stealth program and to grant it virtual immunity from budget cuts. Propulsion technology and avionics are two other areas in which the Soviet Union is striving to close the gap with the US.

For the longer term, the Soviet Air Forces have developed a plan to use the "breathing space" created by producing only the Su-27 to develop these new technologies and produce a new generation of fighter aircraft comparable to USAF's new F-22 Advanced Tactical Fighter.

Soviet capabilities to design and build such aircraft are still strong, despite the technological lag behind the US. The facilities I saw at the Gromov Flight Research Institute (LII)—known more commonly in the west as Ramenskoye—for testing and evaluating new aircraft and determining design flaws are among the best in the world. Extensive work was performed at LII on the Su-27's flight-control system, including program changes to software that enables Su-27 pilots to fly the famous "Pugachev Cobra" with the flight-control computer on and actively controlling the entire maneuver.

The new Soviet aircraft that the West can expect to see in years ahead will be both a heavy and a lightweight advanced fighter that will eventually replace the Su-27 and MiG-29, respectively. These aircraft will be designed with stealth characteristics and will exhibit considerable advances in avionics and propulsion. Other areas likely to show marked increases in capability are radar; infrared and other passive tracking and acquisition systems; newer, full-authority, fly-by-wire flight controls; and thrust-vectoring nozzles. Many of these systems have already been tested on MiG-29s or Su-27s, so their development will not slow the introduction of new aircraft.

The goal is high-technology fighter aircraft that can operate more-or-less autonomously and receive real-time data from various command, control, and communication nodes.

The Big Question

One of the problems that this plan leaves for the Soviets is what to do with all of the factory space and factory personnel that will be thrown out of work by these current reductions.

Apollon Systsov, the Minister of Aviation Industry, had been banking on employing these facilities and people in the design and construction of commercial aircraft, but the joint ventures, foreign partners, and markets necessary for this conversion have not materialized, and the situation will not change overnight. For this reason, he and others in the ministry have stridently opposed taking the MiG-29 out of production.

Failing to secure commercial aircraft work leaves just two options for the Soviet aircraft industry: to lay off personnel or to aggressively pursue foreign military sales. Current trends suggest that the latter is now a stronger possibility than ever. Several design bureaus have proposed aircraft designs as export fighters, including a Sukhoi design, the Su-37. Special export aircraft may be necessary, as the Soviets are still holding back on any sale of the Su-27 and it is doubtful that they would export their version of an Advanced Tactical Fighter anytime soon. Mikoyan, anxious to avoid being put out of the fighter aircraft business, will seek as many overseas customers for the MiG-29 as it can get.

Difficult challenges await the Soviet Union and its defense establishment. An industrial base that needs to reorient its product line is only one of many serious problems. Another is the large number of troops coming back to the USSR from their bases in eastern Europe and finding no homes, jobs, or hope.

The present course set by Soviet leaders is a gamble that, by cutting down on military expenditures now, the nation can free enough resources to help alleviate the country's economic problems and continue military R&D work at an accelerated pace. As with any gamble, the rewards of success—a new generation of high-technology weaponry—could be substantial. The penalties for failure could doom the Soviet Union to permanent technological inferiority. ■

Reuben F. Johnson, a specialist in Soviet defense issues, is president of the Center for Soviet Assessments. He was a foreign technologies analyst for General Dynamics and GE Aircraft Engines. His most recent article for Air Force *Magazine, "Higher Marks for Soviet Missiles," appeared in the August 1991 issue.*

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The aerospace industry is in flight from southern California, and the consequences are more than regional.

Breakup of the Hive

By David J. Lynch

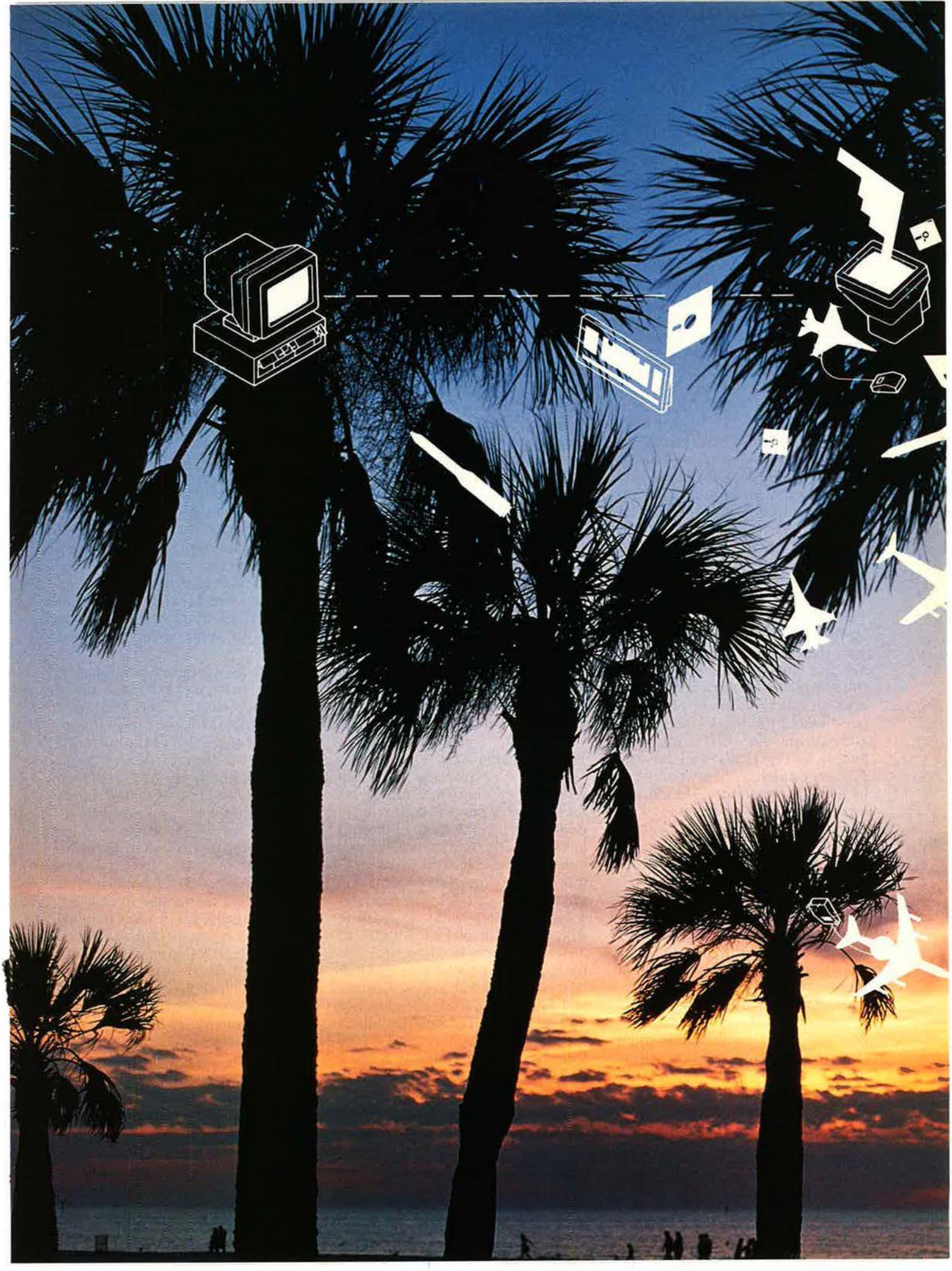
SOUTHERN California's aerospace industry "hive," the dense concentration of physical plant and human talent that gave birth to stealth aircraft, spy satellites, and powerful moon rockets, is gradually breaking apart. Defense contractors increasingly are shifting work away from the aerospace industry's traditional center of gravity near Los Angeles, a move that raises serious questions about future US arms development and acquisition.

Beginning in the 1930s, California's near-perfect weather and its openness to innovation attracted many aviation pioneers looking for a place to call home. Inventors and engineers named Douglas, Northrop, and Hughes, among others, located the companies that bore their names along the state's sunny coastline. Over the past several years, however, what attracted aerospace companies to the area has been largely overshadowed by high taxes, inflexible state environmental and workplace regulations, and indifferent elected officials. As the decline in military spending has accelerated, a shrinking industry has found these irritants less and less tolerable.

The aerospace industry's accelerating flight from southern California has been the focus of local concern for much of 1991, but it remains unaddressed at the national level. Indeed, some see the industry's dispersal as an unavoidable by-product of federal government policies promulgated in the 1980s. "As the industry is decentralizing, as it's coming apart in certain areas, I don't think we look negatively to that," says retired Gen. Robert T. Marsh, the former commander of Air Force Systems Command and chairman of AFA's Science and Technology Committee. "We urged the aerospace industry to seek out the lower-cost areas."

Among the policies that placed a premium on product pricing, and thus on manufacturing costs, was the congressionally inspired push to increase competition in Pentagon contracting.

Some private executives are beginning to sound the alarm about a perceived gradual geographic fragmentation of the US aerospace industry's best and brightest. The



push to escape from California and settle elsewhere, they say, could add subtle inefficiencies to the already troubled arms-acquisition process. Obtaining the skilled personnel needed for state-of-the-art weapons work will become more difficult, industry's reaction times will lengthen, and costs ultimately may increase.

The Workers Come and Go

There is major worry about the effect the ongoing industrial dispersal will have on California's pool of highly trained aerospace designers and manufacturers. In the past, as military programs came and went, aerospace workers followed the work. Men and women who built stealthy F-117 fighters for Lockheed, for example, moved to Northrop as that program wound down and helped assemble the first B-2 bombers, as did former members of Rockwell's B-1B bomber labor force. Thus, separate from the fortunes of any single company, there existed a highly skilled, highly paid corps of aerospace professionals.

As the industry disperses to often far-flung corners of the nation, however, this "shared" work force may disband, to be replaced in other states with less-experienced workers who will move in and out of defense work as military budgets rise and fall but who will bring little long-term experience and no true professionalism. "The potential lack of concentration will be more of a problem in the future," says Jack Nunn of the Office of Technology Assessment, who earlier this year directed a major study of the defense industrial base.

For US aircraft designers and the factory workers who build the airplanes, a dispersed industrial base may pose insurmountable challenges. In the southern California cluster of aerospace and high-technology companies, workers can move from plant to plant and company to company without uprooting their families and selling their homes. "It's different if you're talking about going from L. A. to Fort Worth to Saint Louis to Bethpage [N. Y.] to Seattle. I don't think it happens," says James Roche, a corporate vice president of Northrop.

In areas with a much smaller grouping of aerospace plants, the labor pool may become less adept. "Two things happen to the people," says Mr. Roche. "Some simply migrate out of the industry. Others can't be as sharp. This talent will either atrophy or transition to other industries."

It's difficult to quantify the cost impact of this dilution of the aerospace work force. It is certain, however, that the loss of what Mr. Roche calls "the ability to do it right the first time" is bound to increase acquisition costs at the margin, perhaps substantially so.

No one is suggesting that California's aerospace industry is going to disappear, either overnight or in the longer term. Even after five years of slumping defense budgets and mounting concern over the cost of doing business in the Golden State, an estimated 1.2 million Californians continue to draw paychecks at aerospace companies, their suppliers, or related industries.

In El Segundo, home to TRW Inc., Hughes Aircraft Co., and Rockwell International Corp., a staggering 48.8 percent of all jobs are linked to aerospace, according to a May 1991 study by the consulting firm McKinsey & Co. In the Los Angeles area as a whole, more than twenty percent of all manufacturing jobs are rooted in the aerospace industry.

The California Axis

For the Air Force, the Los Angeles–Orange County axis represents the cradle of several high-priority weapons programs. Two top aircraft initiatives, Northrop's B-2 bomber and Douglas Aircraft Co.'s C-17 transport, are under development in Pico Rivera and Long Beach, respectively. In a wide swath from Burbank north of Los Angeles to Newport Beach in the south, one finds Lockheed's famous "Skunk Works," Rockwell's Peacekeeper and Small ICBM missile guidance unit plant, McDonnell Douglas's Delta rocket facility, and Loral Corp.'s Sidewinder missile production line. The industrial legacy represented in this area, its boosters claim, is unequaled anywhere in the country.

It's no accident that some of the most innovative recent weapon developments—chiefly, stealth technologies—have emerged from southern California's design shops. The programs listed above have benefited from a creative, corporate synergy that is hard to describe but very real to the area's aerospace community. "If you're isolated," explains Northrop's Mr. Roche, "you won't have that same kind of intellectual ferment, the sense that things are 'doable.'"

Robert Paulson, who wrote the McKinsey study, says the benefits of an aerospace cluster may even outweigh the extra costs associated with remaining in California. His preliminary research suggests that the advantages of depreciated factories, a skilled work force, and nearby suppliers more than make up for the ten to twelve percent cost premium associated with staying in California.

Mature, high-volume production programs are the chief candidates for moving out of state, according to Mr. Paulson, but defense budget trends point to fewer such programs and relatively more low-volume, developmental efforts where skilled designers are especially valuable. "The productivity benefits of the cluster are quite substantial," he says.

How does weapon development benefit from the existence of an aerospace cluster? The McKinsey study cites at least three advantages. First, the collocation of contractors such as Lockheed, Hughes, Rockwell, and Northrop speeds innovation through "faster information and manpower flows." Second, the large number of firms reduces the risk of and need for investment in specialized training, university research facilities, or common infrastructure such as airfields. Finally, the market demand generated by prime contractors in the area fuels a flourishing network of second-tier subcontractors, where much of the real manufacturing innovation occurs.

"The benefits of the Los Angeles–area 'hive' are very important and will be very difficult to duplicate elsewhere," the McKinsey study concludes.

Face-to-Face Meetings

Industry executives add a practical but often overlooked consideration: the value of face-to-face

contact with partners and suppliers. In October, when Rockwell and Lockheed announced they had joined forces to compete for the Navy's A-X aircraft program, officials pointed to the companies' common southern California location as a key strength. Competitors played down the significance, but Rockwell Chief Operating Officer Sam Iacobellis was adamant: As in real estate, location matters in the defense business. Lou Kurkjian, a Hughes corporate vice president and thirty-five-year industry veteran, agrees. "There's no question being able to personally interact has its advantages," says he.

Others are skeptical. Martin Libicki of the National Defense University says "it's really hard to make a case" that the cluster concept is real. Technological developments may be eroding some of the productivity advantages. Despite the practical pluses of working with the guy next door, say a number of experts, contractors routinely pair up even on highly complex programs with teammates located hundreds, if not thousands, of miles away. For example, the principal subcontractors on the B-2 program—Boeing Co. of Seattle and LTV Corp. of Dallas—are far removed from the Pico Rivera, Calif., plant where 9,000 Northrop workers labor over the new bomber.

Northrop, and other weapons makers, can work successfully with industrial partners across the country using innovative computer technologies that suggest a revolution in defense manufacturing. To return to the example of the B-2, Northrop, Boeing, and LTV were joined by a common computer database. As Northrop refined its B-2 design, minute changes entered in the company's electronic blueprints immediately registered on computer screens in Seattle and Dallas. The difficult chore of updating paper engineering drawings was reduced to a few quick keystrokes.

Says Donald Hicks, a former Northrop executive and later Under Secretary of Defense for Research and Engineering, "Every time there was a change, every contractor knew about it. It made it actually better than being next door because the guy next door might have screwed up and done it wrong."

Such computer-aided design/computer-aided manufacturing (CAD/CAM), with its reliance on so-called "paperless" factories, is perhaps the most exotic factor facilitating the dispersion of the southern California aerospace industry, but more familiar technologies also come into play. Northrop and McDonnell Douglas, for instance, managed their joint work on the YF-23 Advanced Tactical Fighter prototype through weekly video teleconferences, according to Northrop spokesmen.

Technology may be facilitating the breakup of the aerospace cluster, but the true forces of change are California's shifting business climate and pure politics.

Technology may be facilitating the aerospace cluster's geographic dispersal, but it isn't really the engine of change. The true forces behind the breakup are California's shifting business climate and pure politics.

The Pull—and Push

Over the past few years, California has witnessed a steady erosion of its preeminence in aerospace as business has flowed to other locations. In 1990, Lockheed announced it would locate its F-22 Advanced Tactical Fighter work force in Marietta, Ga., not Palmdale, Calif. Before it was canceled, Northrop's Tacit Rainbow missile went to Perry, Ga. It happens that Georgia is the home state of Sen. Sam Nunn, the powerful Democrat who chairs the Senate Armed Services Committee.

Business not only is being pulled elsewhere, but it also is being repelled by California. Earlier this year, McDonnell Douglas decided to build a new commercial airliner in a place that insiders dubbed "anywhere-but-California." The company also shifted some of its C-17 production from Long Beach to Saint Louis and sent part of its Delta rocket manufacturing to Salt Lake City, Utah.

On one level, these decisions were motivated by conditions unique to each company, but the common link was dissatisfaction with California's business climate. Executives complain that the state's environmental and workers' compensation regulations drive up costs. Douglas Aircraft estimates that safety and environmental rules add $33 million to its annual operating costs, more than double the premium in 1986.

The list of complaints is lengthy. A laborious, bureaucratic channel for obtaining air-quality permits typically runs from six to twelve months to, in the worst cases, two to four years, according to a McDonnell Douglas analysis. Labor unions keep California wages high, at least in comparison with such states as Georgia. Requirements for environmental impact statements, even on small expansion projects, are a further impediment to new programs in the area. Aerospace leaders complain that the California workers' compensation package is so generous that it provides for stress disability claims resulting from everyday job pressures. The familiar daily problems of unaffordable housing and congested freeways also make it difficult to attract and retain workers.

"Doing business in California has become increasingly more complex and costly," claims the McDonnell Douglas briefing. "The desirability of California for expanding or entering into new business ventures has eroded because of regulatory and legislative actions."

Despite the industry's importance to California, whether measured in employment, $2.5 billion in state tax contributions, or prestige, the state's congressional delegation is notoriously inattentive, even indifferent, to the fate of major weapons programs. Democrat Alan Cranston, California's senior Senator, is a leading critic of the B-2 bomber, which employs 9,000 Northrop workers. Rep. Mel Levine, also from California, is a staunch opponent of most aerospace sales to

the Middle East, and Rep. Barbara Boxer, currently a candidate for a Senate seat, has been a particularly harsh industry adversary for years.

Indifference in Washington

The California cluster's dispersal is occurring against a backdrop of national indifference to defense industrial base concerns. The Bush Administration's policy toward the defense drawdown is largely a free-market strategy. Such a laissez-faire stance could pose problems during future crises, according to several recent studies. It is one of the principal conclusions of "Lifeline Adrift," an AFA study released last September.

In addition, an Office of Technology Assessment report, which decried "the lack of a national [defense industrial base] strategy," concluded last July that "defense contractors and government organizations are adapting to change in an *ad hoc* manner that could jeopardize the nation's future ability to develop affordable, high-performance weapon systems and to mobilize its defense industrial capacity in crisis and wartime."

Aerospace executives fear that defense industrial base policy is not receiving the attention it deserves. The subtler questions, such as those regarding the benefits of having and maintaining an aerospace cluster in California, fall off the table altogether. Says Hughes's Mr. Kurkjian, "I don't think anybody outside California cares."

For now, industry efforts to arrest the flight of business from southern California are confined to the state level. In May, several chief executives of aerospace firms met with Gov. Pete Wilson to seek his commitment to modify state policies that encourage the exodus. The extraordinary, hour-long meeting with Governor Wilson, a former member of the Senate Armed Services Committee, included Donald Beall of Rockwell, Kent Kresa of Northrop, Malcolm Currie of Hughes, Dan Tellep of Lockheed, and Ron Cedillos, a small testing subcontractor.

In July, when Mr. Cedillos announced the formation of Californians for Aerospace Leadership (CAL), a coalition aiming to preserve the state's industry, Governor Wilson appeared at the inaugural press conference via video hookup. CAL's efforts on behalf of the industry are expected to include an advertising campaign highlighting the voting records of the state's congressional delegation on major weapon systems.

Mr. Cedillos's surprisingly high profile in the industry's drive for regulatory and political relief is appropriate. The aerospace industry is typically thought of as McDonnell Douglas, General Dynamics, Northrop—the major prime contractors. Increasingly, however, critical skills and innovations are found in the ranks of subcontractors, such companies in the southern California cluster as ACL Technologies, Energy Container Corp., and Blaisdell Manufacturing. Unknown outside the aerospace community, these firms represent a cornerstone of defense industrial know-how and innovation but may be the first to suffer from the industry's dispersal, according to analysts.

Unknown outside the aerospace community, subcontractors represent a cornerstone of defense industrial know-how and innovation but may be the first to suffer from the industry's dispersal.

The aerospace hive's creative synergy is perhaps most important in the interaction between the primes and their key subcontractors. Northrop's Mr. Roche argues that the cluster of major primes in the Los Angeles region creates a predictably high demand for subcontractors' talents, which hones the skills of these smaller companies to a fine edge. The subcontractors' proximity to their customers carries other advantages. For example, it facilitates the downward flow of contract requirement data.

"No question," says General Marsh, "the vendors and the subcontractors in the proximity of the primes understand the requirements better, can communicate better, and can be more responsive to concerns."

For some suppliers, being near the major contractors may be a necessity. The advanced computer equipment that allows primes to interact may not be available at a supplier. Communication for these vendors may have to be done the old-fashioned way: face to face.

The dispersal of the California aerospace industry is not occurring in a vacuum. The industrial base is being ravaged by a sixth consecutive year of reduced defense spending, with no improvement likely before the end of the decade. From its 1985 peak of $376 billion, measured in constant Fiscal 1992 dollars, military spending has fallen to $290.8 billion and is expected to hit $250 billion by the middle of the decade. What will be the impact of such reductions? "The industrial base for weapons production will shrink, perhaps jeopardizing the ability of the United States to produce weapons in large quantities later in the 1990s or the next decade, should they be needed," concluded a recent Congressional Budget Office study.

That's why some analysts say breaking up the southern California aerospace cluster may make a bad situation worse. Jack Nunn of OTA suggests that the cost and labor inefficiencies of a dispersed base may not be tolerable at a time of shrinking resources. "Congress should therefore examine new ways of rationalizing the base so that the nation retains a sound [defense industrial base] and not simply a collection of lucky survivors," said the OTA report. ■

David J. Lynch covers the aerospace industry and national defense topics for the Orange County Register *in California. He is a former editor of* Defense Week *Magazine. His most recent article for* Air Force *Magazine, "The C-17 Is Up," appeared in the December 1991 issue.*

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From Vietnam to Desert Storm

By John D. Morrocco

ONE YEAR after President Bush gave the go-ahead to launch what was to become one of the most successful military campaigns in US history, analysts and historians are still sifting through the evidence to ascertain definitive lessons to be learned.

Operation Desert Storm will unquestionably mold the debate over post–cold war military doctrine for years to come. The US experience in the Persian Gulf War will become a touchstone for decisions on reshaping military forces, selecting weapons, and determining how to employ them. The exercise has spawned a cottage industry among journalists, think tanks, and armchair strategists who seek to derive fundamental truths for the future.

There are numerous pitfalls in such an approach, however. The war in the Gulf was unique in many ways, and a large number of the lessons may not be applicable to other scenarios.

Desert Storm must be analyzed in a broader historical context if fundamental truths are to be identified. That requires a basic understanding of what the US learned from its last major conflict—the Vietnam War—and how successfully it applied those lessons to the prosecution of a war nearly two decades later.

The 1991 war marked Washington's first involvement in a major conflict since the wind-down of the war in southeast Asia in the early 1970s. The military machine the US brought to bear against Iraq was shaped greatly by the Vietnam experience.

One of the most controversial aspects of the Vietnam War revolved around the question of the value of airpower. The limits of airpower were made painfully apparent in that conflict.

The war also called into question US reliance on high technology. Ever since World War II, the US had pursued a policy of substituting machines for individuals in combat. This approach was costly, and, in Vietnam, the benefits were hardly visible. For example, the effort to use a high-tech combination of sensors and air strikes to stem the flow of men and materiel down the Ho Chi Minh Trail to South Vietnam proved a costly failure.

Ultimately, experience gained in

An F-4 refuels before flying a "MiG-CAP" (combat air patrol) mission over Vietnam, armed with AIM-7 Sparrows and AIM-9 Sidewinders for air superiority. The lessons learned by US pilots in the skies over North Vietnam helped shape the strategy for Operation Desert Storm.

Vietnam would pay off in Desert Storm. The art of electronic combat evolved from primitive beginnings in Vietnam into a formidable tool. Remotely piloted vehicles, shunned by military leaders for years because of poor performance in Vietnam, began living up to expectations in the Gulf War. Precision guided munitions, first introduced during the Vietnam War, were employed with great effect in Iraq.

Still, the most significant lessons from Vietnam were applied well before January 17, 1991, when Air Force F-117s dropped the first bombs of the Gulf War. In strategic planning and overall management of the air campaign, the legacy of Vietnam was felt most strongly.

The electronic warfare technology that produced stunning results in the Gulf War had its beginnings in Vietnam. In response to the threat from surface-to-air missiles, the Air Force developed the Wild Weasels. Dedicated Weasel aircraft like this F-105G found SAM sites and took them out with AGM-45 Shrike missiles or AGM-78s.

The Critical Air Boss

One manifestation was the decision by Gen. H. Norman Schwarzkopf, the overall military commander, to create a single manager for air operations, a move that had become an article of faith among airmen in the wake of Vietnam.

The specter of Vietnam haunted senior American political and military leaders in the months immediately following the August 2, 1990, Iraqi invasion of Kuwait. It was especially vivid in the minds of senior Air Force officers, many of whom had served in that war.

During a trip to review Air Force units deployed in the Mideast in September 1990, Gen. Michael J. Dugan made it clear that the mistakes of Vietnam would not be repeated.

The Air Force Chief of Staff at the time, who from December 1966 to November 1967 flew an A-1E with the 1st Air Commando Squadron in South Vietnam, spoke for many when he predicted, "This wouldn't be a Vietnam-style operation, nibbling around the edges."

General Dugan went on, "The way to hurt you is at home, not out in the woods somewhere." Discussing the type of air campaign he envisioned against Iraq, the General said, "We are looking for centers of gravity where airpower could make a difference early on."

On that trip, discussions with General Dugan and other senior members of the Air Staff often drifted back to Vietnam. Lt. Gen. Jimmie V. Adams, the deputy chief of staff for Plans and Operations at the time, said Air Force leaders had thought a lot about the Vietnam experience as they prepared for the air campaign against Iraq. (General Adams has since pinned on his fourth star and now commands Pacific Air Forces.)

"I think we learned a lot of lessons in Vietnam, and one of them is that gradualism does not work," said General Adams, who served a year-long tour flying F-4 Phantoms out of Thailand. "We hope that, if we are allowed to inflict pain, . . . we would be allowed to inflict it rapidly and with an overwhelming capability, not unlike in Linebacker II, which, in fact, brought the North Vietnamese to the bargaining table." He was referring to the unrestricted bombing of targets in and around Hanoi and Haiphong in December 1972, raids authorized by the Nixon Administration after peace talks had broken down.

"While everyone wants to hold up Vietnam as the example showing

USAF photo by Sgt. Kimberly Yearyean

One Vietnam lesson applied in the Gulf War: Prosecute the enemy before you have to meet him in the air. Sustained bombing enabled coalition forces to roll over what used to be one of the world's best-equipped armies in just 100 hours. Lying amidst the wreckage of its hangar, this is one MiG-25 that would pose no further threat.

that airpower can't do it all," said General Adams, "the lesson that we learned out of the war was that airpower can't do it all *if it isn't applied correctly.*"

Rolling Thunder

The policy of gradual escalation in the bombing of the North was long a thorn in the sides of airpower advocates. Code-named "Rolling Thunder," it envisaged the measured application of airpower, gradually increasing in intensity, to make Hanoi cry uncle and abandon its war in the South. By the end of 1968, this policy had proved bankrupt.

From the outset, US military leaders had advocated a different course: a massive and rapid strategic air campaign against key military, industrial, and economic targets in the heartland of North Vietnam. They would later argue that the political decision not to heed their professional advice was a major contribution to the US failure in the war.

The perceived failure of airpower in Vietnam had long been an albatross around the neck of the Air Force. General Dugan and others saw the impending conflict with Iraq as an opportunity to show what airpower could do if applied correctly. In deliberations of the Joint Chiefs of Staff, the Air Force Chief of Staff forcefully pressed adoption of a pure air option. General Dugan lost that policy battle, however, and eventually lost his job when he aired his views too explicitly in public.

The idea of relying on airpower alone to achieve American war aims was rejected by JCS Chairman Gen. Colin L. Powell, who also based his arguments on the legacy of Vietnam. General Powell advocated to his fellow Chiefs the massing of an overwhelming air, sea, and land force to eject Iraqi forces from Kuwait. Gen. Merrill A. McPeak, who replaced General Dugan as Chief of Staff, questioned the necessity of such a large force. Though he was less emphatic than General Dugan had been, General McPeak believed airpower could do the job.

General Powell argued that the US needed a force that could ensure total victory. According to high-level military officials, General Powell posed to airpower advocates a difficult question: "What if we don't win?" The nation could not afford another Vietnam, he argued.

Nonetheless, airpower was to play a key role in the armed campaign launched in the early morning hours of January 17, 1991. It was applied much as prescribed by General Dugan four months earlier. Allied air commanders put into motion a strategic air campaign that included rapid strikes against key military and economic targets in Iraq.

Among the first hit were the "centers of gravity" to which General Dugan had referred: Iraqi command-and-control facilities and other targets that would weaken the political and military control exercised by Saddam Hussein and his inner circle. Next came a concerted effort to destroy Iraq's offensive capabilities, including its nuclear, biological, and chemical production facilities and stockpiles, as well as its Scud missiles. Iraq's economic infrastructure was also targeted. Then the campaign shifted its emphasis to strikes against Iraqi ground forces.

The true effectiveness of the bombing against certain segments of this target set is questionable. The most glaring example is Iraq's nuclear weapons program. Overall, however, the US goal unquestionably was achieved. After thirty-eight days of sustained bombing, the allied ground offensive was able to roll over a disorganized and demoralized Iraqi army—formerly one of the world's largest and best equipped—in just 100 hours.

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The lessons of Vietnam were both tactical and technological. Dual-role fighters such as this 4th Tactical Fighter Wing F-15E, equipped with a forward-looking infrared system and both air-to-air missiles and air-to-ground laser-guided weapons, illustrate some of the Air Force's adaptations.

Prophets Vindicated

After more than forty years of unfulfilled promises, airpower achieved nearly all that its most vocal advocates had said it could do.

The concept of "victory through airpower," espoused by Giulio Douhet, Billy Mitchell, and other prophets of airpower, was largely realized in the war against Iraq. While it must be remembered that the situation in the Mideast was ideally suited to air warfare, the success of the bombing campaign proved that airpower could be decisive.

A key element—perhaps *the* key element—in the success of the air war was General Schwarzkopf's creation of an air boss. Overriding the natural desires of the services to run their own air operations, General Schwarzkopf demanded an integrated air campaign run by a single commander for air. Armed with the increased authority given to field commanders under the Goldwater-Nichols Act, General Schwarzkopf was able to avoid the pitfalls his predecessors had faced in Vietnam.

The result was that, for the first time, all US air units went into action under the same operations plan. This was a complete change from the parochialism of two decades earlier, when each military service in the Vietnam War ran its own separate air war.

During the early stages of the air campaign against North Vietnam, Navy and Air Force commanders vied for the relatively few targets open to them. Overlapping command structures and poor communications between Navy carriers and Air Force headquarters in Saigon often resulted in Navy and Air Force strike forces going against the same target.

To eliminate confusion and duplication of effort in Vietnam, the two services agreed to limit operations to certain times of the day. Navy aircraft would hit targets in the morning, for example, while Air Force planes would strike in the afternoon. This solution was soon found to be impractical, as weather delays often led to overlapping missions.

By the end of 1965, an interservice committee arrived at a compromise that lasted for the remainder of the campaign. North Vietnam was divided into six geographical areas, known as "route packages." The Air Force and Navy were given sole responsibility for hitting targets in each of their assigned route packages under the loose coordination of the Commander in Chief, Pacific.

Separately, the air war over South Vietnam was controlled from Saigon by Gen. William C. Westmoreland. He also ran air operations against the Ho Chi Minh Trail in neighboring Laos in conjunction with the US ambassador in Vientiane. By 1970, when the US launched its incursion in Cambodia, the United States was running four separate air wars in southeast Asia, with little coordination among them.

Although there are ninety bombs in this photo, that is still eighteen shy of the full load that a B-52 could carry. The Air Force, remembering bomb shortages in Vietnam, mounted a massive logistics effort in Operation Desert Shield to guard against repeating that problem in Operation Desert Storm.

"Damn Valuable Lesson"

"We learned a pretty damn valuable lesson from that," observes Lt. Gen. Michael A. Nelson, who took over as Air Force deputy chief of staff for Plans and Operations in January 1991. "You need some 'king' who has the coordinating and command-and-control authority to make things happen in a cohesive and coherent way."

In the case of Operation Desert Storm, this person was Air Force Lt. Gen. Charles A. Horner, acting as Joint Forces Air Commander. "He was really the choirmaster, the guy with the baton," General Nelson said. "I have no doubt that our experience in southeast Asia was relevant here. It helped us to see the benefits of a single manager for air."

General Horner, who flew forty-eight combat missions in F-105s over North Vietnam and another seventy in F-105 Wild Weasels, had undisputed control of all US air assets in the Persian Gulf theater. He also was given carte blanche in mapping out an air campaign to achieve the objectives set forth by Washington.

Working closely with General Horner was Brig. Gen. (now Maj. Gen.) Buster C. Glosson, who was given the job of developing that plan in detail. General Glosson, another veteran of the Vietnam War, said some of his actions in planning for the air campaign against Iraq were a direct result of his southeast Asia experiences.

"There were two scars that General Horner and I took away from Vietnam," he said. "One was the fact that we flew missions [in Vietnam] with only one or two bombs, so we weren't about to run out of munitions" in the Gulf War. The second scar, according to General Glosson, was the front-line pilot's sense of isolation from overall planning of the air war in Vietnam. "Sure, I was getting a target and was told to go destroy it," General Glosson said, "but no one had ever taken the time to explain to me how what we were doing was going to lead to some ultimate objective."

Bomb shortages, caused by inadequate stockpiles and logistics snafus, often resulted in pilots being sent on missions against heavily defended targets in the North without

Staff photo by Guy Aceto

Unlike in Vietnam, planning for Desert Storm routinely included personnel from the units that would fly the missions. Senior political leadership left the details to the military professionals. Capt. Dan Kolota (left) and Capt. Ken O'Neill are from the 354th Tactical Fighter Wing, Myrtle Beach AFB, S. C.

a full load of bombs. To guard against this, the Air Force in Operation Desert Shield mounted a massive logistics effort, sustained throughout the war. While isolated instances of munitions shortages were reported during the war, they were not nearly so widespread as in Vietnam.

As for eliminating the pilots' sense of isolation, General Glosson brought into the planning process personnel from each unit that would actually fly missions, in addition to having them on the planning staff at headquarters in Riyadh. As each combat unit deployed to bases in the Mideast, two representatives were sent to Central Command headquarters. There they worked alongside representatives from the Army, Navy, Air Force, and Marines, as well as coalition partners.

The Plan Is Yours

"When the planning for the air campaign was finished and it came time to execute, it was as much their plan as it was our plan," General Glosson explained. "I think that is probably different from any other air campaign that we've ever executed, in that it was not something dictated from headquarters that [the front-line pilots] didn't have anything to do with."

In fact, when the overall air campaign was laid out in skeletal form, General Glosson sent it to each wing commander for his approval. "This is our plan," he told them, "and you have the option of asking me to change anything you want to. Nothing is sacrosanct. We're just trying to do this the smartest way possible."

While General Glosson and General Horner were pursuing this effort to plan from the bottom up, they felt little pressure from above. From General Glosson's perspective, one of the most important factors in the success of the war was the absence of top-level interference in the planning and day-to-day execution of the air campaign.

"We did not have low-level echelons of civilians in the White House or in the Pentagon giving us guidance, second-guessing us, and tweaking everything we did," he said.

In Vietnam, field commanders were exasperated by the micromanagement to which they were subjected by higher headquarters and civilians at the Pentagon. In the early years of the war, targets were selected at the White House by President Johnson and a handful of his most trusted advisors. The President once boasted to reporters, "I won't let those Air Force generals bomb even the smallest outhouse without checking with me."

Defense Secretary Robert S. McNamara also took a personal interest in the smallest of details. One Air Force general recounted how, after a bombing strike against a key bridge in Laos, the pilot who took the bomb-damage assessment photographs was whisked to the Pentagon. He soon found himself in Secretary McNamara's office on his hands and knees going over bombing routes, release points, and other details of the mission with the Secretary.

As the conflict wore on, President Johnson and Secretary McNamara eventually eased their grip on the reins and allowed the military more latitude in the daily execution of the war. By then, however, the initiative had been lost.

This high level of political control in planning and daily operations was noticeably absent in the Gulf War. Once the decision to go to war had been made, President Bush and Defense Secretary Dick Cheney gave operational commanders a virtual free hand in planning and executing the campaign to meet the stated political objectives. The only condition imposed from above was that the plan of operations should be designed to minimize casualties to the allied force and minimize collateral damage and civilian casualties.

"In my opinion, the significance of what President Bush, Secretary Cheney, and Chairman Powell were able to do has not received the recognition that it should," General Glosson said. "We get hung up on the lessons that all of us majors and captains learned in Vietnam. But the senior political leadership in this country learned a lesson, too."

He goes on, "History shows that . . . too much political involvement at a lower level is the most detrimental thing you can do to the military profession," he said. "That did not happen in this war." This was one lesson, said General Glosson, that he hoped would not be lost on future generations. ■

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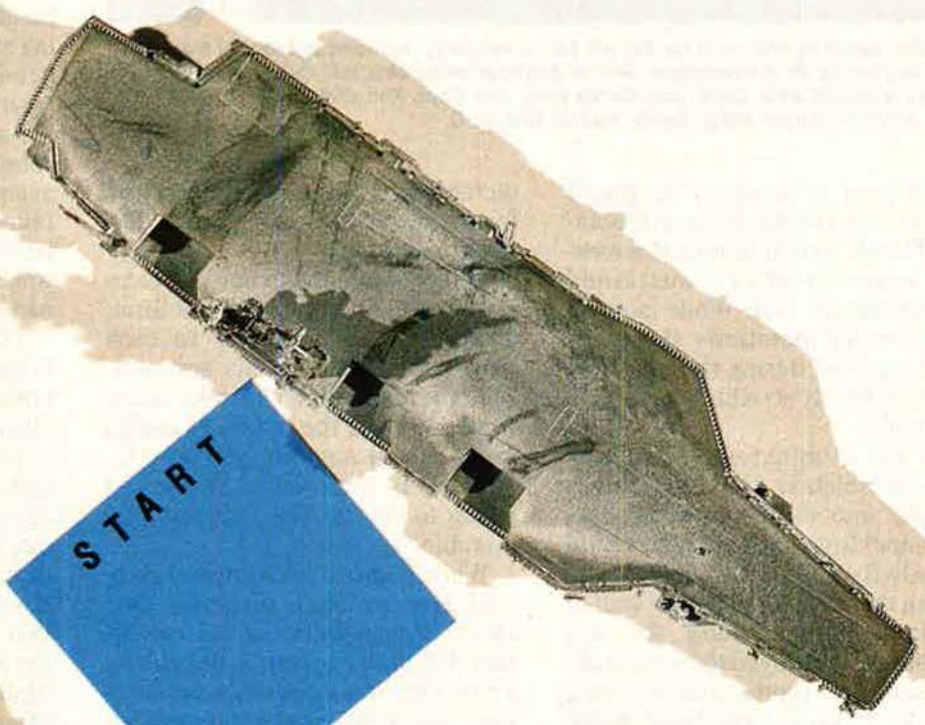
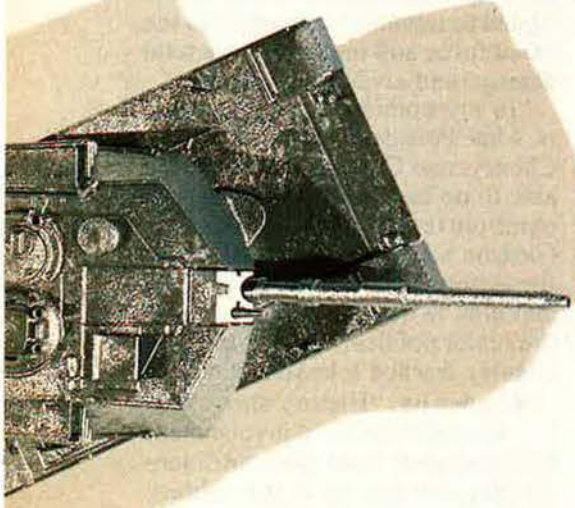
The defense budget debate was supposed to be easy. That was only one of the surprises.

Scorecard 1991

By Larry Grossman





THE debate on the defense budget was supposed to be easy in 1991. The Berlin Wall was history, Germany was reunified, and the Warsaw Pact was going out of business. Moreover, President Bush and Congress already had shaken hands on the top-line Pentagon spending figure.

Then war broke out in the Persian Gulf. The Strategic Arms Reduction Treaty was signed. The failed putsch raised fears of chaos in the Soviet Union. The President ordered Strategic Air Command to stand down from alert its bombers and many ICBMs and began removing tactical nuclear arms from Europe. By year's end, Washington began fretting about a nuclear arms program in Iran.

These factors all helped scramble the defense debate. The level of Pentagon budget authority for Fiscal 1992—$290.8 billion—was established late in 1990 by the Budget Enforcement Act worked out by the White House and Congress. Just how that $290.8 billion would be allocated, however, was the focus of sharp disagreements from February 7, when Secretary of Defense Dick Cheney unveiled his plan in the midst of Operation Desert Storm, until late November, when Congress gave final approval to its own version.

The Fiscal 1992 budget officially ignored the war in the Persian Gulf. The budget summit agreement imposed separate caps in 1992 and 1993 on the amounts Congress could appropriate for defense and for domestic spending. The spending level was based on domestic fiscal constraints and a revised US military strategy that turned away from the Soviet Union and toward regional threats.

In late 1990, the budget summiteers agreed to chop defense spending in 1992 one percent below the amount needed to keep pace with inflation and a real four percent in 1993. In Fiscal 1991, Congress hit the Pentagon with a much deeper cut, driving spending levels down by an inflation-adjusted twelve percent. The Pentagon projects that the decreases will continue, showing a real thirteen percent reduction in 1991–96 and a cumulative reduction of thirty-two percent between 1985 and 1996.

In Fiscal 1992, national defense investment accounts, which include money for procurement, research and development, military construction, and the Energy Department's nuclear weapons work, are to rise to $119.6 billion, up from $115.2 billion in 1991.

"Fantastic Success"

When it comes to weapons procurement, however, the Defense Department finds itself once again with less money than it had a year earlier. The four percent cut in Fiscal 1992 comes on top of last year's decision to pursue a twenty-four percent reduction over time.

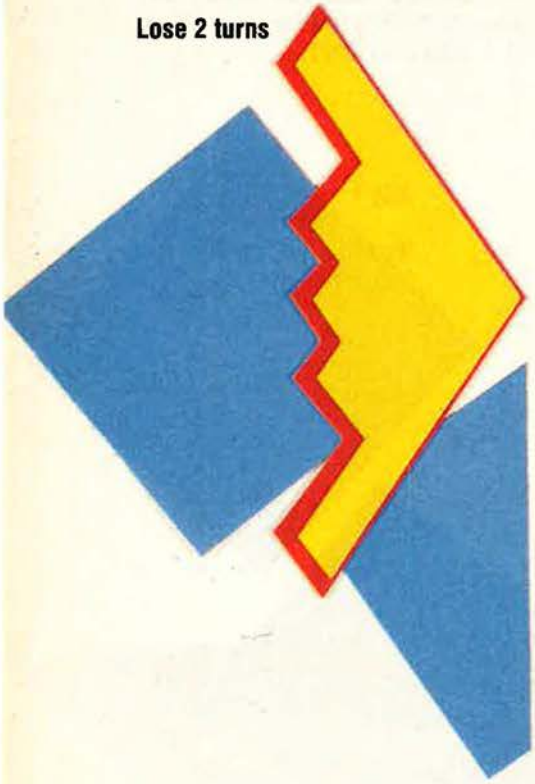
The Pentagon continues to bet heavily, albeit selectively, on high-technology programs. "The fantastic success of American arms in the Persian Gulf today relates directly to the investment . . . made over the years in technology," Secretary Cheney told Congress.

The Air Force's procurement and research accounts grew more than those of any other service. Taken together, they rise nine percent, from $22.7 billion to $24.8 billion.

July 26

B-2 test anomalies identified

Lose 2 turns



Unlike last year, however, the Administration's 1992 request contained a number of cancellations—eighty-one in all—of weapon systems. As is usual in the defense budget process, Congress resuscitated several.

For the third year running, the Air Force's B-2 Stealth bomber served as the focus of the most contentious debate seen on any weapon system. The Air Force requested a total of $4.82 billion to spend on the B-2 in 1992. This included $2.46 billion for procurement of four B-2s in 1992 and $455 million in advanced procurement for seven additional bombers in 1993. Also requested was $289 million for spare parts and $1.56 billion to continue development. In 1990, the House voted to terminate B-2 production in Fiscal 1991, permitting no new-construction aircraft beyond the fifteen it previously agreed to buy. The Senate fully funded the Air Force's request, and, led by Sen. Sam Nunn, the Georgia Democrat who chairs the Senate Armed Services Committee, the body reaffirmed its support for the bat-winged bomber.

After last year's vitriolic conference between the two sides, Senator Nunn and his House counterpart, Rep. Les Aspin (D-Wis.), conceded they had "agreed to disagree." Unable to reach a compromise on the B-2 program, Congress provided money to cover a funding shortfall but authorized no new construction of aircraft.

During the Fiscal 1992 debate, B-2 backers hoped to capitalize on the Desert Storm success of the F-117 Stealth fighter. The Air Force sent to Capitol Hill its top Persian Gulf planner, Lt. Gen. Charles A. Horner, as well as several F-117 pilots, all of whom testified about the merits of stealth technology. Would General Horner have used the B-2 bomber in the Gulf War if it had been available? "You bet I would," he told the House Appropriations Committee's Defense Subcommittee.

Nevertheless, the House, led by Representative Aspin, once again voted to end the B-2 program, funding only R&D aspects of the program. In his Procurement and Military Nuclear Systems Subcommittee, Mr. Aspin garnered a bipartisan 15-4 vote to spike the program.

Senator Nunn successfully ushered the B-2 through the Senate, but one of the plane's most vocal supporters, Sen. James Exon (D-Neb.), warned Air Force Secretary Donald B. Rice of impending trouble. If the White House did not quickly launch a vigorous public campaign for the program, said Senator Exon, the B-2 would be in serious trouble.

Senator Exon on Target

Unfortunately for the Air Force, Senator Exon couldn't have been more on target. As a result of the decline of the Soviet threat, President Bush's nuclear stand-down order, and word that the B-2 was showing less-than-expected stealthiness during tests, support for the bomber eroded.

In the end, Senator Nunn and Representative Aspin agreed to forgo purchase of any new B-2s, authorize $4.4 billion for new parts and advanced development, and fence $1 billion for a prospective sixteenth plane, which must be approved separately and which might never be built. Congress also erected several testing hurdles that the B-2 must get over before more money can be spent on the aircraft.

The Air Force budget sought to continue F-16 production through Fiscal 1993. Convinced that stealth technology had revolutionized air warfare, however, the Senate voted to terminate F-16 production early—in 1992—and shift the money to reopen a cold Lockheed F-117 Stealth fighter assembly line to add twenty-four new F-117s to the fleet of fifty-six already in service. The House, on the other hand, supported the Air Force's request of $1.07 billion for forty-eight more F-16s.

The Air Force said that the Senate's position would leave it unable to meet tactical fighter force-structure requirements. Ending F-16 production after 1991 would also

August 19–23

Soviet coup is launched, fails

Go back to START

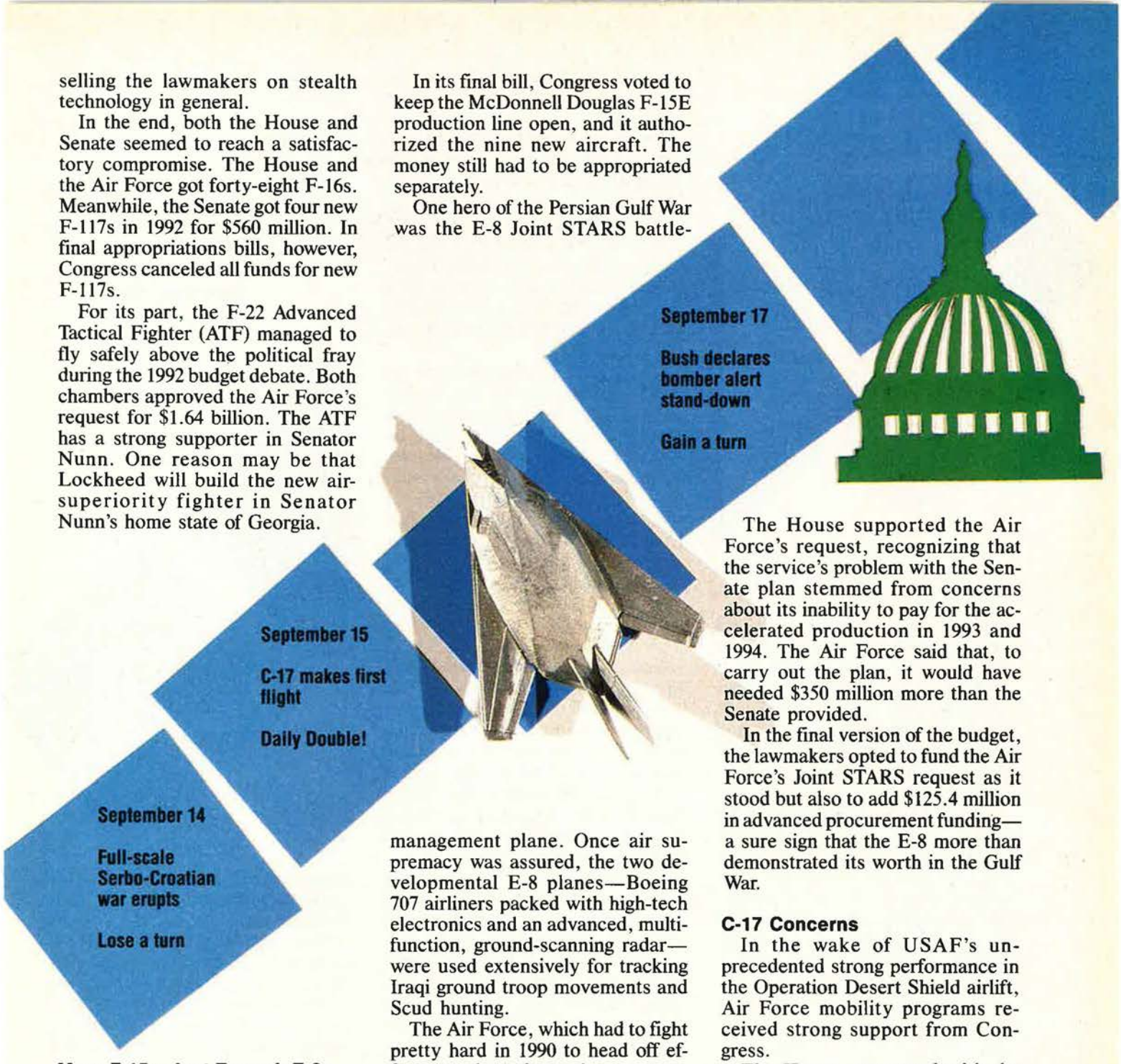
delete seventy-two planes from an existing multiyear contract, costing $645 million in termination penalties. "The Senate plan to procure F-117s is impractical," the Air Force asserted in an appeal.

Initially, it seemed that the Senate was willing to trade more F-16s to the House for a better B-2 outcome. The F-16 is heavily supported by House members, the Texas delegation in particular. At some point, however, the debate became one of F-117 vs. F-16, and the Air Force found that, in its promotion of the B-2, it may have done too good a job

selling the lawmakers on stealth technology in general.

In the end, both the House and Senate seemed to reach a satisfactory compromise. The House and the Air Force got forty-eight F-16s. Meanwhile, the Senate got four new F-117s in 1992 for $560 million. In final appropriations bills, however, Congress canceled all funds for new F-117s.

For its part, the F-22 Advanced Tactical Fighter (ATF) managed to fly safely above the political fray during the 1992 budget debate. Both chambers approved the Air Force's request for $1.64 billion. The ATF has a strong supporter in Senator Nunn. One reason may be that Lockheed will build the new air-superiority fighter in Senator Nunn's home state of Georgia.



More F-15s, Just Enough E-8s

On the Pentagon's list of cancellations was the Air Force's F-15E, an air-superiority and ground-attack fighter that proved itself time and again in the Persian Gulf air war but which the service thought was already available in sufficient numbers.

The Senate found $125 million in Fiscal 1992 for three new F-15Es and authorized six F-15Es in a supplemental 1991 bill. The six 1991 aircraft would be bought with $250 million, part of the $624 million that the Saudi Air Force paid for twenty-four older F-15s.

In its final bill, Congress voted to keep the McDonnell Douglas F-15E production line open, and it authorized the nine new aircraft. The money still had to be appropriated separately.

One hero of the Persian Gulf War was the E-8 Joint STARS battle-management plane. Once air supremacy was assured, the two developmental E-8 planes—Boeing 707 airliners packed with high-tech electronics and an advanced, multifunction, ground-scanning radar—were used extensively for tracking Iraqi ground troop movements and Scud hunting.

The Air Force, which had to fight pretty hard in 1990 to head off efforts to close down the program, found itself in the unlikely position of lobbying against a Senate plan to double the production rate of Joint STARS.

The service has planned to buy no airplanes in 1992 and only three E-8 aircraft by 1994. The Senate wanted to top the Air Force's advanced procurement request of $62.7 million with another $62 million and would have directed USAF to spend $652.2 million from the Desert Storm Defense Cooperation Account for the production of six planes—two each in 1992, 1993, and 1994.

The House supported the Air Force's request, recognizing that the service's problem with the Senate plan stemmed from concerns about its inability to pay for the accelerated production in 1993 and 1994. The Air Force said that, to carry out the plan, it would have needed $350 million more than the Senate provided.

In the final version of the budget, the lawmakers opted to fund the Air Force's Joint STARS request as it stood but also to add $125.4 million in advanced procurement funding—a sure sign that the E-8 more than demonstrated its worth in the Gulf War.

C-17 Concerns

In the wake of USAF's unprecedented strong performance in the Operation Desert Shield airlift, Air Force mobility programs received strong support from Congress.

The House concurred with the Air Force's position that it was important to spend $1.98 billion to purchase six developmental C-17 long-range airlifters in Fiscal 1992.

The first C-17 made a successful first flight in September *[see "The C-17 Is Up," December 1991 issue, p. 46]*, but the House Armed Services Committee was concerned that Air Force plans to build twelve C-17s in 1993 would be moving too fast. The panel noted that flight tests would not be finished until that year. Worried about concurrent development problems, the House slowed the program by funding only $122

million of the $222 million requested for components for six C-17s in 1993.

The Senate voiced even sharper concern about C-17 management problems, schedule slippages, and cost overruns. It rejected the Air Force's request, funding just four C-17s with $1.52 billion.

In the end, the Air Force received only four new C-17s in 1992 and some $122.4 million in advanced procurement funding for eight more in future years. However, Congress said only $400 million of that could be spent until Secretary Cheney submits a five-part report addressing congressional concerns.

The Senate rejected the Pentagon's decision to stop construction of Peacekeeper ICBMs. It authorized $652 million to buy twelve more test missiles and emphasized that it was important to keep the nation's only ICBM production line open at a time of Soviet instability.

The Senate did bar the Air Force from conducting a planned Peacekeeper rail-garrison test launch. The House, which ordered the test launch last year, funded the Air Force's request of $260 million. The President's September arms-control initiative left congressional negotiators with an easy decision. Because President Bush canceled the Peacekeeper rail-garrison, Congress saw no reason to disagree. However, the lawmakers funded the procurement of six test missiles for $57 million.

The House authorized $549 million, as requested, to develop the Midgetman single-warhead Small ICBM and its off-road, mobile launcher. The Senate followed suit. Even though President Bush moved to cancel the mobile Midgetman, congressional experts chose to fund the program anyway, saying that an option for mobility is essential to the program.

Congress as a whole approved the Air Force's request for another 120 stealthy AGM-129 Advanced Cruise Missiles, at a cost of $502 million, as well as $177 million for ongoing development of the nuclear-armed, Short-Range Attack Missile II (SRAM II) that could be launched from both the B-1 and B-2 bombers.

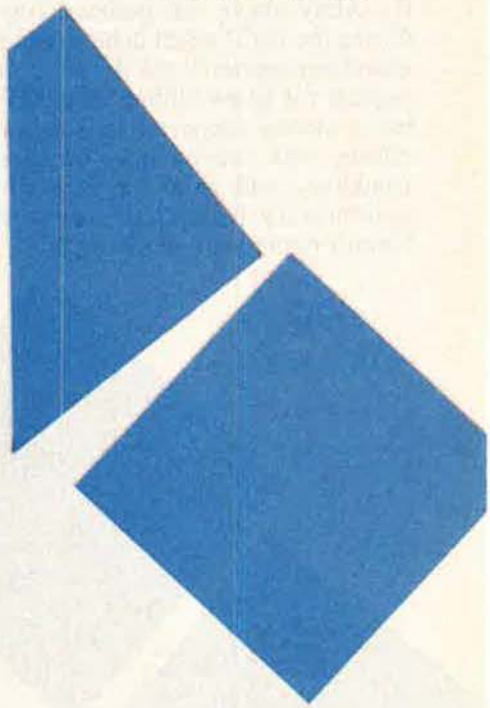
In June, the House zeroed SRAM-T development funding, banking $61.2 million in Pentagon and Energy Department funding. The Senate reduced SRAM-T spending to $34 million. Capitol Hill insiders say the Senate never had any intention of buying SRAM-T, a tactical nuclear weapon for use in a NATO–Warsaw Pact war in central Europe. It was kept in the budget as a B-2 bargaining chip. The Senate had the same thing in mind when it funded the unrequested twelve Peacekeeper test missiles.

On September 27, President Bush announced a number of unilateral US nuclear moves, including cancellation of SRAM II and SRAM-T as well as the rail-garrison basing system for the Peacekeeper and the road-mobile capability for the Midgetman. Some B-2 supporters said the timing of the President's initiative undercut their position at the bargaining table.

The Most Controversial Item

The Strategic Defense Initiative generated conflicts in 1991 that proved most difficult to resolve, more so than any other arms program considered in Congress during the year.

Since SDI's inception in 1983, Congress has funded the program to the tune of about $3 billion each year but with little or no specific guidance regarding its purpose. Last year proved to be no exception. In his 1992 blueprint, President Bush recast SDI to emphasize early deployment of a GPALS (Global Protection Against Limited Strikes) system. GPALS would protect the nation against an accidental or unauthorized launch of a ballistic missile. This scenario has come to seem less far-fetched, given the breakup of the Soviet Union. The system would be based on the so-called Brilliant Pebbles system of space-based interceptors.



The SDI program got a boost as Americans watched Patriot interceptor missiles knock Iraqi Scuds out of the skies above Saudi Arabia and Israel. "You cannot watch the Scuds fly at Tel Aviv and Riyadh and not be concerned that we have a way to develop the capacity and field the capacity to deal with ballistic missiles," Secretary Cheney said while defending GPALS before Congress. Opponents of SDI argue that there is little relationship between SDI's more ambitious goal of global

defense and antitactical missile defenses, such as that provided by the Patriot system.

The Senate approved $4.6 billion of the President's $5.2 billion SDI request. The House went lower, funding just $3.5 billion. While the Pentagon looked skyward, both the House and the Senate endorsed a focus on ground-based weapons capable of intercepting limited strikes. Unlike the Senate, however, the House denied all spending on Brilliant Pebbles.

The Senate mandated deployment by 1996 of an antiballistic missile (ABM) system that complies with the 1972 US-Soviet ABM Treaty, which, as amended in 1974, limits each nation to defenses at one site only. Senators urged the President to renegotiate the ABM Treaty to allow for more than one ABM location.

The Senate and the House agreed on a specific SDI plan for 1992, the first year for which they have done so. They even set a tentative deployment timetable for ground-based interceptors. Congress allotted $4.15 billion for SDI and set up a program that would place interceptors at a single site at Grand Forks, N. D., around 1996. This allows deployment of an antimissile defense system without violating the ABM Treaty.

Personnel Cuts

The scope and magnitude of cuts in military personnel had been worked out by the Pentagon and Congress the previous year.

The House and the Senate approved the Pentagon's request to reduce active-duty military personnel end strengths in FY 1992 to 1,886,000, a cut of 106,000. Due to the Gulf War, Congress allowed the armed forces to waive 1991 force reductions included in last year's spending plan. For its part, DoD got its reduction rate back on track and will meet its goal of cutting active-duty personnel by twenty-five percent by 1995.

The Air Force will reduce its uniformed personnel from 508,600 in 1991 to 486,800 in 1992. The Army faces reductions of 42,000 personnel per year, reaching end strengths of 660,600 in 1992 and 618,000 in 1993. Navy end strength will fall 18,321 in 1992 and 15,400 in 1993, to 536,000 sailors, and 182,200 Marines will be in uniform in 1993, after reductions of 5,735 in 1992 and 5,800 in 1993.

The Senate also moved to lower the ceiling on US troop strength in Europe to 235,700 in Fiscal 1992. This would amount to a reduction of about 50,000 from the number of personnel in Europe at the end of Fiscal 1991.

Both chambers passed so-called sense of the Congress provisions encouraging the President to reduce military personnel deployed in Europe to under 100,000 by 1995. Both the House and the Senate approved the Pentagon's requested 4.2 percent pay raise effective January 1.

While Congress let the Pentagon proceed in its planned active-duty reduction in force, both House and Senate rejected the military's proposal to slice more than 107,000 members from the 1.08 million–member National Guard and Reserve. The House approved a cut of fewer than 38,000 Guardsmen and Reservists, the Senate just 32,716.

In its annual conference appeal, the Pentagon stated what it views as the obvious: "Retention of reserve component forces at previous levels is not strategically warranted or fiscally supportable." Even though active-duty force structure is on its way down, Congress chose not to cut too deeply into the politically powerful Guard and Reserve and agreed to the House's position.

In May, the House Armed Services Committee approved a provision repealing the 1948 statutes barring assignment of women to combat aircraft. Several months later, the Senate followed suit. The move brought together liberal Democrats and some of the Senate's most conservative Republicans. "Individual ability and individual skill—not gender—must determine who flies," said Sen. William Roth, a Delaware Republican. In removing the congressionally imposed restrictions, "we give women the chance to compete for these positions."

In the final version of the 1992 budget, Congress formally lifted the forty-three-year-old ban on women flying in combat aircraft, allowing them to fly Air Force fighters in battle and deploy aboard Navy carriers. ■

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Spatial disorientation is the most common cause of fatal Class A flying mishaps in the Air Force.

Which Way Is Up¿

By Robert E. van Patten

I ONCE had occasion to swap pilot yarns with an elderly retired Air Force colonel who was the luckiest man I ever met. He had somehow managed to survive near-simultaneous encounters with two of the deadliest pilot-killers.

Speaking of his cadet days in the 1940s, the colonel remarked that, like every other cadet, he was convinced that he was a natural-born pilot, and immortal too. In the grip of these delusions, he flew his Stearman biplane trainer straight into an overcast, just to see if all he had been told about "flying blind" was true. He was lucky; the overcast was thin, so the murk above him was brighter than the murk below him. He had no difficulty staying oriented with respect to "up" and "down."

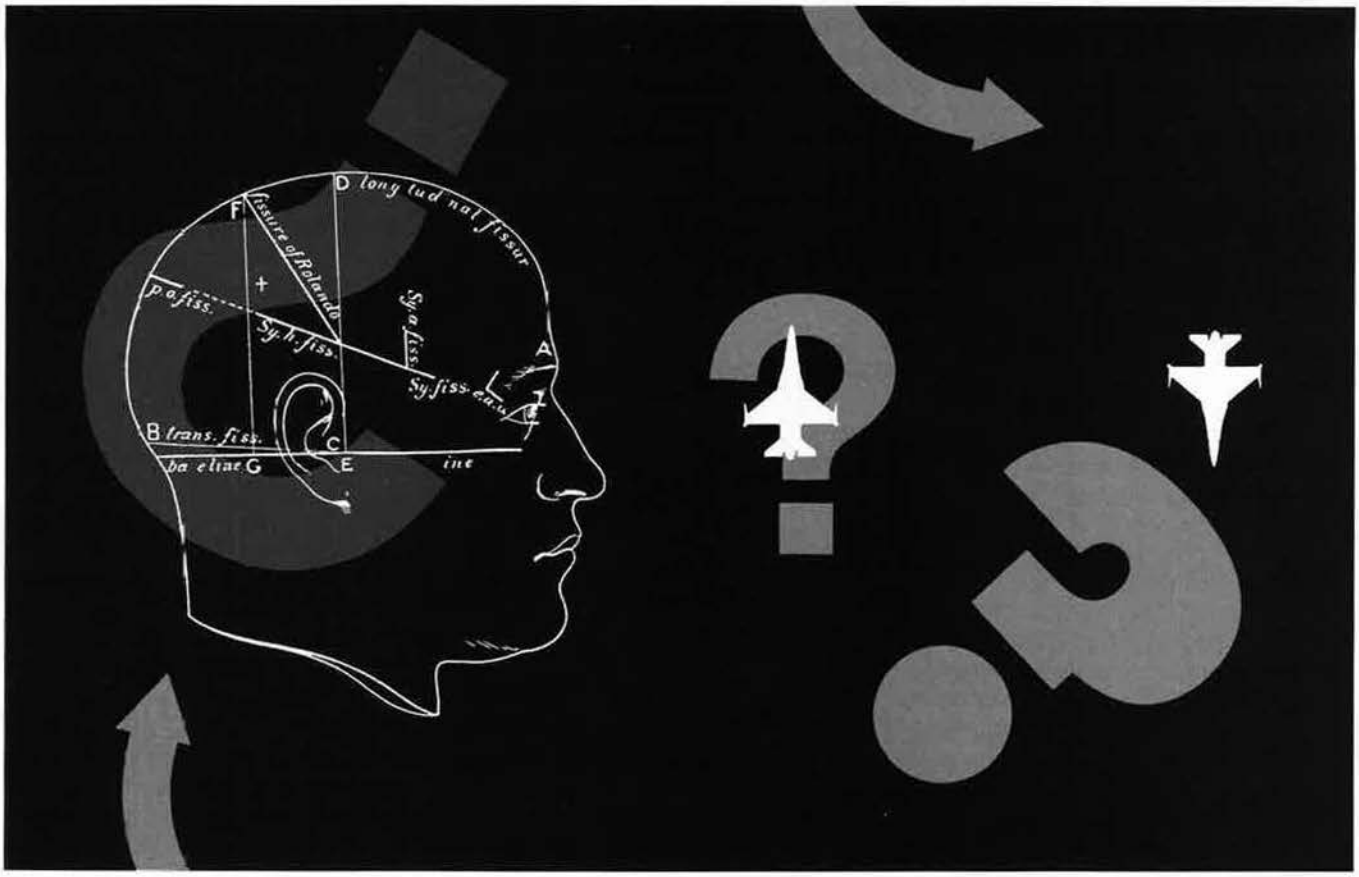
He flew around in the soup for a while and then made an uneventful let-down into clear air and returned to base. "Piece of cake," or some similar thought, went through his mind.

Two weeks later, now firmly committed to his delusions, he again deliberately entered an overcast. This time, the murk was thick, and he almost ran out of luck. By the time he realized he could no longer tell which way was up, it was too late.

His first clue that something was wrong, he told me, was when he noticed that "the plane was acting kind of strange" and that the joystick had become difficult to move. Then he noticed that he had developed a dangerously high airspeed. At about this time, he looked up over his upper wing and, as he fell out of the overcast, saw he was staring at a Georgia tobacco barn.

Now realizing very late that he was inverted and caught in a power dive, he retarded the throttle to idle and yanked on the pole with all his strength. He remembers pulling so hard that he could feel the stout oak of the joystick bending.

That, in fact, was the last thing he remembered before the moment, some time later, when he emerged from G-induced loss of consciousness and found himself earnestly studying his hand before his face and thinking, "Is this my hand?" Thanks to the inherent stability of the Stearman biplane and to the reduced power setting, the plane had recovered by itself to level flight and



was sedately puttering through the air while he was out cold.

Rare indeed is the individual who survives nearly simultaneous encounters with spatial disorientation and G-induced loss of consciousness. Spatial disorientation (SD) is the most common cause of fatal Class A mishaps in the Air Force. G-induced loss of consciousness (G-LOC) is second. Like I said, he is the luckiest man I ever met.

A Stealthy Killer

Spatial disorientation is such an effective and stealthy killer because it affects our most fundamental perceptions of our surroundings. Nature has equipped humans with powerful and subtle means for determining our orientation in any earthbound setting. Probably the most important orientation sense we possess is vision. Even in simulators deliberately designed to induce SD, a good out-the-window visual display will permit the pilot to avoid it. In an aircraft flying in zero-zero weather, vision is, of course, no help, and we are deprived of one of our fundamental orienting methods.

Equally important are the exquisite little structures located in the inner ear: the organs of balance, known also as the vestibular organs. Each ear has two sensory systems, each with a distinct purpose.

The semicircular canals are little tubules filled with a fluid that moves and stimulates other sensors in accordance with the angular accelerations we experience in pitch, roll, and yaw. The semicircular canals are arranged at right angles to each other and lie, approximately, in the pitch, yaw, and roll planes of the body.

The semicircular canals tell us nothing, however, about which way is up or down. That job is done largely by the otolith organs. In the otolith ("otolith" is Greek for "ear stone") organs, tiny calciferous grains compress or distort little hair-like sensors in whichever direction the local gravity vector moves them. This direction we sense as "down." The otoliths sense linear accelerations instead of the angular accelerations sensed by the semicircular canals.

Less subtle are other anatomical sensors that contribute to our sense of "up." Early aviators knew about these sensors, which gave rise to the expression "flying by the seat of your pants" and which, until modern instruments came into widespread use, governed the way everybody flew. It was a part of having "air sense."

A skilled early airman could tell by the feeling in his buttocks whether the turn he was in was coordinated or not. In an open-cockpit plane, he could tell by the pressure of the wind on his face if his aircraft was skidding in yaw.

Sensors in our muscles and joints give us feedback about pull-push, limb direction and position, and so on.

In our daily earthbound life, the otoliths tell us that "down" is right below us on a line passing through the center of gravity of our bodies; the semicircular canals confirm to us that we're not reeling around, or from side to side, or fore and aft; the pressure on the soles of our feet confirms that gravity is where we think it is; and our vision powerfully confirms all of these inputs. We stay out of trouble and get where we're going.

Launched From a Carrier Deck

Contrast this with a situation frequently faced by pilots launching from an aircraft carrier. Carrier SD accidents (like most of them) commonly occur during adverse visual conditions or at night. The pilot moves up to the catapult, hooks up, gets set, and salutes the catapult captain. At full thrust, assisted by the snap of the catapult, the fighter streaks down the deck under longitudinal acceleration of about three Gs. To understand what happens next, we have to do a little physics.

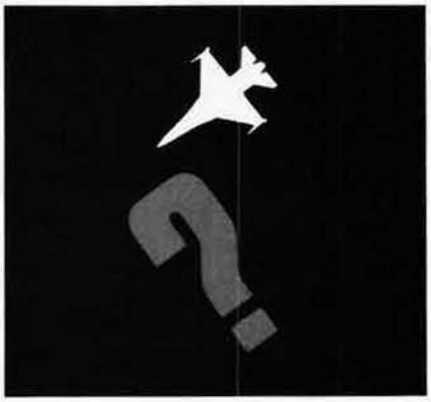
The pilot's otolith organs are now subjected to two different linear accelerations: the one G of earth gravity, pointing straight down, and three Gs of longitudinal acceleration, pointing directly aft. If you sum these two accelerations properly, you get a total acceleration vector of almost 3.2 Gs, and the direction of this G force points backwards and down at an angle far from the normal vertical axis. This "specific force" is interpreted by the brain as the "new" direction of "down." The pilot thus has the powerful impression that he has rotated onto his back.

If the pilot cannot orient himself to the horizon immediately, he is going to have an instantaneous impression that his climb angle is much steeper than it is. To make matters worse, his visual system may go along with the joke and give him the impression that his instrument panel is also moving upward. The pilot's instinctive reaction is immediately to issue a "pitch-down" command in an aircraft that is barely flying and is, in addition, a bare seventy-five feet above the water. Water, when hit at any speed higher than about sixty knots, might as well be concrete.

This situation is one in which many Navy pilots have been killed and is a good example of the most insidious of the three types of SD: Type I, unrecognized spatial disorientation.

Current Air Force scientific thinking defines unrecognized SD only in conjunction with loss of situational awareness resulting from excessive work load, channelization of attention, and distraction. The pilot's subconscious is flying the aircraft while his conscious attention is elsewhere.

In one such case, bombing demonstrations were being performed for a military audience. The first aircraft into the target missed it. The pilot of the second aircraft in the strike became so fixated on the target and so determined to outdo his predecessor that he flew his aircraft straight into the ground. This is an example of unrecognized SD, in



which there was no spurious vestibular input of any kind to the pilot. He died because his conscious mind was not thinking about flying.

Carbon Copy Accidents

Another classic example goes back to the early days of high-performance jet flying. In one specific type of aircraft, it was necessary for the pilot to lean to one side and down in order to reach and manipulate the channel selector on the radio. After a number of fatalities with this aircraft during landings at night or under instrument conditions, accident investigators finally realized that there must be a common factor.

The common thread that ran through all of the crashes was this: Impact always followed, or coincided with, the same turning maneuver at the same point in each landing. In every accident, the aircraft abruptly curved into the ground.

At first, the problem seemed destined to remain a puzzle. The landing maneuvers were simulated in the same type of aircraft at a sufficiently high altitude to ensure a safe recovery if it proved to be some vicious habit of the plane itself. The investigators, however, found no problem—no wingroot stall, no sudden pitch-over, nothing.

Finally, someone suggested having the test pilots go aloft and run through the entire landing scenario, again at safe altitudes, and do exactly what the pilot would be doing at every point during the landing. The answer to the mystery surfaced immediately. During a turn, the pilot leaned over to change the channel on his radio and, instantly, had the powerful and urgent impression that the plane had rolled and climbed.

In this case, again, the pilots' instinctive reaction was exactly wrong. It was to reverse the climb, get the nose down, and get the wings back to the right bank angle. At low altitude, this instinctive reaction led to the observed fatal maneuver just prior to the crash.

The culprits here were three. First, the pilot was functioning under time pressure and high task load while maneuvering at low altitude. Second, in leaning down to reach his radio, he was forced to look away from the front panel and thus was distracted from the instrument cross-check that would have saved him.

Finally, when the body is moving at significant speed in a curved path, head motions can produce asymmetrical input to the vestibular organs, giving a powerful impression of rolling and turning. This effect is called the Coriolis illusion, named after a French artillery officer, Gustave-Gaspard Coriolis, who first noticed how compound angular motions influence the long-distance flight of artillery projectiles (the Coriolis force).

Diverted Attention

This example shows how pilot activities or work load can exacerbate the stealthy and insidious effects of unrecognized spatial disorientation. Researchers at the Air Force Inspection Agency at Norton AFB, Calif., have learned from close examination of Class A mishap records that Type I accidents are often accompanied by a loss of situational awareness (LSA).

LSA can be caused by simple inexperience or inattention, but more frequently it is caused by high work load and channelization or distraction of attention. To make a bad situation worse, this channelization of attention often distorts the pilot's perception of time so that instrument checks are delayed until it is

too late to correct a situation that has been steadily worsening while the pilot's attention was elsewhere.

The second class of spatial disorientation, Type II, is known as recognized SD. In this case, the pilot is aware of the disorientation and, if he is experienced enough and disciplined enough, can work through a proper recovery sequence—if, in fact, a recovery is physically possible.

The third major class of SD, Type III, is incapacitating spatial disorientation. Here, the disorienting motion of the aircraft is so severe and so violent that the pilot may not be able to maintain physical contact with the controls, or he may be disoriented enough or threatened enough to be incapable of rationally perceiving and processing information and making decisions. Worse, this kind of violent-motion environment usually generates a trembling of the eyes (nystagmus), which prevents the pilot from reading the flight instruments upon which his recovery and his life depend.

Fortunately, this type of SD occurs rarely and usually in extreme weather or out-of-the-envelope flight regimes. The scene of Chuck Yeager's F-104 flat-spin accident in the movie "The Right Stuff" gives a good idea of what this is like.

There are many other types of spatial disorientation. One involves tricks played by a pilot's vision and perception. It includes special problems of sloping runways, unfamiliar surroundings close to the runway, runways significantly narrower or wider than what the pilot is used to, sloping coastlines or cloud layers, featureless surfaces of snow or water. The list goes on and on.

Not Much Help for Pilots

There has to be, or at least should be, some way of introducing pilots to spatial disorientation and training them to avoid it, right? Well, there is and there isn't.

For years the device used to introduce pilots has been the Barany chair, which is used to prove to you that, yes, you can get dizzy; yes, you can get very sick to your stomach if you move your head around while spinning; and, yes, things are not always what they seem. Apart from that, the Barany chair is next to useless for spatial disorientation training purposes.

The first real aid to instrument flying was the famous Link trainer, which had a limited motion base permitting unlimited yaw motion with limited roll and pitch motion, a canopy-like hood that could be used to eliminate the trainee's contact with surroundings, and a full set of instruments and controls, usually a reproduction of the cockpit of a BT-13.

The motion base of the Link trainer turned out to be worse than useless because it gave false motion inputs. The main virtue of the Link trainer—not an insignificant one—was its value in teaching the use of the gyro-horizon (what now is called the attitude/direction indicator) and other gyro-stabilized instruments in instrument flight and the lifesaving habit of methodical and periodic instrument cross checks.

As a result of the negative experience with the motion base effects in the old Links, the next generation of military trainers frequently dispensed entirely with motion. Indeed, the presence of motion bases in any flight simulator has yet to prove its value in terms of transfer of the training to the cockpit.

No matter how good these flight simulators may be, they are, in their present form, useless for training in or demonstrations of spatial disorientation. To understand why, recall that SD frequently results from certain kinds of angular acceleration input to the semicircular canals and certain kinds of linear acceleration input to the otoliths.

To reproduce these with any fidelity, an SD demonstrator/trainer must be able to produce sustained angular and linear accelerations. This cannot be accomplished on any conventional motion base used in flight simulators.

Consequently, the design and production of spatial disorientation trainers is a complex and relatively young science. Only recently has it been widely understood that it is necessary to have unlimited motion in pitch, yaw, and roll as well as planetary motion capable of producing moderate levels of sustained (linear) accelerations in a spatial disorientation simulator.

Returning to the issue of Type I SD, recall that channelization of attention, distraction, and target fixation have been cited as the usual companions of a Type I accident. This recently perceived idea has imposed new requirements on the design of spatial disorientation trainers. It is no longer sufficient for the device to provide the appropriate angular and linear accelerations required to generate the illusions.

The cockpit of a modern SD trainer must provide a functioning, aircraft-specific cockpit simulation. Moreover, this simulated cockpit must be sufficiently complex to allow the trainee to experience the kinds of mission work load stresses that will allow him to learn how their distracting effects can get him killed by SD.

In order to achieve a significant training effect with these devices, motion that is consistent with true flight profiles must be provided. In terms of training, it is also necessary to provide identical, repeatable stimuli so that the nature of the training is the same from student to student. After all, no teacher would conduct a class in which each student had a different book.

Consequently, modern SD demonstrators/trainers are computer controlled. In the most advanced models, the flight profiles are captured in software to provide identical, repeatable demonstrations and training. Computer-generated imagery is also now an important part of the design of these machines; in the most advanced ones, the student has a wide-field-of-view, high-resolution, color visual display, which provides the SD trainer with many of the characteristics inherent in a flight simulator. ■

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A unique fighter plane and the men who flew it pioneered a new element of airpower with far-reaching consequences.

Night Fighters

By John L. Frisbee

EARLY in the morning of March 2, 1945, 1st Lt. Herman Ernst lifted his fighter off the runway of Strip A-78 near Florennes, Belgium. His mission was to patrol between the US First Army bomb line and the Rhine River. German aircraft were active in that area, supporting their retreating ground forces and attacking Allied supply lines. Before Lieutenant Ernst had been airborne for an hour, his fighter took flak hits that he judged not serious enough to abort the mission.

A few minutes later, a bogie was picked up two miles away at an altitude of 6,500 feet. As he closed on the target, Ernst identified it as an Me-110 taking violent evasive action. At a range of 400 feet, he opened fire, seeing strikes on the aircraft fuselage. The German pilot peeled off in a screaming dive and was lost in the uncertain visibility.

Almost immediately, another bogie was spotted a thousand feet below. Lieutenant Ernst maneuvered to a position behind the enemy aircraft, now identified as a Ju-87, and fired from 500 feet. Hit and out of control, the Ju-87 dove into the ground, exploding on con-

Photos from the Jeffrey Ethell Collection

The US built only one night fighter during World War II: the P-61 Black Widow, Northrop's first major project. The first few off the production line, in 1943 (above), were painted olive drab and sported a gun turret atop the fuselage, but the aircraft soon received its trademark coat of black (opposite), and the turret was deleted after the first thirty-seven P-61As.


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tact, but the hunt was not over yet. Another Ju-87, trying desperately to evade Lieutenant Ernst's plane, was nailed with two three-second bursts from 300 feet, went into a flat spin, and crashed in flames.

Two confirmed and one damaged in less than twenty minutes isn't bad at any time of day, but this particular action took place during hours of darkness between 4:50 and 5:06 a.m. Herman Ernst and his radar observer, 1st Lt. Edward Kopsel, were members of the 422d Night Fighter Squadron (NFS), flying an aircraft remembered dimly by most of us, if at all: the Northrop P-61 Black Widow, the only night fighter built by the US during World War II. Before the war ended, Army Air Forces had sixteen night fighter squadrons scattered throughout every theater of operations, all but one of them flying P-61s. The last squadron to receive the big black bird, shortly after V-E Day, was the 416th, based in Italy.

Collectively, AAF's night fighters shot down 158 enemy aircraft confirmed. There were many more probables. It often was impossible to confirm a night victory because P-61 crews operated independently, frequently behind enemy lines. Eight Black Widow crewmen, among them Lieutenants Ernst and Kopsel, became aces with five confirmed victories. There probably were several more who had at least five kills, some of which could not be confirmed. On night intruder missions, the P-61s took a heavy toll of enemy transportation, depots, factories, troops, and ground armament.

The pioneering work of AAF's World War II night fighter squadrons is little noted today. It should be given greater attention. These squadrons and their Navy counterparts are the forebears of the American all-weather tactical fighters that performed so brilliantly around the clock, in good weather or bad, to make possible a quick and relatively bloodless victory in the 1991 Persian Gulf War. How did this half century of evolution begin?

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P-61s were first operationally deployed in Britain in May 1944. The Black Widow scored its first combat victory in the Pacific theater, in June 1944, and saw combat for the first time in Europe a month later. By war's end, fifteen USAAF night fighter squadrons, in every theater of operations, were flying the P-61.

Birth of the Black Widow

The US Army Air Corps, which became the Army Air Forces on June 21, 1941, first showed serious interest in night fighters late in 1940. Before then, the technology for night combat was not at hand, big money was going to heavy bombers, and there seemed no urgent need for airborne night defense of the country.

That wasn't true in England, at war and suffering almost nightly bombing raids by the Luftwaffe. A year earlier, Britain had foreseen the need for a night fighter and had pressed the twin-engine Bristol Beaufighter into service, equipped with a rudimentary airborne intercept (AI) radar. Douglas A-20s, called Havocs, and some de Havilland Mosquitos were also modified for night air defense.

On the other side of the Channel, the Germans were fitting airborne radars to light bombers—for example, the Me-110. With plenty of targets to shoot at as the RAF turned to night bombing, some German night fighter pilots, who remained on duty continuously until they were killed or the war ended, ran up phenomenal scores against Allied bombers. The leading Luftwaffe night fighter ace was Maj. Heinz-Wolfgang Schnaufer. He racked up 121 victories.

Air Corps observers in England were convinced that the United States should develop a specifically designed night fighter. A proposal from Northrop Aircraft was accepted, and, in December 1940, a contract for two experimental planes was signed. An AI radar was designed by scientists at MIT's Radiation Laboratory. By mid-June 1941, their development work was completed and turned over to Western Electric for production. Retired Maj. Robert Graham, a former P-61 radar observer and night fighter ace who had trained on the British SCR-540 radar, rated the Western Electric SCR-720A vastly superior to the British model in all respects.

In the interim, until the Northrop fighter was ready for operations—and it turned out to be a long interim—the AAF used a number of Douglas A-20s equipped with British radars. That plane, designated P-70, was used for training night fighter crews at bases in and near Orlando, Fla. When the US entered World War II and sent troops to the Mediterranean in late 1942, AAF night fighter units in North Africa and Italy used British Beaufighters and Mosquitos until they could be reequipped with P-61s.

In October 1943, after many development delays, the first production P-61A rolled off the Northrop line at Hawthorne, Calif. It was a state-of-the-art aircraft, looking like no other in the AAF inventory. With a wingspan of sixty-six feet, an empty weight of 21,000 pounds, and a maximum gross of 34,400 pounds,

the P-61A dwarfed all other fighters. It was almost as large as and considerably faster than the North American B-25 medium bomber.

The P-61's fuselage, which housed radar, armament, and a crew of three, was slung between twin booms that supported Pratt & Whitney R2800 engines and tapered back to twin tails. Atop the fuselage was a power turret with four .50-caliber guns, usually locked in forward position and fired by the pilot. The remotely controlled turret could be unlocked and fired by the pilot, gunner, or radar observer and would rotate 180 degrees for defense against attacking aircraft. Mounted in the lower fuselage were four fixed 20-mm cannon fired by the pilot. The P-61 lacked the grace and elegance of a Spitfire or Mustang, but its armament gave it much of the persuasiveness of a Sherman tank.

The P-61 lacked the grace and elegance of a Spitfire or Mustang, but it boasted some persuasive armament. The turret, restored halfway through P-61B production, carried four .50-caliber guns and rotated for defense against attacking aircraft, and four fixed 20-mm cannon were mounted on the lower fuselage.

Early in the P-61A production run, the dorsal turret, which caused serious tail-buffeting problems, was deleted. It was not restored until part-way through the P-61B run. Except for the first few aircraft, P-61s were painted black and came to be known as Black Widows. Like most aircraft, the P-61 went through many modifications during its production life: more powerful engines, improved radar, a radar altimeter, underwing pylons for bombs and auxiliary tanks, night vision devices, and so on. At war's end, 200 P-61As and 450 Bs had been delivered to the AAF. The C model came too late for combat.

Pilots liked the P-61. It was an exceptionally stable instrument aircraft and gun platform, relatively fast for its day and purpose with a top speed of 372 miles an hour, a service ceiling of 34,000 feet, low landing speed, and no bad habits. Single-engine performance was remarkably good. Despite its size, the Black Widow, which had retractable ailerons (actually wing spoilers) could turn with most Allied fighters. In one formal contest with a P-47, the Widow came out on top, much to the surprise of those who weren't acquainted with this strange new bird.

The Widow Goes to War

The first squadron to fly the P-61 in combat was the 6th NFS, which had used P-70s and P-38Js as night fighters in Hawaii. Soon after the unit arrived at Saipan with its new fighters, Lt. Dale Haberman and his radar observer, Flight Officer Ray Mooney, scored the P-61's first kill, a Mitsubishi Betty bomber, shot down on June 30, 1944. That was the first of three confirmed victories for the Haberman-Mooney team.

In the European theater, the first P-61-equipped night fighter squadron to see combat was the 422d, commanded by Lt. Col. Oris A. Johnson, now a retired major general. Its initial combat sortie was led by Colonel Johnson on the night of July 3, 1944. While awaiting deployment to the Continent, 422d crews cut their combat teeth against German V-1 buzz bombs. Lieutenants Ernst and Kopsel registered the first of the squadron's five V-1 victories on the night of July 15.

The operations of squadrons in various theaters were shaped to some extent by geography and combat environments. In the Pacific, for

Photos from the Jeffrey Ethell Collection

Only forty-one P-61Cs had been completed by the end of the war. With armament deleted and a new color scheme, the P-61 saw seven more years of service as the photoreconnaissance F-15A Reporter (above), redesignated RF-61C in 1948. A few P-61Bs became P-61Gs, modified for weather reconnaissance.

example, a squadron often had detachments on several islands. In Europe, unit integrity was generally maintained. All squadrons shared some problems to varying degrees. They were small units with from twelve to twenty aircraft, most with fewer than 300 men, in the midst of many larger units. The squadrons were commanded in most cases by lieutenant colonels. Size and rank put them at the low end of the logistics totem pole. This was compounded by the novelty of the Black Widow, which had many unique components. Replacement aircraft were slow to come. At one point, the 422d was down to one operational fighter.

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Ten squadrons of P-61s were deployed in time to take part in the war in Asia and in the Pacific theater: two based in China, three in the Philippines, three on Iwo Jima, and two in New Guinea. Night fighter squadrons were small units with from twelve to twenty aircraft and, in the Pacific, often had detachments on several islands.

The AAF had no previous combat experience with night fighters. Planners and operators at higher levels knew little about the aircraft's capabilities and limitations. Ground-based radar controllers, accustomed to dealing with large numbers of friendly and enemy aircraft, did not at first appreciate the precision needed for effective control of single planes. Squadron commanders and their staffs had to feel their way, developing and changing tactics and techniques as they climbed the combat learning curve. It was one of the most challenging assignments a young commander could have.

At first, the P-61 was used as a purely defensive weapon system—a role for which it had been designed based largely on RAF night fighter experience. By the time P-61s reached the combat theaters in mid-1944, both German and Japanese forces were in retreat. There were no large bombing attacks, hence few targets to shoot at.

In a defensive role, the operating procedures of all squadrons were similar. A P-61 crew usually operated individually in an assigned patrol area. Crews were on alert for two nights, then off for two. An alert crew preflighted its aircraft late in the afternoon, using red goggles to protect night vision. Patrol missions usually lasted two hours, but there were many instances, especially in the Pacific, of a crew chasing a bogie for several hours before getting into firing position or losing its target.

Night fighter crews maintained contact with a ground radar controller who could vector them to the vicinity of a bogie. At that point, the radar observer took over, using his AI radar to position the pilot for attack, preferably from low and astern. Since friendly aircraft were often in the area, and IFF (identification, friend from foe) equipment was either lacking or undependable, positive visual identification had to be made before the P-61 crew could fire. A good deal of time was spent chasing friendlies. Visual identification, often in bad weather, required very close proximity to the aircraft being tracked. It was sweaty work, sometimes demanding several close passes. If a particular P-61 did not have a power turret, the radar observer could be moved from his tail position to the gunner's seat behind the pilot and, using night binoculars, could help identify bogies.

The firepower of the P-61, even without turrets, was awesome. Since a crew had to close to within a few hundred feet for identification, they seldom opened fire, usually with little if any deflection, without getting a kill of at least observed hits. Enemy pilots in all theaters soon learned that the P-61 was not to be trifled with. When Black Widows were known to be in their area, more than a few Axis pilots decided this was not the time to die for the Führer or the Emperor and suddenly were reminded of urgent business elsewhere.

One of the major hazards faced by Black Widow crews, especially in the foul weather of western Europe, was the lack of blind-landing equipment. During the Battle of the Bulge in December 1944, the 422d NFS flew in impossible weather, losing three aircraft and one crew to landing accidents. On the positive side, they shot down ten enemy planes, destroyed much ground hardware, and earned a Distinguished Unit Citation.

The Black Widow sometimes was used as a day fighter during bad weather and occasionally even in good weather. Carl Bjorum of the 421st NFS in the southwest Pacific tells of a clear-weather daytime encounter between a flight of four P-61s and seven Japanese fighters. As the enemy planes crossed in front of the P-61s, a Widow gunner "took the entire cockpit out of the [Japanese leader's aircraft] as though it had been done with a pile driver."

The Japanese pilots, apparently thinking they had taken on some P-38s, lined up for a stern attack. Three more were downed by the four .50-caliber guns in the P-61s' turrets, and the remaining three headed for the clouds.

In the last months of the war, P-61s of the 418th NFS, now carry-

Jeffrey Ethell Collection

The P-61A was almost as large as and considerably faster than the North American B-25 medium bomber. Despite its size, the Black Widow could turn with most Allied fighters: In one formal contest with a P-47, the Widow came out on top. The P-61C, with its turbosupercharged engine, was even faster but came very late in the war.

ing wing tanks, were flying both escort and intruder missions from Okinawa to Japan. One of the last air victories in the Pacific theater was scored by Lt. Robert W. Clyde and his radar observer, Lt. Bruce K. Leford, of the 548th NFS based at Ie Shima, on the night of August 14, 1945. That P-61 crew pursued an enemy plane down to wave-top level, where it crashed without the Black Widow crew firing a shot.

Widows on the Offensive

From the start, the more imaginative squadron commanders and some higher-ups saw that the P-61 had, beyond its primary mission of air superiority, at least limited capabilities for augmenting fighter-bombers in the remaining two missions of the tactical air forces: isolating the battlefield and close support of ground troops. With the technology available at the time, neither could be done as effectively as with fighter-bombers, particularly the latter mission, which requires extreme accuracy. Since offensive operations hadn't been foreseen, few night fighter crews had any training in air-to-ground gunnery or bombing.

Despite the absence of ground-based radar capable of precisely positioning a crew at low altitude and the lack of airborne radar for acquiring and hitting surface targets, most of the night fighter squadrons, whether flying P-61s, Beaufighters, or Mosquitos, were heavily involved in night offensive operations before the war ended. Their goal was to keep pressure on the enemy around the clock to deny him rest, mobility, and logistic support.

Depending on the configuration of the Black Widows they flew, P-61s began carrying 250- and 500-pound bombs, rockets, napalm, and flares in night interdiction missions and on harassing penetrations against enemy airfields. Air-to-ground operations were limited to nights of at least moderate visibility, with targets illuminated by flares or napalm.

The 422d NFS, which had removed its power turrets to improve aircraft performance and whose birds were not equipped with bomb racks, depended on the firepower of the Widow's four 20-mm cannon in helping to isolate the battlefield. That squadron is credited with destroying or damaging nearly 1,000 locomotives and items of rolling stock and extensively damaging some forty German factories and depots.

At least once, P-61s were used in daytime offensive operations. In March 1945, a large concentration of Japanese troops was located on Cebu, an island in the east-central Philippines. Two crews of the 550th NFS obliged the local Philippine guerrilla commander by tearing up the Japanese assembly area with their cannon prior to the guerrillas' attack.

Hail and Farewell

In little more than a year of combat operations, the P-61 had been transformed from a purely defensive night fighter into the closest approach to an all-weather fighter to come out of World War II. In a defensive role, the undisputed champion of AAF's sixteen night fighter squadrons was the 422d NFS in Europe. That squadron is officially credited with forty-three victories and produced six of the eight night fighter aces. Its record has been meticulously documented by Charles McEwen, a wartime member of the squadron, in his history of the 422d NFS.

The Black Widow was the best night fighter to be fielded by any country during World War II, but, coming as it did at the beginning of the jet age, its life span was destined to be short. A few remained on active duty with Air Defense Command until the early 1950s.

The AAF's World War II night fighter squadrons were few in number, small in size, and manned largely by junior officers and airmen. Their crews did some of the most demanding but little-noted flying of the war and were responsible for developing tactics and techniques in an untried area of air combat. These men made a lasting contribution to the evolution of airpower. They laid the foundation on which new technology built today's all-weather tactical air forces. ■

Contributing Editor John L. Frisbee was Editor of Air Force *Magazine from 1969 until 1980. A graduate of the Armed Forces Staff College and the Canadian National Defence College, he served the US Air Force as a fighter and bomber pilot, a planner on the Air Staff and at major commands, a teacher at West Point and the Air Force Academy, and a special assistant to the Secretary of the Air Force. He retired as a colonel. His "Valor" articles are a regular monthly feature of this magazine; his most recent full-length article, "The Lessons of North Africa," appeared in the September 1990 issue.*

Valor

By **John L. Frisbee,** Contributing Editor

A Bridge Downtown

Col. Bill Norris led a tactically perfect mission against the best-defended target in North Vietnam.

SOME targets have become legends in the history of air warfare. Among those of World War II are Berlin, Schweinfurt/Regensburg, Ploesti, and Rabaul. The Vietnam War's counterpart to Berlin was Hanoi, "Downtown" to the fighter pilots, with one target at the top of the list—the Paul Doumer railroad and highway bridge over the Red River.

In March 1965, the Joint Chiefs of Staff submitted to Secretary of Defense Robert S. McNamara a list of ninety-four targets in North Vietnam that should be hit in a twelve-week campaign that stood a good chance of taking North Vietnam out of the war. The highest-priority target, once North Vietnam's line of communications south of the twentieth parallel had been severed, was the Doumer Bridge.

Why was that bridge, 8,500 feet long including its terminal viaducts, so important? Four of five major rail lines came together to cross the bridge from the north into Hanoi. All supplies moving by rail from China and the port of Haiphong had to cross the Doumer Bridge, as did much truck traffic. This valuable North Vietnamese asset was defended by 300 AA positions with 37-mm, 57-mm, 85-mm, and 100-mm guns; eighty-five SAM sites each with four to six missiles; and MiG fighters on several bases in and near Hanoi.

The 1965 JCS target list was never implemented as a concentrated campaign for fear of antagonizing China and the Soviet Union by bombing high-priority targets in and around Hanoi. Lower-priority targets north of the twentieth parallel were released from time to time, and the F-105 "Thud" pilots who did most of the bombing went north when weather permitted, carrying their iron bombs. (Guided "smart" bombs didn't come along until a few years later.)

One of the Thud pilots who had gone north many times was Col. William C. Norris, who had flown 100 F-51 missions in Korea, had spent most of his career in fighters, and now commanded the 355th Tactical Fighter Wing's 333d Squadron. He remembers those days in southeast Asia with a mixture of pride and bitterness.

"During Rolling Thunder [the limited air campaign against North Vietnam], we lost 252 F-105s. Every day, those pilots who went to the Hanoi area went to one of the most heavily defended areas in modern warfare. Worst of all, they were forced to fight under the most ridiculous rules of engagement. Those unrealistic rules certainly contributed to our heavy loss rate and also hindered us from accomplishing our mission. To go to Hanoi day after day not only took great courage, but, more important, it took loyalty to your country"—whose leaders seemed not to understand air operations or the hazards to their own men, which they were compounding.

On the morning of August 11, 1967, the Doumer Bridge was released for attack that afternoon. Colonel Norris wanted to lead the attack force, but, since he had just recovered from a morning strike on railyards near Hanoi, he was not allowed to do so. Instead, because of his experience as a strike force leader who had flown more than ninety missions in the North, he was selected to plan the mission, which would be led by Col. Robert White (of X-15 fame). A span of the rail bridge and two spans of the highway bridge were knocked down in a highly successful mission.

It was vital to go back while the weather still was good and ensure that the bridge would be out of use for weeks or months. This time the enemy defenders would be fully alerted, knowing the bridge was no longer off-limits. Colonel Norris was chosen to lead a force of F-105s and F-4s, including F-105 Wild Weasel defense-suppression aircraft. As force commander, he also was leader of the flak-suppression flight that would go in first to attack AA gun positions.

As they crossed Thud Ridge with Hanoi in sight, the strike force was hit by MiGs, one flight boring in on Colonel Norris from eleven o'clock. He told his pilots, "Hang onto those bombs, and we'll barrel through them." Turning head-on into the MiGs, he opened fire with his cannon, scattering them in all directions. Within seconds he had to get back in position to go down first against the enemy guns. The bridge was hit again, and all of the strike force made it home safely—an indication of the success of Colonel Norris's flak-suppression flight and the performance of the Wild Weasels. Some 300,000 tons of war supplies would not reach Hanoi over that bridge while it was down until early October.

Colonel Norris, today a retired major general, was awarded the Air Force Cross for his leadership of the August 12 mission. Rather than being remembered for that award, he says, "I would much rather be remembered as an F-105 Thud pilot of the Rolling Thunder campaign in 1967." There could be no finer tribute to comrades who fought, died, and suffered in Hanoi's prisons. Knowing what lay ahead, the best of those men competed for a place on the toughest missions. The reason may defy layman's logic. They did it because they were fighter pilots. ■

AFA/AEF Report

By Daniel M. Sheehan, Assistant Managing Editor

Cornhusker Pride

The **Ak-Sar-Ben (Neb.) Chapter** has a lot to be proud of. A recent golf tournament staged by the chapter raised money for the SSgt. John F. Campisi Children's Educational Fund. Sergeant Campisi, a technician with the 55th Organizational Maintenance Squadron, was killed August 11, 1990, in Saudi Arabia, the first American fatality in Operation Desert Shield. His widow Charlene accepted the check honoring her husband's memory from Jim McCoy, chapter president at the time, and tournament organizer Charlie Daubs. The presentation was made in conjunction with the chapter's quarterly meeting, which was attended by Bellevue, Neb., Mayor Inez Boyd; SAC Deputy Chief of Staff for Personnel Col. Jeff Harrington; and 55th Strategic Reconnaissance Wing Vice Commander Col. Bill Betz.

This support for education is in keeping with the chapter's tradition of staunch patronage of the area's young people. AFROTC Cadet Jonathan A. Sutherland of the University of Nebraska and AFJROTC Cadet Tanris Jenkins of Bellevue East High School are the most recent recipients of $500 scholarships from the chapter.

The success of its members at AFA's national level is another source of chapter pride. At this year's National Convention, chapter members Don Adams and Jim McCoy were tabbed for posts as National Director and National Vice President (Midwest Region), respectively.

Connecticut Cooperation

The Connecticut AFA chapters joined forces to honor the contributions of the 439th Military Airlift Wing, Westover AFB, Mass., to Operations Desert Shield and Desert Storm. The chapters, in conjunction with the American Society for Quality Control, held a dinner in Hartford for the 439th MAW, already the recipient of AFA's Outstanding Reserve Unit Award, and heard an address from Col. James P. Gallin, the wing's vice commander. MSgt. Kelly Payne, a personnel systems manager technician at Westover and one of the twelve Outstanding Airmen of the Year, was the special guest.

The chapters handed out several awards at the meeting. State President John McGrath and former State Secretary Billie Luchini received Scott Associate Awards, First Connecticut Chapter President Don Fairchild accepted a Silver Membership Award on behalf of his chapter, and Flying Yankees Chapter President Don Graves received a Medal of Merit. Many dignitaries were on hand for Colonel Gallin's speech and the awards presentations, including National Directors Joe Falcone and Joe Zaranka, National Vice President (New England Region) Robert N. McChesney, and John Levitow, the only USAF enlisted man to receive the Medal of Honor for valor in Vietnam. The chapters also hosted a table of guests from a nearby veterans home and hospital.

Louisiana Convention

The **Ark-La-Tex Chapter** hosted the 1991 Louisiana State Convention in Bossier City. State President Doyle Blasingame opened the convention by welcoming members and guests from the state's four chapters. The delegates held business sessions, attended workshops, and heard a report on Operation Desert Shield logistics from the 8th Air Force Briefing Team from Barksdale AFB, La. The convention also featured a golf tournament, and the Ark-La-Tex Chapter sponsored a horse race at nearby Louisiana Downs.

Chapter News

The seemingly indefatigable Bob

Ak-Sar-Ben Chapter member and AFA National Director Don Adams rises to discuss AFA membership at the Nebraska Congressional Breakfast. Bob Spires, Sen. Robert Kerrey's chief of staff, listens attentively at right. Rep. Peter Hoagland (D-Neb.) also spoke at the breakfast, emphasizing USAF reorganization.

Hope has long lent his name to a celebrity golf tournament sponsored by the **Riverside County (Calif.) Chapter** to benefit the Morale, Welfare, and Recreation programs at nearby March AFB. Proceeds from the tournament average $14,000 each year. Chapter President Ed Dvorak gave Mr. Hope a plaque in tribute to more than half a century of support for the military.

In Texas, Wanda Jones, **Panhandle Chapter** secretary and vice president for aerospace education, accepted the USAF American Spirit Award from Lt. Col. Bruce Stewart of Mather AFB, Calif., during ceremonies at the Amarillo Independent School District Building.

AEF Calendars

The Aerospace Education Foundation still has a limited number of 1992 calendars honoring the USAF men and women of Operations Desert Shield and Desert Storm. Through donations to the calendar program, more than 25,000 AFA members have supported AEF's von Kármán Graduate Scholarship Program, the Eagle Plan (enlisted tuition assistance), and the foundation's publishing efforts. If you reside in the continental US and wish to receive another copy of the calendar or replace a damaged copy, contact Arthur Hyland, AEF, 1501 Lee Highway, Arlington, VA 22209-1198. Phone: (703) 247-5839.

Samuel M. Tennant (right) accepts a Jimmy Doolittle Fellowship from former Under Secretary of the Air Force and current Aerospace Corp. Board Chairman James M. Plummer. Mr. Tennant received the fellowship in honor of his service as corporate president and CEO of Aerospace Corp. until his retirement last December.

Have AFA News?

Contributions to "AFA/AEF Report" should be sent to Dave Noerr, AFA National Headquarters, 1501 Lee Highway, Arlington, VA 22209-1198. ■

Bulletin Board

I have available several hundred pages, torn out of magazines, of manufacturers' **ads picturing military airplanes** and guided missiles of the 1950s. **Contact:** Charles Johnson, 6004 Laketree Ln., Temple Terrace, FL 33617.

Seeking information, anecdotes, photos, patches, and other memorabilia of the **21st Tactical Airlift Squadron** (formerly the 21st Troop Carrier Squadron) to update the squadron's history in preparation for its fiftieth anniversary next April. **Contact:** Capt. Stephen Garstka, 21st TAS, PSC 78 Box 2878, APO AP 96326.

Collector seeks USAAF/USAF uniforms, **patches,** insignia, photos, and stories from 1941 to 1951, the Air Force's "transitional decade." I am especially interested in the China-Burma-India theater. **Contact:** George E. Dively, Jr., P. O. Box 10743, Alexandria, VA 22310-0743.

Collector seeks senior or junior **AFROTC ribbon bars. Contact:** Kent Kistler, 3506 221st Ave. S. E., Issaquah, WA 98027.

Seeking the whereabouts of **Wade Townley,** of Boston, Mass., who was stationed at RAF Sealand, England, in 1950–52. **Contact:** John Stiles, 48 Squirrel Rise, Marlow Bottom, Bucks. SL7 3PN, England.

For a book, author seeks interviews with former Lockheed, CIA, and Air Force A-11, YF-12, and **SR-71 personnel.** The emphasis is on program development and fleet refurbishment in the 1980s, including PARPRO, I&W, SIOP, and sigint. **Contact:** Ernest Blazar, Suite 740, 122 C St. N. W., Washington, DC 20009.

Seeking contact with the widow of **Sy Lambert,** who graduated from navigation school at Ellington Field Tex., in April or May of 1944 and was reported missing on his first mission with 15th Air Force in September or October 1944. **Contact:** Robert Miller, 301 E. 52d St., New York, NY 10022.

Seeking contact with veterans of the **832d Engineer Aviation Battalion** who served with the unit in or near Mainz, Germany, during World War II. **Contact:** David S. Dunlap, 5825 Will Rogers Dr., Enid, OK 73703.

Seeking information on the whereabouts of **Dave Dressler,** who was based at RAF West Ruislip, England, in 1966–68 until he was sent to Vietnam. **Contact:** Linda Denzey, Lee View Berrynarbor, Ilfracombe, North Devon EX34 9SG, England.

The newly formed **Sabre Jet Historical Society** is dedicated to the past, present, and future activities of the North American Aviation F-86 Sabre and its foreign-built variants. **Contact:** Rick Mitchell, 428 Madingley Rd., Linthicum, MD 21090

Seeking contact with **SSgt. Alfred Perez,** who was stationed at the Air Force Cambridge Research Center, Hanscom AFB Mass., in 1958–62 and worked at a research center in Italy before his retirement. **Contact:** John Berry, Suite 611, 323 Geary St., San Francisco, CA 94102.

For a history of **Dodge City AAF, Kan.,** I am seeking pictures, memorabilia, and anecdotes from airmen stationed there. **Contact:** Col. Joseph K. Nevins, USAF (Ret.), 2317 Hampton Rd., League City, TX 77573.

For a book, I am seeking photographs of **nose art** from 1970 to the present. Please include historical data about the aircraft, especially serial number, combat sorties, and crew members. **Contact:** Pat Cherry, 211 E. Hillcrest, Monrovia, CA 91016.

Seeking information on **Pvt. Lee "Pierre" Cacciaboudo,** who was in the 574th Bomb Squadron, 391st Bomb Group, 9th Air Force, at Matching Green, England, and Foye/Ami, France. **Contacts:** Eric Chipman, 150 Park Rd., Chelmsford, MA 01824. Angelo DeBello, 848 Pleasant Ave., Westbury, NY 11590.

Seeking information on **TSgt. James B. Walker,** who served in Australia and New Guinea during World War II. He was a radio operator/mechanic assigned to the 141st or 142d Army Airways Communications System Squadron, 68th AACS

Group, in 1943–44. **Contact:** MSgt. J. B. Walker, Jr., USAF (Ret.), 888 Woodhill Rd., Dayton, OH 45431.

Seeking information on the whereabouts of **Lt. Col. Raymond Dee "Stevie" Stevens,** from East St. Louis, Ill., who was with Hq. 9th Air Force in England in 1944 before serving with the Strategic Air Arm in Europe. **Contact:** Jane Newbury, 69 Kings Rd., Westcliff-on-Sea, Essex SS0 8PH, England.

Seeking the whereabouts of **James Oliver Ballard,** a B-29 lead bombardier in the 769th Bomb Squadron, 462d Bomb Group, 58th Bomb Wing, in the China-Burma-India theater during World War II. He was at West Field on Tinian from May 1945 to the end of the war. **Contact:** Joseph W. Crume, Jr., R. R. #4, Box 86, Tipton, IN 46072.

Seeking information on **Dale McKenzie,** from Prineville, Ore., who flew in P-38s with 8th Fighter Squadron, 49th Fighter Group, 5th Air Force, in the Pacific theater during World War II as a bombardier/navigator or observer. He was stationed at Luzon, Leyte Gulf, Ie Shima, and Atsugi Airdrome. **Contact:** Michael C. McKenzie, 20712 Eastwood Ct., #1, Torrance, CA 90503.

Seeking contact with **Lt. Col. Wendell Ashley,** last known to be at Edwards AFB, Calif., and **MSgt. Kenneth Thomas,** last known to be at Chanute AFB, Ill. **Contact:** Eric E. Harris, P. O. Box 81, Victor, CO 80860.

Seeking contact with members of the **54th Fighter Group,** 42d, 56th, and 57th Fighter Squadrons, who served in Alaska in 1942. **Contact:** Maj. Gen. C. M. McCorkle, USAF (Ret.), 9524 Bay Ct., Carmel, CA 93923.

Seeking contact with veterans of the **409th Bomb Group** who are not already members of the 409th Bomb Group Association. **Contact:** Thomas R. Sammons, 216 S. Jones Blvd., Las Vegas, NV 89107.

Seeking contact with USAAF Night Fighter veterans, especially John G. Smith, Edward "Ted" Collegan, and Hardin E. Ross of the **425th Night Fighter Squadron. Contact:** A. E. "Bud" Anderson, 8885 Plumas Cir., D-1116, Huntington Beach, CA 92646.

Seeking to buy or trade **World War II flying gear,** especially flying goggles, oxygen masks, and A6A flying boots. **Contact:** MSgt. Jonathan E. Drew (Ret.), PSC 75, Box 215, APO AE 09719.

Seeking contact with **James Contrel** (or Contrell or Contreal), a South Carolina native based at RAF Fairford, England, in 1952, where he knew Private O'Shea. **Contact:** Amanda J. Dunning, 21 Millwood Rd., Speke, Liverpool L24 2UP, England.

Seeking contact with the relatives of **MSgt. Peter Weisgram,** whose last known duty station was Wright-Patterson AFB, Ohio. **Contact:** O. B. Chandler, N50W15320 Honeysuckle Ln., Menomonee Falls, WI 53051.

For an exhibit, I am seeking reminiscences, letters, photographs, and other memorabilia of the USAF-sponsored **Ground Observer Corps. Contact:** Col. Broun H. Mayall, USAF (Ret.), 2403 Constellation Dr., Colorado Springs, CO 80906-1115.

Seeking contact with anyone who knew **2d Lt. Miles Bernard McDougal,** who served with the 340th Fighter Squadron, 348th Fighter Group, in the Pacific theater during World War II. **Contact:** Charles L. Perkins, 710 Middlebrook Cir., Tallahassee, FL 32312-2419.

Seeking contact with members of the **745th Bomb Squadron,** 456th Bomb Group, who were in Italy between August 1944 and January 1945. **Contact:** John Wright, 323 Dean Dr., Farmersville, OH 45325.

Seeking photos and information on B-24s, especially the B-24 ***The Jig's Up*** of the 36th Bomb Squadron stationed at Cheddington and RAF Alconbury, England, from August 1944 until February 1945. **Contact:** Stephen M. Hutton, 4016 Old Sturbridge Dr., Apex, NC 27502.

Seeking contact with participants in the bombing mission on **Bruex/Most, Czechoslovakia,** in mid-April 1945. I need to know the dates, units, and types of aircraft. I recall that it was a mixed formation of B-17s and B-24s, accompanied by P-38s or P-47s. **Contact:** CMSgt. Dietrich Schuetze, USAF (Ret.), PSC 13, Box 717, APO AE 09187.

Seeking contact with anyone interested in forming a **United States Forces Japan** Association. **Contact:** Col. Robert E. Rayfield, USAF (Ret.), 2107 Applegate Dr., Corona, CA 91720.

Seeking information on the transfer of forty **F-4Cs to the Spanish Air Force** in 1971. These aircraft had been assigned to the 81st Tactical Fighter Wing at RAF Bentwaters/Woodbridge, England. I need to know when the first of these aircraft arrived in Spain and whether they were flown by Spanish or American pilots. **Contact:** Gonzalo Avila Cruz, Av. Dr. F. Rubio, 75 5B, Madrid 20840, Spain.

Seeking contact with relatives of **MSgt. Charles William Sherman** and other members of Det. 124th Army Airways Communications System Squadron, stationed at McClellan AFB, Calif., between August 1946 and December 1948. Also seeking **SSgt. Marguerite Butler,** who served in the weather squadron at McClellan at that time. **Contact:** John S. Stevenson, 1517 Lakeview Ave. N., Leesburg, FL 34748.

Seeking a copy of ***Contrails: The Story of the 100th Bomb Group,*** which was printed about 1947. **Contact:** Stanley E. Nichols, 9171 Olson Rd. N. W., Bremerton, WA 98310.

For a history of the B-25, I am seeking contact with any personnel involved with **Azon bombs,** glide bombs, and glide torpedoes. **Contact:** N. L. Avery, 2231 Bobcat Trail, Mount Shasta, CA 96067.

For a comprehensive article, I am seeking contact with **8th Air Force** bomb crew veterans of the April 8, 1945, Halberstadt, Germany, mission. **Contact:** Hans-Detlef Mebes, Lessingstrasse 5, D-6830 Schwetzingen, Germany.

Collector seeks **Civil Air Patrol** uniforms, insignia, and memorabilia, especially from the 1940s

If you need information on an individual, unit, or aircraft, or if you want to collect, donate, or trade USAF-related items, write to "Bulletin Board," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be brief and typewritten. We cannot acknowledge receipt of letters to "Bulletin Board." We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Items or services for sale or otherwise intended to bring in money will not be used. Photographs cannot be used or returned.—THE EDITORS

and 1950s, and all current unit patches. **Contact:** Charles Wiest, 7651 Baylor Dr. #3, Westminster, CA 92683.

Seeking the whereabouts of **Lt. George H. Braun,** copilot, and **SSgt. Weldon Isler,** engineer gunner, both members of my B-25 crew of the 500th Bomb Squadron, 345th Bomb Group, who made a crash water landing at Kavieng, New Ireland, on February 15, 1944. **Contact:** Col. William J. Cavoli, USAF (Ret.), 2147 Encino Loop, San Antonio, TX 78259.

For a nostalgic history of the Air Force, I am seeking **anecdotes about Air Force life**—tales of humor, hardship, triumph, and frustration. Also seeking photos in the same vein. **Contact:** Col. Walter J. Boyne, USAF (Ret.), 21028 Starflower Way, Ashburn, VA 22011.

Seeking contact with anyone who served with headquarters and headquarters squadron of the **36th Pursuit Group** from 1940 to 1943 in Puerto Rico and St. Croix. **Contact:** Leroy Graziotti, 11812 Dawn Dr., Yuma, AZ 85365.

Seeking contact with members of aviation cadet **Class 43-H** who attended primary at Douglas, Ga., and did not attend last year's reunion. **Contact:** Andrew H. Heath, 204 Homestead Dr., Colonial Heights, VA 23834.

Seeking aviation-related clothing, equipment, patches, and photos. I am especially interested in jet fighters. Also seeking contact with **Capt. Patrick Shay** of the 944th Tactical Fighter Group. **Contact:** Ernest Jude P. Madriaga, #24 Brgy. Rd. Garcia Tubao, La Union 0509, the Philippines. ■

Unit Reunions

Bataan and Corregidor
The American Defenders of Bataan and Corregidor will hold a fiftieth-anniversary reunion/convention May 12–17, 1992, at the Airport Marriott in San Francisco, Calif. **Contact:** John Crago, 615 Lehmeyer St., Huntington, IN 46750.

Cannon AFB
Personnel who served at Cannon AFB, N. M., will hold a reunion June 12–14, 1992, in Clovis, N. M. **Contact:** Bertha Wells, 312 W. Yucca, Clovis, NM 88101. Phone: (505) 763-3198.

MATS Squadrons
Former members of the 1501st Air Terminal Squadron (Travis AFB, Calif.) and the 1502d Air Terminal Squadron (Hickam AFB, Hawaii) who served between 1955 and 1959 will hold a reunion June 4–6, 1992, at the Drawbridge Estate in Fort Mitchell, Ky. **Contact:** James G. Hampton, 3401 Lincoln Ave., Covington, KY 41015-1269. Phone: (606) 261-1407.

Nagoya and Komaki ABs
Personnel who served at Nagoya and Komaki ABs, Japan, will hold a reunion June 11–14, 1992, in Oklahoma City, Okla. **Contact:** Sam Alexander, 1922 Oakhill Dr., Norman, OK 73071-1612. Phone: (405) 364-8634.

Red River Valley Fighter Pilots
The Red River Valley Fighter Pilots Association "River Rats" will hold a twenty-fifth-anniversary reunion April 22–27, 1992, at the Sahara Hotel in Las Vegas, Nev. **Contacts:** Red River Valley Fighter Pilots Association, 6237 S. Greenwich Rd., Derby, KS 67037. Phone: (316) 788-7525. J. D. Allen, 6753 W. Carrera Dr., Las Vegas, NV 89103. Phone: (702) 873-5959.

Stalag Luft III
Former Stalag Luft III POWs will hold a reunion April 23–26, 1992, in St. Louis, Mo. **Contact:** Robert L. Weinberg, 2229 Rock Creek Dr., Kerrville, TX 78028. Phone: (512) 257-4643.

2d Ferrying Group
Veterans of the 2d Ferrying Group and 2d Foreign Transport Group who served at New Castle AAB, Del., between 1942 and 1946 will hold a fiftieth-anniversary reunion May 5–8, 1992, at the Christiana Hilton Hotel in Newark, Del. Former military and civilian personnel are invited. **Contact:** Temple Robinson, 5961 E. 18th St., Tucson, AZ 85711. Phone: (602) 747-4466.

9th Bomb Wing
Members of the 9th Bomb Wing who served at Travis AFB, Calif., and Mountain Home AFB, Idaho, will hold a reunion September 16–19, 1992, in Colorado Springs, Colo. **Contact:** Frank J. Malkiewicz, 13980 Silverton Rd., Colorado Springs, CO 80921. Phone: (719) 495-3211.

23d Photo Recon Squadron
Members of the 23d Photo Reconnaissance Squadron will hold a reunion September 10–13, 1992, in Colorado Springs, Colo. **Contact:** William L. Martin, 4380 Sedate Ln., Colorado Springs, CO 80917. Phone: (719) 596-7519.

Cadet Class 42-B Ass'n
Members of Class 42-B will hold a fiftieth-anniversary reunion February 19–23, 1992, at the Marines Memorial Club in San Francisco, Calif. **Contact:** W. E. Radtke, 214 Marinda Dr., Fairfax, CA 94930. Phone: (415) 454-4978.

Class 42-H
Members of Class 42-H (Kelly Field, Tex.) will hold a reunion September 23–26, 1992, at the Gunter Hotel in San Antonio, Tex. **Contact:** Reet Poe Smith, 4917 Ravenswood Dr., Apt. 455, San Antonio, TX 78227. Phone: (512) 675-1845.

Class 52-G
Members of Class 52-G will hold a reunion October 23, 1992, in Destin, Fla. **Contact:** Jack Gilliland, 1232 Redwood Ln., Gulf Breeze, FL 32561. Phone: (904) 939-0662.

52d MAS/52d TCS
Former members of the 52d Military Airlift Squadron and the 52d Troop Carrier Squadron will hold a fiftieth-anniversary reunion June 12–14, 1992, in San Bernardino, Calif. **Contact:** Capt. Bill Harnly, 52d Military Airlift Squadron (MAC), Norton AFB, CA 92409. Phone: (714) 382-4251.

Class 55-V
Class 55-V will hold a reunion October 22–25, 1992, in San Antonio, Tex. **Contact:** Col. Ed Lloyd, USAF (Ret.), 3504 Saddlestring Trail, Austin, TX 78739. Phone: (512) 282-0882.

55th Strategic Recon Wing
Past and present members of the "Fightin' Fifty-Fifth" will hold a fifty-first-anniversary reunion January 25, 1992, at the E4 Hangar at Offutt AFB, Neb. **Contact:** Captain Wheelock, Hq. 55th Strategic Reconnaissance Wing Protocol, Offutt AFB, NE 68113-5000. Phone: (402) 294-5797.

92d Bomb Wing
The 92d Bomb Wing will hold a reunion July 17–18, 1992, at the Coeur D'Alene Hotel in Coeur D'Alene, Idaho. **Contact:** Retirees Activity Director, 92d Combat Support Group, Fairchild AFB, WA 99011.

307th Bomb Group/Wing
Veterans of the the 307th Bomb Group and Wing (B-29 unit) who served between 1946 and 1954 will hold a reunion August 13–16, 1992. **Contacts:** Pete Petronaitis, 4832 Rean Meadow Dr., Dayton, OH 45440. Phone: (513) 434-0871. Harold K. Sams, 4100 Tonawanda Trail, Dayton, OH 45430. Phone: (513) 429-0639. Leon Rosenberg, 3 Wellington Dr., Stony Brook, NY 11790. Phone: (516) 751-7324.

308th BW/308th ARS
The 308th Bomb Wing and 308th Air Refueling Squadron will hold a reunion June 18–20, 1992, at the De Soto Hilton Hotel in Savannah, Ga. **Contact:** Norman Davis, 6707 Cable Car Ln., Wilmington, NC 28403. Phone: (919) 256-6036.

405th Fighter-Bomber Group
Former members of the 405th Fighter-Bomber Group, which included the 509th, 510th, and 511th Fighter-Bomber Squadrons, who served at Langley AFB, Va., between 1952 and 1958 will hold a reunion in May 1992 in Las Vegas, Nev. **Contact:** Roger Warren, 7550 Palmer Rd., Reynoldsburg, OH 43068. Phone: (614) 866-7756.

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to "Unit Reunions," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Please designate the unit holding the reunion, time, location, and a contact for more information.

409th Bomb Group
The 409th Bomb Group will hold a reunion May 3–5, 1992, in Las Vegas, Nev. **Contact:** Thomas R. Sammons, 216 S. Jones Blvd., Las Vegas, NV 89107. Phone: (702) 870-4088.

456th Bomb Group
Veterans of the 456th Bomb Group will hold a reunion June 3–6, 1992, in Milwaukee, Wis. **Contact:** Jim Watkins, 11415 Minor Dr., Kansas City, MO 64114. Phone: (816) 942-5594.

461st Bomb Group
The 461st Bomb Group will hold a reunion October 23–27, 1992, in Dayton, Ohio. **Contacts:** Frank C. O'Bannon, P. O. Box 36600, Tucson, AZ 85740. Ed Chan, P. O. Box 117, New Hyde Park, NY 11040.

494th Bomb Group
Former members of the 494th Bomb Group, which included the 373d, 864th, 865th, 866th, and 867th Bomb Squadrons (World War II), will hold a reunion July 7–14, 1992, at the Marriott Hotel in Newton, Mass. **Contact:** Lt. Col. David H.

Rogers, USAF (Ret.), 3333 Sierra View Ln., Sacramento, CA 95821-2538. Phone: (916) 487-1856.

820th Bomb Squadron
The 820th Bomb Squadron, 41st Bomb Group, 7th Air Force (World War II), will hold a reunion April 30–May 3, 1992, at the Radisson Hotel in Asheville, N. C. **Contact:** William W. Childs, 3637 Patsy Ann Dr., Richmond, VA 23234. Phone: (804) 275-6012.

1045th Operation/Evaluation/Training Group
Former members of the 1045th Operation, Evaluation, and Training Group Detachment 1 (Eglin AFB, Fla.) and Detachment 2 (Okinawa, Japan) are planning to hold a reunion September 25–27, 1992, in Tucson, Ariz. **Contact:** Charles J. Monka, 6199 E. Broadway, Apt. 107, Tucson, AZ 85711-4010.

4450th Tactical Group/37th Fighter Wing
Military and key civilian personnel associated with the F-117A Stealth fighter program will hold a reunion May 22–25, 1992, at the Hilton Hotel in Las Vegas, Nev. **Contact:** USA Hosts/Stealth Fighter Reunion, 5030 Paradise Rd., Suite B-108, Las Vegas, NV 18119. Phone: (702) 798-0000 or (800) 634-6133.

DACCEUR
Charter members (both military and civilian) of the Defense Area Communications Control Center (Europe) who served in France between 1962 and 1966 are invited to join in a thirtieth-anniversary reunion to be held in Florida in 1992. **Contact:** Kaye Palmer, 609 S. E. 28th Terrace, Cape Coral, FL 33609-3520. Phone: (813) 574-6757 or (813) 458-5968.

Tactical Recon Ass'n
We would like to hear from Tactical (photo/weather) Reconnaissance personnel who served in World II, or who are currently serving in tactical reconnaissance units and would be interested in attending our reunion September 30–October 4, 1992, in Sacramento, Calif. **Contact:** Tactical Reconnaissance Association, 2706 Edgewater Dr., Niceville, FL 32578.

28th Military Airlift Squadron
For the purpose of planning a reunion in 1992, I would like to hear from members of the 28th LSS/28th ATS/28th MAS (C-124 Squadrons) who served at Hill AFB, Utah, between 1953 and 1969. **Contact:** Col. Victor Lisec, USAF (Ret.), 3540 Nantucket Dr., Fairfield, CA 94533. Phone: (707) 425-6644.

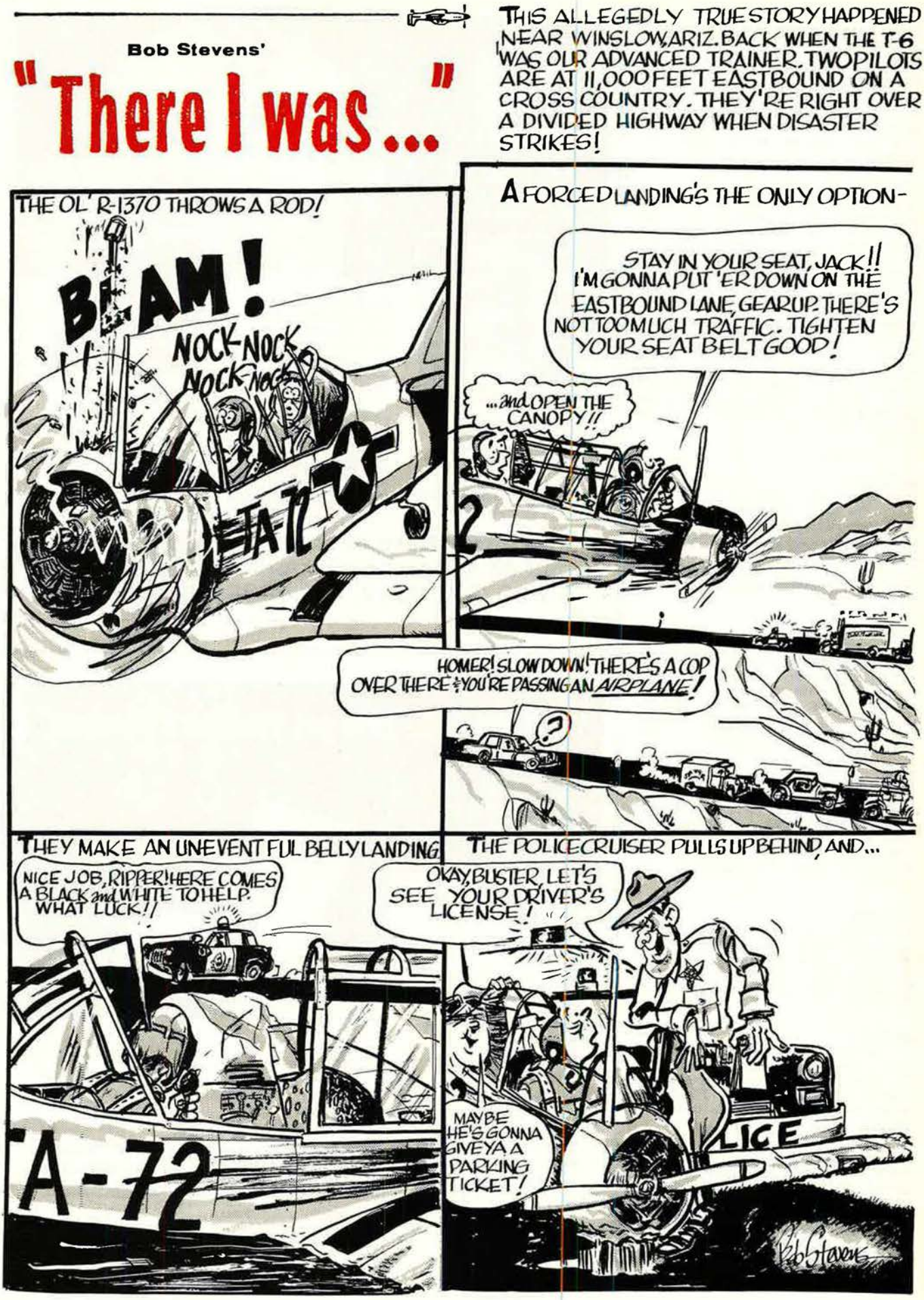
Class 43-B
In order to compile a directory and plan a fiftieth-anniversary reunion, I would like to hear from members of Class 43-B who served at Luke AFB or Williams Field, Ariz. **Contact:** Col. John V. Back, USAF (Ret.), 3463 E. Pasadena Ave., Phoenix, AZ 85018.

Class 45-C
Seeking contact with former instructors, air and ground crews, and pilots of Class 45-C (Marfa, Tex.) who would be interested in holding a reunion in 1992. **Contact:** Lt. Col. Theodore R. Heiland, USAF (Ret.), 116 N. Rosewood Dr., Albany, GA 31705.

Class 10221-B
Seeking former class members of Flight Engineering Class 10221-B who served at Chanute AFB, Ill., between October 1951 and March 1952 and who would be interested in holding a reunion in conjunction with the Boeing Co. B-29 fiftieth-anniversary celebration on August 14–16, 1992. **Contact:** Jay R. Losselyong, 26 Jefferson Ave., San Rafael, CA 94903. Phone: (415) 479-3476. ■

Bob Stevens'

"There I was..."



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