JANUARY 1987/$2

AIR FORCE MAGAZINE

UBLISHED BY THE AIR FORCE ASSOCIATION

Climbing for the Stars

Aeronautics Today and Tomorrow

Jane's Aerospace Survey 1987

WHEN NORTHROP DESIGNED IRCM, IT CHANGED THE COURSE OF MISSILES.

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Electronics Systems Group
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"Without the Osprey, the hostages might still have been with the hijackers."

"First word of the hijacking set a fast chain of events into motion . . .

"Although the airport was many miles away, the Air Force CV-22s slipped up on them quickly, quietly. In fact, we were on top of them before they could react. The Ospreys gave us clandestine precision and surgical accuracy. There was not one casualty among the hostages.

"Maybe, just maybe, this kind of response will send terrorists a message: Using innocent people for your purposes just won't work any more."

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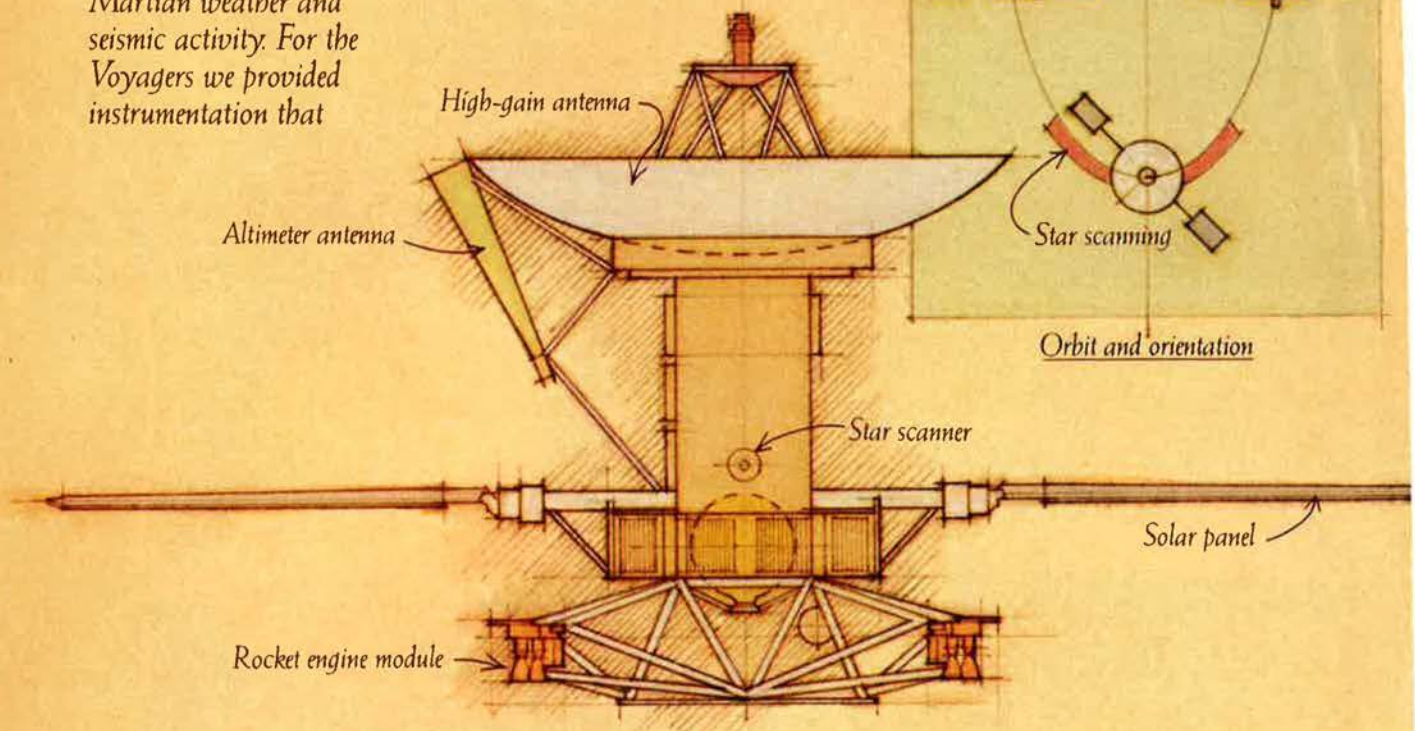
And it will rewrite mission profiles like no other aircraft in the world, ushering in a new era in special operations aviation.

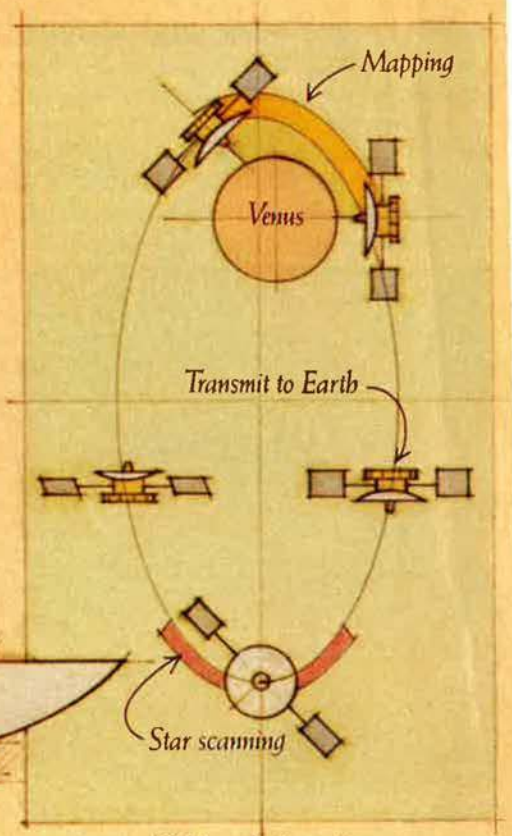
Bell Boeing
THE TILTROTOR TEAM

In space: looking back to look forward.

What can the nature and origin of the universe tell us about the future of Earth? To help answer that question, we make craft and instruments for traveling billions of miles in space and seeing as far as 15 billion years back in time. Martin Marietta was the integrator and builder of two Viking landers, which sent back remarkable photos of the surface of Mars, examined soil samples, and studied Martian weather and seismic activity. For the Voyagers we provided instrumentation that reported on electromagnetic activity near Jupiter and Saturn—Voyager 2 went on to Uranus, some 2 billion miles from Earth. That was nine years after launch; next destination, Neptune, in 1989. These are but a few results of Martin Marietta's ability to create survivable, mystery-solving craft and their instruments—from concept through mission completion.



Magellan Spacecraft



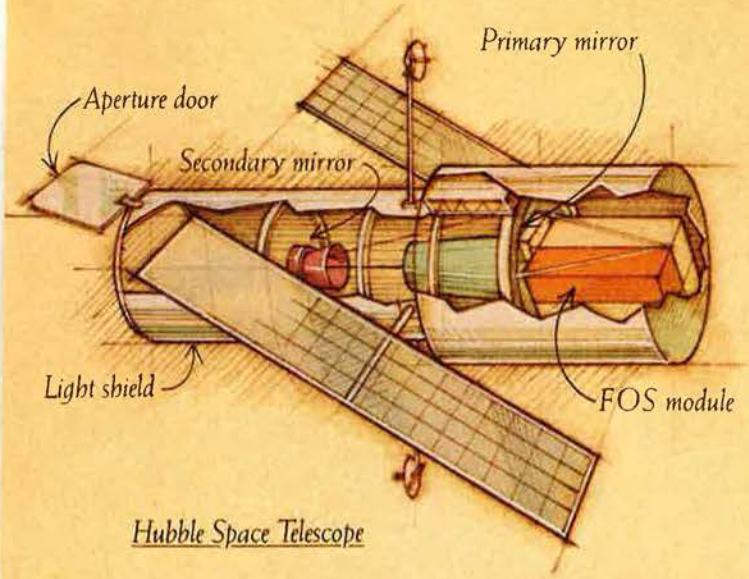
Orbit and orientation

Mission: map Venus.

From orbit, Magellan's radar will penetrate the planet's thick, gaseous cloud cover and send back photo-like images of nearly 90% of its surface. Our role: design, integrate, build and test the craft.

Viewing the infant universe.

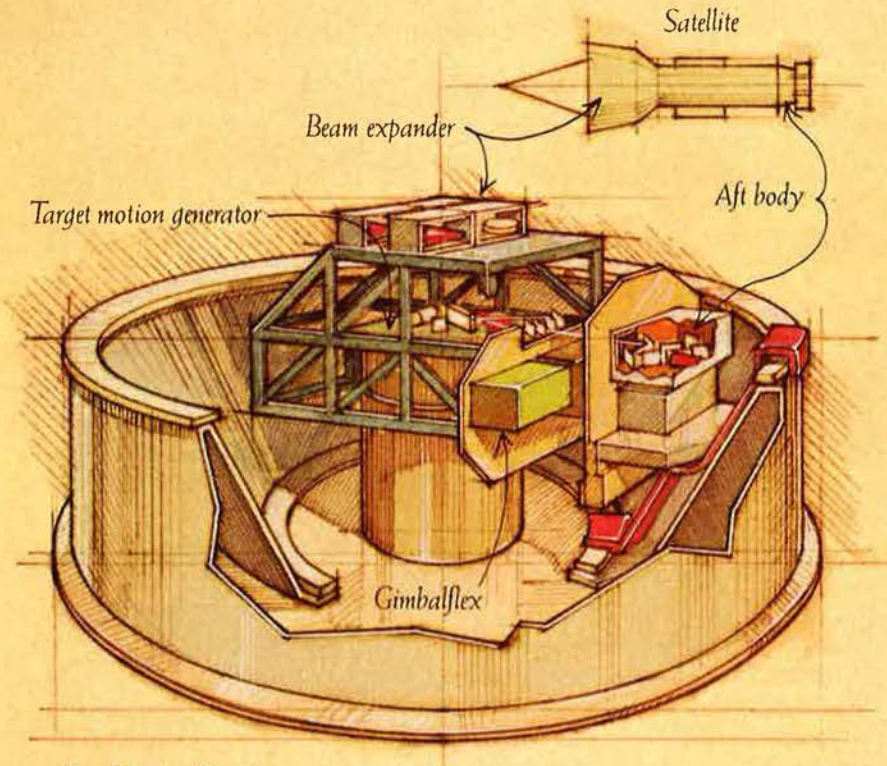
For the Hubble Space Telescope we are providing the Faint Object Spectrograph (FOS), which will see objects up to 15 billion light-years away. Since the universe is estimated to be 18-20 billion years old, astronomers will witness events close to its birth.



Hubble Space Telescope

The fine points of fine pointing.

Precisely controlled, space-spanning energy delivery and collection systems create difficult pointing and retargeting challenges, which we can now simulate. This new lab is working toward the precision to zero in on a football-size object 3,000 miles away, in support of the Strategic Defense Initiative research program.



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PUBLISHED BY THE AIR FORCE ASSOCIATION

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ge 100

bout the cover: USAF's Thunerbirds roar overhead as an xpression of America's aeroautical prowess. A special secon on "Aeronautics" begins n page 42. (Photo by John lartin Meek)

Special Section: Aeronautics

Features

Departments

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AN EDITORIAL

Rethinking Basic Strategy

By John T. Correll, EDITOR IN CHIEF

Well into December, the Pentagon was still laboring to put final touches on its plan for modernization of the ICBM force. This will be one of the most important issues to come before the 100th Congress, which convenes a few days from now. Specifically, Congress will be considering concepts for configurations of the new Small ICBM and basing modes for both the small missile and the MX Peacekeeper. In a larger sense, though, the deliberations will be about whether and how ballistic missiles fit into the future defense strategy of the United States.

Cold logic would suggest that all factions—arms-control enthusiasts and defense hardliners alike—should agree, at least in principle, to push ahead vigorously with ICBM modernization. Even those strategists who predict the obsolescence of ballistic missiles see no realistic alternative to them for some years yet. And if the United States slackens its efforts to counter the massive and continuing buildup of Soviet ballistic missile forces, there will be no motivation for the Soviets to take arms-control discussions seriously.

Those arguing the issue, on Capitol Hill and elsewhere, will have the benefit of a particularly wide-ranging analysis of strategic force requirements. By the middle of January, the Joint Chiefs of Staff will present their assessment of President Reagan's idea, introduced at the Reykjavik summit, for the United States and the Soviet Union to make deep cuts in strategic weapons over the next five years and eliminate ballistic missiles totally in ten years. At Reykjavik, Soviet leader Mikhail Gorbachev responded by repeating his previous call for the superpowers to rid themselves of all nuclear arms. No immediate agreement was reached, primarily because President Reagan refused to bargain away his Strategic Defense Initiative, which he believes will eventually free the world from the threat of ballistic missiles.

Reykjavik has generated a fundamental reevaluation of strategic arms requirements, and Congress will be keenly aware of that as it weighs the ICBM modernization package. Congress will also have to take into account the feasibility of sweeping, Reykjavik-style changes. There are major military, political, and economic questions to be explored. There is widespread doubt that alternative force structures of sufficient size would be affordable—and further doubt about their basic adequacy. In Europe, the news from Reykjavik resurrected concerns about how firmly the protection of NATO remains linked to the protection of the United States.

Since World War II, the United States has followed a doctrine of strategic deterrence, keeping Soviet military power at bay mainly by the threat of nuclear retaliation. It has extended the protection of this strategic power to its allies. The specter of escalation to nuclear war is omnipresent in any conflict, so the superpowers have shied away from direct military confrontation. There is no way to know whether this nuclear standoff has prevented a conventional war that might otherwise have been fought in the past forty years. But one by-product is certa The conventional military capabilities of the major po blocs have not been tested against each other.

The West, having thus avoided head-on challenge by other side's first team, has grown too reliant on nuclear we ons. This is an unhealthy predicament, but it has worked so and it has kept defense budgets down. Nuclear weapons unmatched in sheer deterrent effect. As military forces they are relatively inexpensive. ICBMs, particularly, pu great deal of striking power on ready alert at low cost. Nucl forces, however, are not a satisfactory substitute for conv tional forces—although the free world has tried to make th so, with the result that allied theater forces today prov limited flexibility and few nonnuclear options in any conflic significant size.

The Soviet Union and the Warsaw Pact have the overwhel ing advantage of numbers in conventional forces. The West h traditionally held a quality edge, but the straight conventio matchup is so unfavorable that the US is compelled to rej Gorbachev's proposal, which would ban nonballistic as well ballistic nuclear weapons.

It is a standard assumption in arms-control circles that t US and its allies would increase their conventional forces compensate for any reduction in nuclear forces. That could b but governments on both sides of the Atlantic are groani under the burden of their present defense budgets. It is diffic to imagine them funding double-digit increases in fighter win and infantry divisions. It is equally difficult to imagine th with nuclear arms drawn down on both sides, the Soviet Uni would hold its conventional forces at constant levels while t West built toward parity. A key question is whether any fea ble combination of conventional forces, backed up by nuclea capable bombers, cruise missiles, and theater aircraft, wou be sufficient to deter aggression and attempts at intimidati by the Soviet Union.

Underlying the entire issue, of course, is the degree of con dence to be placed in the Strategic Defense Initiative. N everyone shares the President's faith in it. Former Secretary Defense James Schlesinger, for example, calls SDI "a colle tion of technical experiments and distant hopes." Improv defenses would be a worthwhile part of an overall strateg posture. Perhaps the day will come when defenses alone w be enough, but no such capability has been demonstrated ye

Until SDI is operational and an equitable, thoroughly ve ifiable arms-control agreement is in place, we will need mo ern nuclear deterrent forces, including ballistic missiles. It not presently possible to mount any other response of equ credibility to Soviet military power.

If we allow that threat to go unanswered, our hand at th bargaining table is weakened, perhaps hopelessly so. An more important, our ability to protect our national interes will be dangerously diminished.

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The men and women of the Air National Guard have always been entrusted with the defense of our country. With the combat-proven F-16 as their primary fighter, they'll be better equipped to carry on their proud tradition.

GENERAL DYNAMICS

AIRMAIL

ıe First Priority

The final paragraph AFA's State-ent of Policy *(see "Government's rst Responsibility," p. 6, November 6 issue)* was an appropriate re-inder that our Constitution was es-blished in order to provide for the ›mmon defense and to promote the eneral welfare—not the other way ound. Unfortunately, as a free and ›en society, we have a history of mili-ry unpreparedness that could be fa- l in this nuclear age.

Not many are left who recall the onths it took to mobilize and train a ilitary force in World War I, but there e many of us who do remember the ›uisiana maneuvers of 1941, just a w months before Pearl Harbor, hen sticks were used to simulate ri-es and trucks were marked as make-elieve tanks. Some also remember ıe Korean fiasco, when B-29 crew niefs robbed spare parts from each ther to keep their tired old aircraft loft.

As a peaceloving, democratic soci-ty, we have an aversion to military reparedness, partly because it re-inds us of the futility of war and part- because of the pressing demands or social and economic progress. hose of us who served must never llow our elected representatives to orget why our founding fathers made ıe defense of our nation their first riority.

You do a great service in this re-pect.

Maj. Maurice E. Connor,
USAF (Ret.)
Aptos, Calif.

ommissary Privileges

The Enlisted Association of the Na-ional Guard of the United States EANGUS) gratefully acknowledges he support of AFA for our commis-ary initiative for reservists as stated n your "Commitment Is a Two-Way treet" policy paper in the November 986 issue.

Our efforts were successful, and he fourteen-day maximum entitle-nent (a compromise to the varying ength of reserve component annual raining periods) to be used at the in-dividual's discretion over a one-year period of time is contained in the FY '87 DoD Authorization Act. It has been a long time in coming.

We firmly believe that the long-range benefits of this entitlement will rank with the new GI Bill as an incentive that will sustain our efforts to continue to maintain the strength and readiness of the reserve forces into the next century in the face of Gramm-Rudman-Hollings austerity.

Alan D. Obermiller
Executive Director
EANGUS
Washington, D. C.

Time for a Change

As a retired regular USAF officer working for the federal government, I was happy to see in your November 1986 issue AFA's stand in support of the removal of the dual-compensation limitation for retired officers *(see "Commitment Is a Two-Way Street," p. 95, November '86 issue).*

The 1964 Dual-Compensation Law was grossly unfair to a small segment of our retired military population.

With recent changes to both the federal and military retirement systems and with older changes to the regular accession program, which strives to have its ranks above captain filled almost entirely with regular officers, it is time this law be changed.

I would like to learn more about what steps are being taken to have this law changed and to offer my support.

Lt. Col. James H. Steinmeier,
USAF (Ret.)
Baltimore, Md.

Do you have a comment about a current issue? Write to "Airmail," Air Force Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Letters should be concise, timely, and legible (preferably typed). We reserve the right to condense letters as necessary. Unsigned letters are not acceptable, and photographs cannot be used or returned.

Backseat for R&M?

I was totally disappointed in your November 1986 policy paper "Modernization in Midstride." Again, the Air Force R&M 2000 program was given a backseat in the bus. Coverage of the program, starting on page 85, begins with, "In the future . . ."

The senior Air Force leadership commitment is now—not in the future! The Chief of Staff and the Air Force Secretary made that point on July 31, 1986, long before your AFA Convention. The B-52 offensive avionics system that helped that old warrior blow the socks off of the competition in SAC's bombing competition is now—not in the future. A 4,000-cycle core in the F100 engine is now—not in the future. Fuel- and oil-quantity indicators going from less than 200 hours with extensive calibration requirements to 18,000–20,000 hours of failure-free operation with internal calibration are now—not in the future. Major electronic components going from the half-life of a flash bulb to well over 2,000 hours at reductions in acquisition and life-cycle costs are happening now—not in the future.

When is the Air Force Association leadership going to wake up? The R&M program is not some insidious predator competing for scarce resources in terms of cost and schedule. It is the very essence of performance and always has been. Ask the troops who launched out of Lakenheath and Heyford if they want to wait until the future!

I have watched with increasing frustration the continued perception by AFA that this R&M thing will pass and should be put on the back burner while senior combat commanders have embraced R&M as a means to fight and win!

While the senior leadership of the Air Force is banging away on contractors that we are serious about R&M, AFA again sent the subtle message to aerospace industry: "Wait this R&M thing out—it will pass!"

Col. Jack Reynolds, USAF
Deputy Ass't to the Commander,
AFLC, for R&M
Wright-Patterson AFB, Ohio

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AIRMAIL

• *Colonel Reynolds wrote to this column in July 1985, accusing this magazine of ignoring the R&M issue. As we pointed out then,* AIR FORCE *Magazine has reported the R&M story thoroughly.*

This Association strongly supports such initiatives as R&M 2000 and in no way espouses the "wait-it-out" position that Colonel Reynolds imputes to it. The passage in "Modernization in Midstride" to which he refers, read in context, is clear and unequivocal on that point. To believe otherwise is a willful misreading of AFA's position.—THE EDITORS

Propaganda?

As a charter member of the Air Force Association, I was disappointed in seeing the 1986–87 AFA Statement of Policy in the November 1986 issue.

Such phrases as "emasculating already sparse defense budgets" appear to be propaganda of the military-industrial complex rather than a responsible summary of our national security needs.

Better the Association should include a paragraph admonishing the military to reduce wasteful procurement policies and the defense industry to purge itself of unethical executives.

Col. Peter P. Dawson,
USAF (Ret.)
La Verne, Calif.

A Job Well Done

Re: "Those Bombing Champs From Britain" by Wing Cmdr. John Grogan in the November 1986 issue.

Anyone who doubts the capabilities and commitment of our British allies would do well to read Wing Commander Grogan's article. How he and his teammates went about duplicating England's earlier victories in SAC's Bombing and Navigation Competition, this time with their Tornados, reaffirms that professionalism, skill, and *esprit* are very much alive and well in today's RAF.

Competing on the home team's "turf," struggling with unfamiliar ATC/FAA rules and constraints, and dealing with SAC's high-level format—they not only persevered, they left for home having taught us once again "how the cow ate the cabbage" in precision-bombing planning, technique, and execution.

To Wing Commander Grogan, I crews, and their compatriots in E gland—congratulations on a job w done.

Col. John E. Jordan, USM(
Huntington Beach, Calif.

Jim Kasler

I was delighted to read the excelle article on the career of Col. Jim Kas *(see "Valor in Three Wars," p. 119, N vember '86 issue).*

Like many other young Canadi fighter pilots, I had the pleasure flying with Jim Kasler when he w attached to the Royal Canadian A Force in the late 1950s as an instru tor at our F-86 Sabre Operation Training Unit in Chatham, New Brun wick. We got to know Jim as a firs class gentleman as well as a supe professional fighter pilot and A Force officer.

Over the years, occasional sma pieces of information in the press ar conversations with other servi members have brought Jim to min but nothing pulled it all together un the well-written article by Joh Frisbee.

My congratulations on a mo thoughtful and well-deserved tribut

Col. Paul A. Hayes
Canadian Forces Air Reser
West Hill, Ontario
Canada

The Duck Lives

As an avid reader of your magazir for the past seventeen years, I kno how you strive for accuracy, but th November 1986 "Aerospace World column contained an error.

The O-2 "Duck," retired in Augu by the 507th Tactical Air Control Win at Shaw AFB, S. C., was not the last A Force O-2. The Air Force Flight Te Center at Edwards AFB, Calif., sti has five operational O-2s. Three ar assigned to the Center's 6514th Te Squadron at Hill AFB, Utah, and th remaining two are here at Edward AFB and are used for range suppo and chase missions.

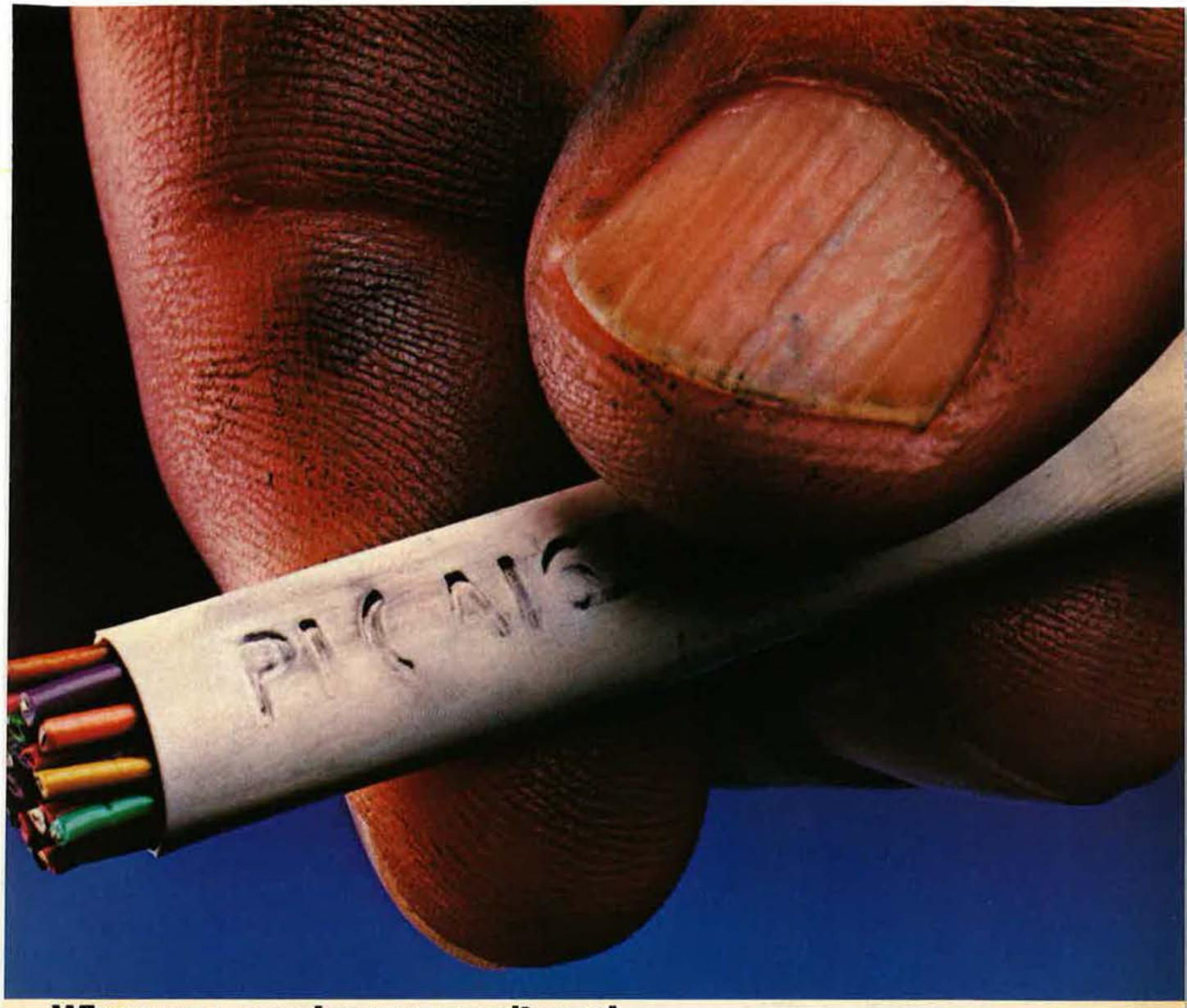
As Mark Twain once said in a cabl from Europe to the Associated Pres "Reports of my recent death are grea ly exaggerated."

Lt. Col. Jerry F. Guess, USA
Edwards AFB, Calif.

• *Colonel Guess is correct. W should have reported that the O-2 ha retired from squadron service in it primary mission.*—THE EDITORS

The Need for Aerial Refueling

The November 1986 issue of Ai FORCE Magazine is replete with nu merous reasons to be optimisti



Why some servicemen can't read.

Wet weather or frequent handling can make it impossible for troops in the field to recognize the coded ink markings on plastic-sheathed wiring. And that's when the inability to read can delay repairs and endanger valuable electronic equipment.

Our search for smudge-proof markings led to laser etching. An exhaustive study of the entire etching process enabled us to develop the right software and marry it to the appropriate laser hardware. The result was an etching method precise enough to yield indelible numbers without melting through the plastic.

At Raytheon, we know that reliability is the ultimate test for any complex electronic system. It has to work each and every time. That's why we never lose sight of the fundamentals in developing and producing such systems. We avoid shortcuts. And we pay attention to all the details—right down to the coding on a cable. It's why we can say, at Raytheon, quality starts with fundamentals.

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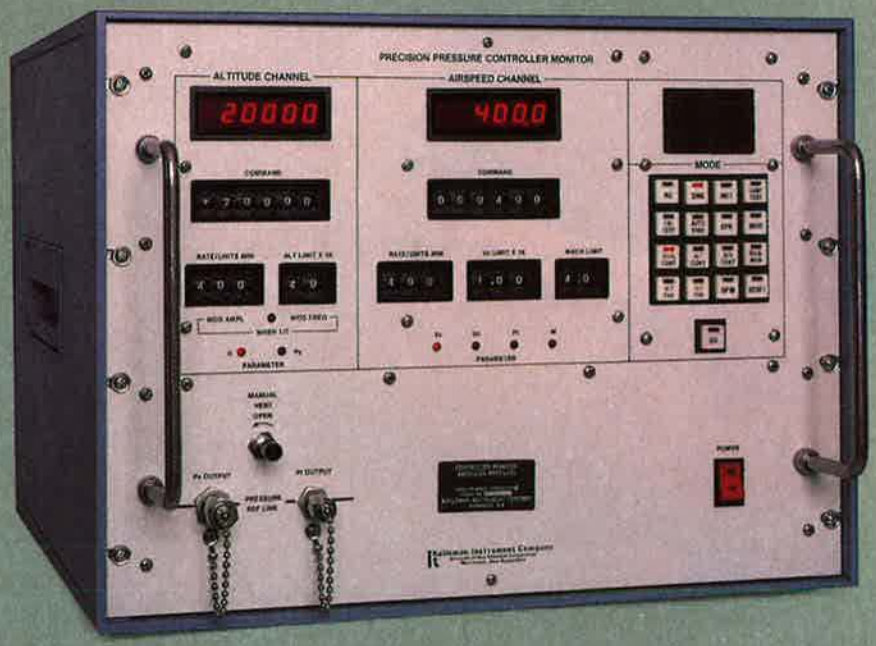
Where quality starts with fundamentals

Kollsman Benchmarks



This Precision Pressure Controller-Monitor (PPC-M) from Kollsman sets a new standard for testing air-data instruments. Solid-state transducers combined with a microprocessor-based design make possible levels of accuracy, repeatability and reliability not previously available.

Altitude range is from -2000 to +90,000 ft; accuracy to ±0.004 in. Hg. Airspeed range is from 20 to 1050 kt. The PPC-M can control or monitor pressures, and its IEEE-488 interface permits remote programming. Read-outs in either English or metric units can be selected.

For a complete description of the PPC-M, or other Kollsman pneumatic test units, write or call, Marketing Manager, Kollsman Avionics Group.

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about the future of American and allied airpower. Despite each new system's considerable potential, all are linked by a common dependence and critical vulnerability—the need for aerial refueling.

Whether C-17 or British Tornado, proper and timely application of tomorrow's sophisticated weapon systems requires a "trip to the tanker." At present, it is unrealistic to assume that, in other than a highly region-specific conflict, adequate tanker support can be forthcoming. Hence, the mission capability of strike and transport aircraft will be severely attenuated.

So long as the bulk of SAC's thirty-year-old KC-135s remains on the ground, supporting SIOP alert commitments, the aerial refueling assets available to theater commanders will be woefully inadequate. The claim that the KC-10 is equivalent to three KC-135s is meaningless when one receiver is "on the boom" while two others flame out alongside, unable to refuel. The reality of combat air refueling dictates a high boom-to-receiver ratio, not necessarily a high tanker-to-receiver ratio.

In any global conflict, the concurrent and equally immediate needs of multinational and multiservice reconnaissance, transport, air superiority, strike, and special operations aircraft will strain American and allied tanker fleets beyond their capability. Combat loss of any tanker makes even the most ideal scenario only tenuously favorable.

What is needed now is the recognition by systems acquisition managers that a larger tanker fleet is essential. Nations around the world are currently converting Boeing 707s into tankers, most of them capable of refueling three aircraft simultaneously. These former airliners are available at a fraction of the cost of the development of a new system. Their commonality in parts and operation makes them easily integrated into existing tanker assets.

The Israeli strike against PLO headquarters in Tunisia and the American strike against terrorist targets in Libya are two recent examples that demonstrate the total dependence of a successful operation on aerial refueling. Such a history lesson is free. If ignored, the cost can be incalculable.

1st Lt. Robert S. Hopkins III, USAF
Bunker Hill, Ind.

Ill-Conceived Boondoggle?

Your November 1986 issue carried no less than four articles extolling the virtues of SDI. It's incredible and appalling that knowledgeable people continue to support that fantasy.

It is understood that it would be unwise for the active-duty military to oppose the Commander in Chief's pet project, but to support the folly of "Star Wars" out of ignorance or for political or other ulterior motives—to the serious financial detriment of our country—is inexcusable.

SDI simply is not feasible for several reasons. The sheer magnitude of developing, deploying, and maintaining a multilayered defense shield that could repel an all-out attack from ICBMs, nuclear bombers, cruise missiles, and SLBMs is a pipe dream and would be cost-prohibitive. Costs are estimated at $750 billion. As with other cost overruns, a trillion-plus dollars is more likely. We simply cannot afford to expend that kind of money on a program whose effectiveness is so suspect.

With SDI costs on top of the current rate of defense spending, we would have more to fear from economic collapse than from military aggression.

Even if we could manage deployment, offensive technology would not stand still. You can be sure that a way would be found to breach SDI. Given the less than 100 percent efficiency of other weapon systems, it is likely that the Soviets could penetrate the shield with their existing capability. An all-out attack, including a dozen succeeding waves of 100 ICBMs each along the same narrow corridor, would do the trick.

But the most compelling reason for the invalidity of SDI would be its inability to protect us from radioactive fallout. An enemy need only detonate a number of dirty nuclear warheads in the atmosphere over the Pacific just off our western shores. The westerly winds will do the rest.

Certainly, we would reap side benefits from the research, but the fact is that SDI can never protect us from all the forms of nuclear attack and is therefore useless. Someone needs to tell the Commander in Chief the truth about this ill-conceived boondoggle.

Col. Warren W. Luce, USAF (Ret.)
Tucson, Ariz.

Hail to the Chief!

I was shocked to see your response to CMSgt. Arthur DeBaun's letter in "Airmail" in the November 1986 issue. In your response, you referred to Chief DeBaun as "Sergeant."

For so long as I can remember, the only acceptable form of address for a chief master sergeant is "Chief." Further, I know of no instance in which the title "Sergeant" can be used.

For shame!

Eric Lemmon
Lompoc, Calif.

• *Mr. Lemmon is correct.*—THE EDITORS

Jack Broughton

John L. Frisbee's glorious tribute to Col. Jack Broughton was well timed for a most deserving individual *(see "Thud Ridge: A Legacy and a Legend," p. 108, October '86 issue).*

While Colonel Broughton was flying "Thuds" at Takhli, some of us in a combat support unit were involved in the buildup on Okinawa. Our unit was in air defense from Naha AB, a marvelous perspective from which to observe—from a distance—the F-105s at Kadena AB just a few miles away.

As air defenders are wont, we also had our name for the F-105s. Third-stool rumors among our colleagues had it that those birds were so heavy that they could taxi up over an Army tank, lift the gears, and squash the beasts. Hence our term "squat-bombers"!

By whatever name, this heavy bomber did yeoman service "down South," as did its air and ground crews.

David C. Phillips
Spring Valley, Calif.

Education on the Block?

Your recent special section in the October 1986 issue on "USAF's Top Issues" was excellent as far as it went, but, unfortunately, it was incomplete. Now we know the top issues in the Air Force, but what can we expect to see cut to provide the funds to support these top issues? Sadly, I believe we will have to endure greater cuts in those "soft" areas, as defined by budgeteers. Normally, education programs are one of the first things to be cut. It appears it is going to be the same again this time.

Funded education has again been put lower on the priority lists than advanced technology weapon systems, but who is going to bring those systems on board if our people aren't properly educated? There are probably as many reasons that funded education is low on the lists as there are people to ask. Most commonly, the reason for cutting education before hardware is that "the mission is to fly

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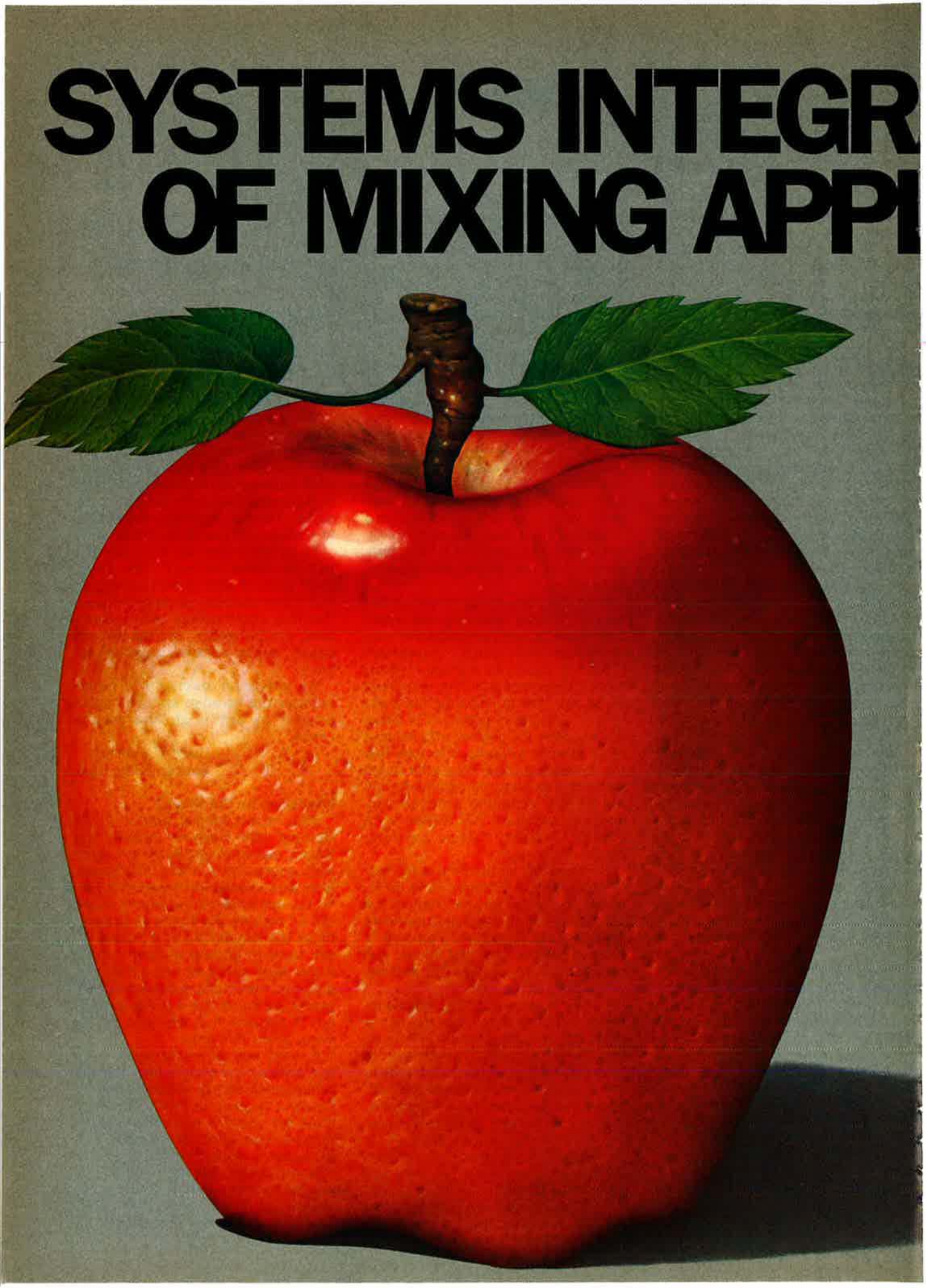

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and fight." Education is neither of these. Additionally, you can cut education for a period without seeing any real effects.

But, over the long run, if you reduce education, you will reduce readiness. Cutting funded education programs produces short-term fiscal savings and long-term disasters. The point is that education is the "seed corn" of the future. If we cut education to support near-term projects, we are dooming our successors to long-term problems.

So when we look at the top issues, we need also to look at the "costs" in terms of what we don't buy. The cost of not buying good education may be too high a price for us to pay.

Maj. David E. Muhleman, USAF
Montgomery, Ala.

322d Bomb Group

I am an Air Command and Staff College student stationed at Maxwell AFB, Ala., conducting research for a historical account of the strategy and tactics used by B-26s during World War II. More specifically, I am researching the 322d Bombardment Group's missions on May 14 and May 17, 1943, against the power plant at Ijmuiden, Holland.

I am interested in contacting any crew members who flew the missions or who were attached to the 322d during that period. I'm also interested in contacting any staff members of the Eighth Air Force or anyone else who may have information about B-26 strategy and tactics, especially for the low-level missions during the Ijmuiden raids.

Anyone having any information on this subject is asked to contact me as soon as possible.

Maj. James N. Openshaw, USAF
539 Larkwood Dr.
Montgomery, Ala. 36109
Phone: (205) 279-8201

Project C-45

The Heritage in Flight Museum in Lincoln, Ill., is renovating a Beech 18 at Logan County Airport, restoring it to a USAF C-45 configuration. We would welcome visits by C-45 veterans who could share with us their know-how and experiences.

Please contact the address below.

Marv Boss or Jack Burke
Heritage in Flight Museum
P. O. Box 1472
Springfield, Ill. 62705

Adopt-A-Plane

A limited number of aircraft in the aircraft museum located at the Pueblo Memorial Airport in Pueblo, Colo., will soon be available for the "Adopt-A-Plane" project. Among these aircraft are an A-26, a B-29, an EB-47, a P2V-5F, and an RB-37.

The Pueblo Historical Aircraft Society is restoring and providing maintenance for the museum. It is a nonprofit corporation and operates a campground a short walk away.

For further information about the museum or the "Adopt-A-Plane" project, please contact the address below.

Lt. Col. William Feder,
CAP (Ret.)
Museum Director
P. O. Box 7433
Pueblo West, Colo. 81007

AIRMAIL

F-102s in Europe

I am writing a book about the history of the F-102 in Europe from 1959–70 and am looking for photos and information. I am especially interested in information regarding the 497th and 431st Fighter-Interceptor Squadrons.

Publication of my book is scheduled for 1987. Anyone having any information is asked to contact me at the address below.

Johan D. Ragay
Ln.v.d. Mensenrechten 151
2552 NR 's-Gravenhage
Netherlands

461st Bomb Wing

I am presently writing the history of the 461st Bomb Wing, which was based in my hometown of Amarillo, Tex., from March 1, 1960, to January 28, 1968. I am including the history of the unit from its inception during World War II as a B-24 outfit.

I desperately need photos and information from personnel who were assigned to this unit. All photos and letters will receive recognition in my book.

Please contact me at the address below.

Barry E. Sullins
13450 W. Dakota Pl.
Lakewood, Colo. 80228

1st Pathfinder Squadron

I served with the 1st Pathfinder Squadron (Provisional), a unit of the Ninth Air Force, during World War II. This unit was disbanded immediately after V-E Day. The crews and aircraft were returned to their bomb group of record, and the squadron that had provided the Ninth Air Force with about fifty percent of its capability to strike targets during the critical winter weather of 1944–45 was gone, almost without a trace.

Forty years have passed, and I have not heard of any reunions or found any mention of the unit in historical accounts of the Ninth.

Some time ago, the whole scene came back into focus when a good friend and squadron mate, Ned Grubb, called. Needless to say, our meeting was a happy one.

If there are any other Pathfinders out there, give me a shout. Maybe we can rent a room and split a six-pack, just like the group guys do.

Paul J. Hughes
Pierpoint E-129
Stuart, Fla. 33494
Phone: (305) 283-2634

1st Transport Group

I've been thinking of compiling a history of the "Crescent Caravan"—an ATC group initially out of Wilmington, Del. (1945), and later called the 1st Air Transport Group when it was based at Westover Field, Mass., and flew the North Atlantic during the 1945–47 time period. I'd like to gather any pictures, clippings, stories, anecdotes, etc., that might contribute to this project.

We had both USAAF pilots and service pilots (airline contract carriers). Maybe we could get a reunion going.

I also wonder if there are any members of Class 43-H, Ellington Field, Tex., out there who would be interested in a reunion. I'd like to hear from anyone with suggestions as to time and place.

George F. Rugge
14041 Painted Desert Rd.
Poway, Calif. 92064

Collectors' Corner

During World War II, a book titled *Pacific Sweep* was published for the Fifth Air Force Fighter Command by the F. H. Johnston Publishing Co. of Sydney, Australia.

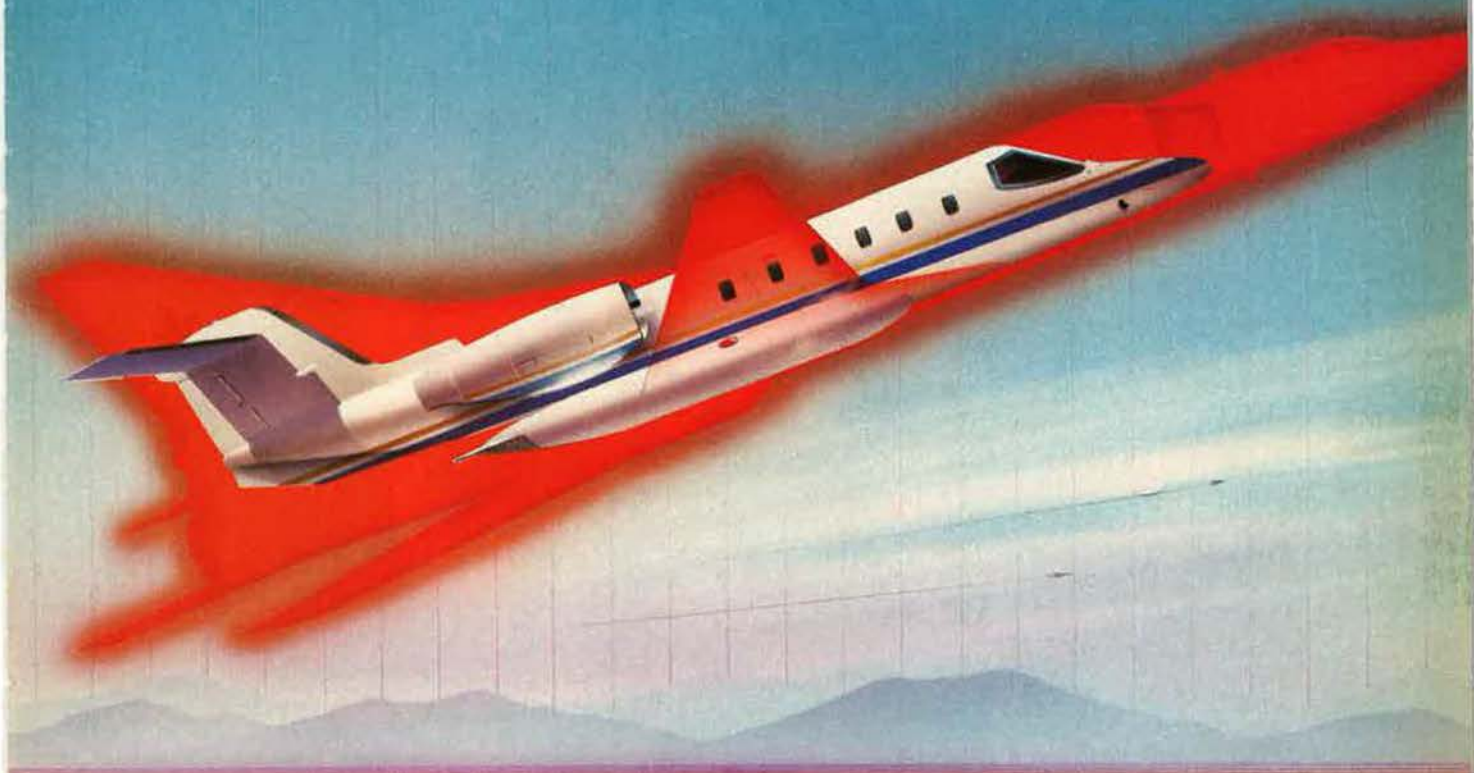
I would like to obtain a copy of this book. If anyone knows where I might secure one, I would like to hear from them.

George E. Mayer
7445 Thomas Ave. S.
Richfield, Minn. 55423

I am very interested in starting an extensive collection of USAF patches and photographs and posters (particularly any featuring post-1950s fighters and recon aircraft), but I'm having a hard time getting started.

If any readers have any such items that they don't want and would be willing to part with, I would greatly

A SHEEP IN WOLF'S CLOTHING



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appreciate it. I will cherish all contributions.

Gina M. Ledda
15179 Russell
Allen Park, Mich. 48101

I am a serious historian of USAF air and security police memorabilia. I am interested in obtaining anything from unit patches to decorated helmet liners, fatigues, beret crests, or old photographs.

Please contact me at the address below. I will answer all letters.

MSgt. Paul A. Block, USAFR
5718 Cambridge Lane, #1
Racine, Wis. 53406

Because of my wife's full-time position with the Ohio Air National Guard, I have become interested in collecting patches from fighter units. I would welcome any assistance in obtaining such patches. I am most interested in A-7 and F-4 units, but would like a variety.

Please contact me at the address below.

Steve Barnes
236 Electric Ave.
Westerville, Ohio 43081

I am new to the hobby of collecting unit patches and would appreciate any help in getting started.

Anyone who could help me out is asked to contact me at the address below.

Sgt. Kevin W. Poolman, USAF
PSC Box 2031
Grissom AFB, Ind. 46971

I am a collector of ANG/AFRES unit patches. I will buy, trade, or accept donations of any patches. I am especially interested in patches from the 177th and 120th Fighter-Interceptor Groups.

Please contact me at the address below.

SSgt. Al Niedrich, USAF
581st AGS/RAWF
PSC Box 357
APO New York 09405

I am working on a collection of Air Force patches. I am especially interested in patches, old and new, from units of the Fifth Air Force, Seventh Air Force, and Eighth Air Force.

Please contact me at the address below.

SSgt. Steve Bowman, USAF
PSC 1, Box 21299
APO San Francisco 96230

Roll Call

I would like very much to correspond with anyone who may have known or flown with my father, Maj. Jay C. Sheridan.

AIRMAIL

He entered the service in 1942 and was a P-47 IP at the end of World War II. He then served with the 86th Fighter Group in Germany from 1946 to 1949, flying P-47s and P-80s. From 1951 through 1959, he flew F-86s at McChord AFB, Kadena AB, and Scott AFB and was a gunnery instructor at Nellis AFB. He retired from the Air Force in 1963 while flying the F-106 with the 438th FIS at Kincheloe AFB, Mich.

Subsequent to his retirement, he worked as an air carrier operations inspector for the FAA out of Indianapolis, Kansas City, and Chicago until his death in 1975.

Anyone having any memories or photographs to share is asked to contact me at the address below.

Dean C. Sheridan
4537 Wicklow Pl., #101
Virginia Beach, Va. 23452

I am trying to locate former members of the 1501st Air Terminal Squadron, Travis AFB, Calif., who served from 1955–57. In particular, I am looking for Colonel Bashaw, Capt. Curt Sweeney, 1st Lt. Lou Mendeola, Lieutenant Kirk, A1C Joe Whitt, George Kobayashi, Tom Harrell, Robert Evans, and Dick Casey.

I am also interested in contacting the following members of the 1502d Air Terminal Squadron at Hickam AFB, Hawaii, who served there during 1957–59: Capt. Frank Cowgill, SMSgt. Marvin Kaplan, Sergeants Trueblood, Horie, and Marsh, Harry Griffin, Jr., George White, James Gamble, and Tom Gomez.

I would greatly appreciate it if someone could put me in contact with any of these men.

James G. Hampton
3401 Lincoln Ave.
Covington, Ky. 41015
Phone: (606) 261-1407

I am trying to locate former members of my old B-17 crew. We were commanded by Lt. Charles Kuhl and served in the Eighth Air Force in 1944.

Crew members included Nick Paradiso, Bob Law, Dale Remley, Fred Tate, and Don Seely.

Any information about any of them would be appreciated. Please contact me at the address below.

Paul McConahey
1409 Paces Trail
Lakeland, Fla. 33809-9541

IN FOCUS...

Bombers for the Battlefield

By Edgar Ulsamer, SENIOR EDITOR (POLICY & TECHNOLOGY)

SAC intends to allocate more of its heavy bomber fleet to theater operations. This will involve aircraft modifications, changes in training, and acquisition of precision-guided and stand-off weapons.

Washington, D. C., Dec. 3

In line with Air Force doctrine, which holds that the aerospace forces form an indivisible whole, the Strategic Air Command has embarked on a comprehensive program to modernize and expand its conventional warfighting capabilities. The central element of this upgrading effort comprises three specific steps. For one, the delivery capability of the bomber force is being expanded. Secondly, SAC is stepping up the acquisition and stockpiling of precision-guided munitions. Lastly, standoff weapons for conventional warfare are receiving major attention.

As Maj. Gen. James McCarthy, the command's Deputy Chief of Staff for Plans, pointed out during a recent AFA symposium, all strategic bombers incorporate a latent conventional capability. SAC, he said, plans to exploit this capability and will increase sharply the number of "dual-role" aircraft in its inventory as well as assign some bombers primarily to conventional warfare missions.

The core of SAC's conventional bomber force, starting in FY '89, will be sixty-one B-52Gs dedicated to theater operations. These G models won't be modified for the carriage of air-launched cruise missiles. At the same time, a total of ninety B-52Gs will be carried on SAC's books as dual-role, capable of nuclear as well as theater warfare. Another major goal in connection with SAC's plans to boost its conventional warfare capabilities is to increase the number of dual-role B-52Hs from twenty-eight aircraft to eighty-four as rapidly as possible.

In similar fashion, the number of dual-role FB-111s is slated to increase from twenty-two to fifty-two aircraft. Also, original plans to assign thirty-two new B-1Bs to the dual-role category have been changed to up the total to ninety aircraft. Lastly, SAC, at the personal initiative of its Commander in Chief, Gen. John Chain, is working toward assigning a dual-role mission to all its bombers. Presumably, this will include some or all of the 132 advanced technology, or "Stealth," bombers (ATBs) that will enter SAC's inventory in the next decade.

Other steps planned by SAC to increase its conventional warfare capability include the addition of pylons and racks to most of the command's strategic bombers as well as the modification of the B-52Hs to carry external gravity bombs. Further, the command is developing and fielding the software and hardware required to launch advanced standoff weapons from strategic bombers.

In step with these hardware modifications, SAC is sharply increasing the training of aircrews and maintenance personnel for conventional warfare missions. This reorientation of the flight-training program will entail a marked increase in the actual release of such conventional weapons as gravity and glide bombs. At present, it does not appear possible, however, to increase flying hours over the previously planned level.

The concept of using strategic airpower in conventional warfare is hardly new. Strategic assets were used often and productively to support tactical operations in World War II, Korea, and Vietnam. Among the most exemplary instances of the application of strategic airpower to conventional warfare was Linebacker II, the intense, albeit truncated, series of B-52 raids against Hanoi in December 1972 that brought the North Vietnamese to the bargaining table in Paris.

The Air Force's updated doctrine treats the aerospace forces as a totality. Concomitantly, airpower must be employed on the basis of which weapons and forces can do a specific task best and without regard to which command owns these resources or whether or not such an assignment dovetails bureaucratically with the candidate command's traditional mission.

As part of this doctrinal shift, SAC's primary emphasis becomes support of the warfighting CINCs, according to General McCarthy. In line with this policy, SAC is "apportioning" significant numbers of B-52s to specific theater operations and such unified commands as PACOM, LANTCOM, EUCOM, and CENTCOM.

SAC, of course, has always been in the business of supporting conventional and theater warfare operations through its tanker forces. US strategic and general-purpose aircraft, supported by SAC's tankers, can operate freely and flexibly in remote theaters without reliance on forward staging areas and facilities. In this context, SAC is taking a number of steps to enhance its tanker fleet and thereby facilitate forward deployment and rapid reinforcement of tactical airpower.

Key here, General McCarthy explained, are modification efforts involving the KC-135R and KC-10. In the case of the KC-135R, SAC plans improvements that go beyond the current reengining and include beefed-up landing gears and boosting tankage to the aircraft's maximum capacity. Theoretically, the aircraft's current usage rate of 300 flying hours per year—when projected over its expected service life of 40,000 flying hours—suggests that the KC-135R might remain in SAC's inventory beyond the middle of the next century.

While it would be moot to make specific forecasts about its operational longevity, he pointed out that there are no technologies on the horizon that make possible a significantly more efficient follow-on design to the KC-135R. Without any particular incentive to replace this long-lived tank-

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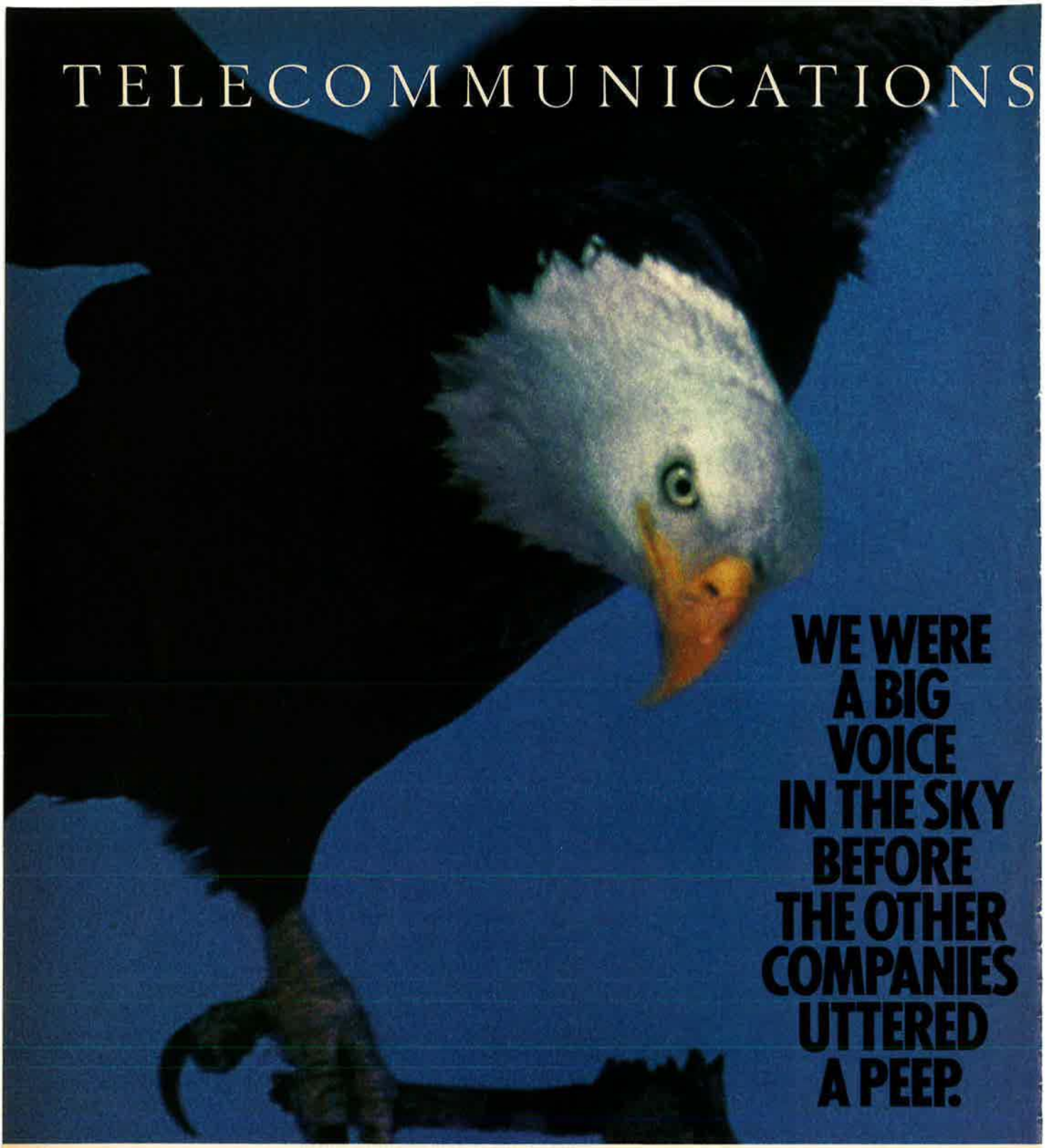

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er, it makes sense to increase its efficiency and utility through a series of modifications. SAC, therefore, is considering various "avionics improvements up to and including glass cockpits" as well as other enhancements that are being retrofitted to a special "Speckled Trout" test-bed, according to General McCarthy.

Demands for the KC-10, especially by the US Navy, General McCarthy stressed, are far in excess of the original forecasts and beyond "our wartime capability" to meet those demands. The US Navy is showing significant interest in the KC-10 for fleet defense and fleet strike missions while basically increasing its dependence on this tanker for air refueling: "They tend to prefer the KC-10 over the KC-135." In addition, the KC-10 "could be used for certain nuclear operations," he added. As a consequence, it might well become attractive to increase the buy of this aircraft from the presently programmed total of sixty aircraft to an appreciably higher number. More than forty-two KC-10s are in the Air Force's inventory at present.

In SAC's view, strategic airpower performs three basic missions in the theater role: counterair, air interdiction, and maritime operations. In the case of B-52Gs assigned to maritime operations, for instance, each aircraft is capable of carrying twelve highly effective Harpoon antiship standoff missiles or a substantial payload of naval strike mines as well as performing massive ocean surveillance by capitalizing on its high-altitude, all-weather, day/night, and long-loiter capabilities. Two B-52s, working in tandem, can complete a radar search mission covering 100,000 square miles of open ocean in two hours, for instance.

The B-52G/AGM-84 Harpoon integration, carried out jointly by the Air Force and the US Navy in eighteen months, is being hailed by both services as a cooperative "success story," according to General McCarthy. Two B-52G squadrons, equipped with Harpoons, provide operational support to both the Pacific and Atlantic Fleets at this time, participate frequently in joint exercises, and are counted on in wartime to complement US naval forces by interdicting and destroying hostile surface ships.

When assigned to conventional warfare missions other than maritime support, the B-52G can deliver an impressive array of conventional munitions that range from general-purpose bombs (from 500 pounds to 2,000 pounds) and cluster bomb units to chemical weapons. A typical payload that the aircraft can deliver over long ranges might consist of fifty-one Mk 82s or a like number of cluster bomb units or eighteen Mk 84 2,000-pound bombs.

IN FOCUS...

B-52Gs configured for conventional missions participate regularly in such JCS-directed exercises as USEUCOM's Able Archer, USLANTCOM's Solid Shield, USPACOM's Cope Thunder, and USCENTCOM's Bright Star. In the case of the latter, for instance, three B-52Gs, after flying 3,600 miles, were at the weapons release point within four seconds of the specified time.

While SAC's conventional warfighting capability is clearly formidable, it "falls short of the theater CINCs' stated requirements, both in the size of the force and in the type of munitions available and certified for carriage on our bombers," according to General McCarthy. SAC's new imperative, therefore, is to "get the bomber involved in the conventional role in a big way."

SAC's work on improved accuracy of key systems already has netted important gains in terms of conventional warfare. The installation of offensive avionics systems on the B-52 fleet, for instance, has cut CEPs (circular errors probable) by about fifty percent. Installation of Navstar Global Positioning System terminals, scheduled for the early 1990s, will decrease CEP by an additional one and a half times, according to General McCarthy.

Lastly, the planned use of precision-guided munitions (PGMs) incorporating terminal guidance will provide accuracies "capable of flying a weapon into a target as small as an office or bedroom." In SAC's view, the technology required for precision attack of point targets is in being. A number of approaches are being explored.

In light of the increasing sophistication and lethality of Soviet air defenses, standoff weapons play a major role in SAC's conventional warfare planning. This means largely the transfer of the command's experience with nuclear standoff weapons—such as the air-launched cruise missile, SRAM, and AGM-28B Hound Dog—to conventional munitions. Among the nonclassified weapon systems under examination for the conventional warfare standoff mission are the AGM-130 rocket-assisted air-launched glide bomb, a conventionally armed version of ALCM, and the Israeli-developed "Popeye" standoff weapon, a 3,000-pound radar- or IR-guided weapon with a range exceeding that of the AGM-130. Flight-testing of "Popeye" is about to get under way.

In building up conventional warfare capabilities, SAC is placing major emphasis on defense-suppression weapons. As the Soviets extend their air defense systems around the world, the importance of modern defense-suppression munitions is mushrooming. This is true for both self-defense as well as cooperative purposes, meaning action in support of other aircraft.

SAC's analyses suggest that because of the strategic bomber's inherent vast payload and the resultant capability to carry large numbers of standoff weapons, aircraft of this type constitute a nearly ideal carrier of these munitions. It would take a large number of fighter aircraft to duplicate the weapons carriage capability of one strategic bomber, according to General McCarthy. Heavy bombers, thus, could complement efficiently and free up for other missions the tactical fighter force.

When assigned to offensive counterair missions, SAC's strategic bombers would be used to seize the offensive at the outset of hostilities, attack runways and support facilities, neutralize or destroy the enemy's aircraft caught on the ground, and thereby release the friendly tactical air forces for other tasks.

The advent of new standoff munitions is likely to add a new dimension to future counterair campaigns by allowing the B-52s to remain outside the enemy's defenses while engaging and destroying multiple targets with pinpoint accuracy. SAC's planners are convinced that B-52s used in concert with standoff munitions could cause the enemy's rail traffic to come to almost total standstill. For instance, B-52s could use precision-guided standoff munitions to destroy tunnels and bridges and air-dropped mines to blow up railroad tracks as well as trains in order to slow or stop the advance of the enemy's follow-on forces.

Furthermore, the strategic bomber forces are well suited for direct support of the US Navy's offensive maritime strategy. Strategic aircraft could expand the area of influence of friendly naval forces, complement the outer air battle through counterair campaigns against the enemy's land-

based naval aviation, carry out interdiction missions against hostile combatants through the use of Harpoon antiship missiles and mines, as well as expand the fleet's area of influence through sea surveillance. In addition, General McCarthy pointed out, "we have the capability to autonomously go into sea areas [and operate under the] free-fire concept that is really effective against some of the scenarios we have played in the past."

In the Stealth, or advanced technology bomber (ATB), that is to enter the command's inventory in the next decade, SAC will have an ace up its sleeve so far as the conventional warfare mission is concerned. The reason, General McCarthy explained, is that this aircraft can be expected to remain effective against even the densest, most sophisticated air defenses, that it will have nonpareil precision strike capability, and that it will enjoy technological advantages for years to come.

While Strategic Air Command is clearly optimistic and enthusiastic about potential future payoffs to conventional warfare capabilities from concepts combining stealthy platforms with smart, autonomous standoff weapons, General McCarthy questioned the practical value of treating this combination as a means for raising the nuclear threshold: "We are not convinced that we can go after Soviet targets with just any kind of munitions. . . . Nuclear weapons remain the most effective means" to wage strategic warfare.

Space Is Not a Mission

There is neither a reason nor a need for a separate Space Force or Space Department, in the view of Gen. Robert T. Herres, outgoing Commander in Chief of the US Space Command who is about to assume the position of Vice Chairman of the Joint Chiefs of Staff. In a noteworthy policy speech to the Air Force Association in Colorado Springs, Colo., General Herres rejected the notion that there will soon be the need for a fourth military department—alongside those of the Army, Navy, and Air Force—to act as the advocate of military space requirements: "Our basic structure has served us well. I see no need to fragment it under the guise of improving it. Rather, I see us taking the skeletal structure we have today and adding muscles here and . . . there. . . . The Department of the Air Force *is* our space force, and we certainly don't need another."

The nation's significant real and potential space capabilities reside in the three military departments, with the lion's share assigned to the Air Force, while "the ability—and the legal responsibility—to employ these forces resides in the US Space Command," he pointed out. The proper role for the Air Force "embraces air operations and space operations, and I believe the Air Force has done very well in both of those areas," he emphasized. He added that while the mission of the US Space Command is space operations, surveillance and warning, and ballistic missile defense planning and requirements development, "our mission is not 'space.' Our mission is to accomplish certain specific tasks *in space* pursuant to national security objectives."

IN FOCUS...

Washington Observations

★ There is mounting concern within the Pentagon about the seeming inevitability of delaying space-based tests of the Teal Ruby system until 1991 because of the protracted standdown of the Space Shuttle. The Teal Ruby test in space was to have occurred—after a series of delays—last year. The Defense Advanced Research Projects Agency (DARPA) is concerned that by the time this infrared detection system, which spots such air-breathing objects as cruise missiles and aircraft within the ground clutter, goes into space, it will represent twenty-year-old technology. Hence, there are tentative plans to terminate the project and instead pursue state-of-the-art approaches.

★ Deputy Secretary of Defense William H. Taft IV, on November 19, 1986, swore in James F. McGovern, the immediate past Staff Director and Chief Counsel of the Senate Armed Services Committee, as the new Under Secretary of the Air Force. Air Force Secretary Edward C. Aldridge, Jr., explained that Mr. McGovern would "supervise and provide overall guidance for handling Air Force issues associated with the budget process [as well as] implement the reorganization of those activities affected by the Packard Commission findings and associated legislation."

Other responsibilities of the new Under Secretary—a 1969 graduate of US Naval Academy and a lieutenant colonel in the US Marine Corps Reserve—are to monitor international programs of interest to the Air Force, "to become deeply involved in such major programs as the Peacekeeper missile, the Advanced Tactical Fighter, Special Operations Forces, and the Strategic Defense Initiative, as well as to coordinate and review all Air Force compartmented [limited access] programs."

While on active duty as a Navy fighter pilot, Mr. McGovern accumulated more than 2,000 flight hours and several hundred carrier landings. His intimate and long-standing ties with Congress—manifested by the attendance of many senior members of both chambers at his swearing-in—presumably will stand the Air Force in good stead in the critical pending budget showdowns.

★ In elaboration of the US arms-reduction proposals tabled at the US/Soviet "presummit" meeting at Reykjavik, Iceland, last fall that produced contradictory interpretations, President Reagan recently told a Washington, D. C., audience that "all our proposals are still on the table, and we see no reason that our negotiating teams shouldn't pick up where we left off. The Soviets have sent signals that they may believe this, too."

Pivotal elements of the US proposal, the President explained, are a "fifty percent reduction in strategic weapons, sweeping reductions in intermediate-range ballistic missiles, a ban on chemical weapons, [and] addressing conventional force imbalances." Asserting that the US will go into those talks with the support of her allies, he expressed the hope that Congress also will support the Administration's terms: "This should be the pillar of our new bipartisan consensus—we will not give away in Washington what we're negotiating over in Geneva. The hopes of too many ride with us to do that."

★ Notwithstanding the current, prolonged standdown of the Space Shuttle, NASA Administrator Dr. James C. Fletcher believes that it will be possible to begin assembly of the US Space Station in 1993 and to complete construction of the facility—twice the size of a football field and in orbit at an altitude 200 miles above the earth—by 1994. The Shuttle remains the only space-launch vehicle capable of delivering the modular components of the structure into orbit. After the fourth Orbiter achieves operational status in 1991, NASA expects to conduct sixteen or possibly twenty Shuttle launches per year—a number, he felt, adequate to accommodate all high-priority DoD payloads as well as the Space Station modules. ■

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CAPITOL HILL

By Brian Green, AFA DIRECTOR OF LEGISLATIVE RESEARCH

Washington, D. C., Dec. 1

Election Results Assessed

The Democrats won control of the Senate from the Republicans by a surprising 55–45 margin in what was expected to be a very tight race and slightly increased their already wide margin in the House of Representatives to 258–177.

The change in Senate control means that Senate committee chairmanships will revert to Democrats and that Democrats will exert more control over the agenda on the Senate floor. Committee staffs will also change as Democrats hire their own people and as the organization of the subcommittees changes. The new Armed Services Committee lineup will include eleven Democrats and nine Republicans, reversing the current ten-to-nine Republican advantage.

Sen. Sam Nunn (D-Ga.) will be the new chairman of the Senate Armed Services Committee (SASC), Sen. John Stennis (D-Miss.) will chair the Senate Appropriations Committee (SAC) and its Defense Subcommittee, and Sen. Lawton Chiles (D-Fla.) will chair the Senate Budget Committee. Sen. John Warner (R-Va.), Sen. Mark Hatfield (R-Ore.), Sen. Ted Stevens (R-Alaska), and Sen. Pete Domenici (R-N. M.) will be the ranking minority members of the SASC, SAC, Appropriations Defense Subcommittee, and Budget Committee, respectively.

SASC and SAC Defense Subcommittee members who lost their seats include Sen. Jeremiah Denton (R-Ala.) and Sen. James Broyhill (R-N. C.) (Armed Services) and Sen. Mark Andrews (R-N. D.) (Defense Subcommittee). Sen. Gary Hart (D-Colo.), a member of the Armed Services Committee, and Sen. Barry Goldwater (R-Ariz.), the Committee Chairman, have retired from the Senate.

The ideological nature of the SASC will probably not change much, but the Senate as a whole will probably shift somewhat to the left. At least four new Senate Democrats are likely to be less inclined to support defense programs than the Republicans they replace. How defense will fare in the new Senate is not clear. Conservative Democrats frequently support Pentagon requests and—in combination with enough prodefense Republicans—could create a majority on many national security issues. The more liberal orientation of the Senate, however, is likely to make a difference on closely fought issues. The fate of the Bigeye binary chemical bomb and funding cuts for the Strategic Defense Initiative were decided by a single vote.

The situation in the House did not change dramatically, with the Democrats picking up only five seats. On the House Armed Services Committee (HASC), several Republicans retired or ran for other offices (Representatives Kramer of Colorado, Hartnett of South Carolina, Hillis of Indiana, Carney of New York, Holt of Maryland, and Whitehurst of Virginia). HASC Chairman Les Aspin (D-Wis.) remains under challenge for his Committee Chairmanship. How that challenge will turn out is still unclear.

Congressional Criticism of Reykjavik

Congressional reaction to the Reykjavik summit and President Reagan's handling of the negotiations, although muted before the election, has been widely negative. Criticism has come from diverse quarters.

Proposals put forward by the US in Reykjavik involved a fifty percent reduction of all strategic nuclear weapons over five years, abolition of all strategic nuclear ballistic missiles over the next five years, and a ten-year nondeployment of ballistic missile defenses. Other proposals that arose included abolition of all strategic arms over ten years and virtual elimination of intermediate-range ballistic missiles in Europe.

Congressional criticism has focused on the lack of clarity concerning proposals and agreements at the summit by President Reagan, US failure to compromise on the Strategic Defense Initiative as the cause of the "failure" of the summit, and the apparently *ad hoc* character of the negotiations as well as the content of the proposals put forward by the US.

Senator Nunn, soon to be the new SASC Chairman, has criticized the apparent confusion over preliminary agreements reached in Reykjavik and the failure to consult the Joint Chiefs of Staff on the military implications of banning ballistic missiles. He also questioned the strategic rationale of the deep reductions proposed by the Administration negotiators, suggesting that banning strategic and theater ballistic missiles would leave NATO with a dangerously weakened nuclear deterrent while the Soviets would continue to enjoy conventional superiority in Europe.

Other Hill sources express discomfort with the high level at which negotiations took place, preferring to leave the "nuts and bolts" of arms control to lower-level negotiators. There is also some feeling, among conservatives as well as liberals, that banning ICBMs would eliminate any first-strike potential. But many note that compliance with such a ban would be difficult to verify and that banning all strategic weapons would pose extraordinary verification problems.

The Administration has strongly defended its proposals. Assistant Secretary of Defense Richard Perle, in hearings before the HASC, argued that SDI was not the sole source of disagreement at the summit. He noted that the Soviet proposal to eliminate "all strategic arms" by 1996 would, according to the Soviet definition, require the US to dismantle its dual-capable aircraft in Europe and at sea while leaving the Soviets with a vast arsenal of similar systems—a proposal the US could not accept.

Mr. Perle also sought to defuse some of the criticism focused on NATO conventional inferiority: "We have no alternative to nuclear deterrence in Europe, and no conventional balance there, even . . . favorable to . . . the NATO alliance, would justify the denuclearization of Europe and the incalculable threat this would pose to our allies." He further noted that the Soviets refused to accept the US proposal to abolish all ballistic missiles, insisting on the broader abolition of all strategic arms. ■

DEFENSE DIALOG

MATE IS READY. Now Rockwell International's Modular Automatic Test Equipment (MATE) system, used to demonstrate testing computer processors in the Peacekeeper Guidance System, can be applied to ICBM and aircraft test programs. Autonetics Strategic Systems Division (ASSD), under IR&D sponsorship, has achieved a real-time, smart Test Replaceable Unit (TRU) within the present MATE structure. Rockwell is also replacing portions of the Jovial written MATE Control and Support Software (MCSS) with Ada; applying Artificial Intelligence/Expert Systems to the MCSS; writing non-C/ATLAS modules in Ada or Jovial; and comparing system throughputs of the Sperry 1630 and HP A900 computer-hosted stations. The Division's MATE IR&D project continues to provide an opportunity to investigate MATE technology growth in hardware, software and procedures

STRATEGIC HARDENED CPU. With the completion of the first full brassboard of the Electronics and Computer Assembly (ECA), Rockwell International achieved a major milestone as guidance and control developer for the USAF Small ICBM. At the heart of ECA is Autonetics Strategic Systems Division's radiation-hardened MIL-STD-1750A central processor. Developed on schedule and within budget, the hardened ECA is designed to increase survivability in severe radiation environments, while controlling the staging and flight of the missile.

THE FUTURE IS NOW. Factory modernization is in full swing at Autonetics Strategic Systems Division with state-of-the-art, computer-integrated manufacturing (CIM) advancements providing major automation improvements. The Anaheim facility's newly installed Automated Manufacturing Cell (AMC) and Automated Material System (AMS), together with our completely automated El Paso plant, provide low cost operating facilities, increased product reliability and a shortened engineering-to-production cycle. The first Peacekeeper boards have been assembled in the AMC and the cell's predicted flexibility offers future program capabilities such as the introduction of Peacekeeper IMU and Small ICBM boards.

EXPERIENCE BEYOND HARDENING. Unsurpassed survivability capabilities developed by Rockwell are now being applied to lethality and target hardening (LTH) to determine the effects of neutral particle beams and high-power microwaves. Autonetics Strategic Systems Division is emphasizing survivability of SDI assets and their application to newer systems. The Division is also involved in the testing, simulation and architectural studies of major weapon systems for our country including Minuteman • Peacekeeper • Small ICBM • B-1B • TACAMO • Air Defense Initiative (ADI).

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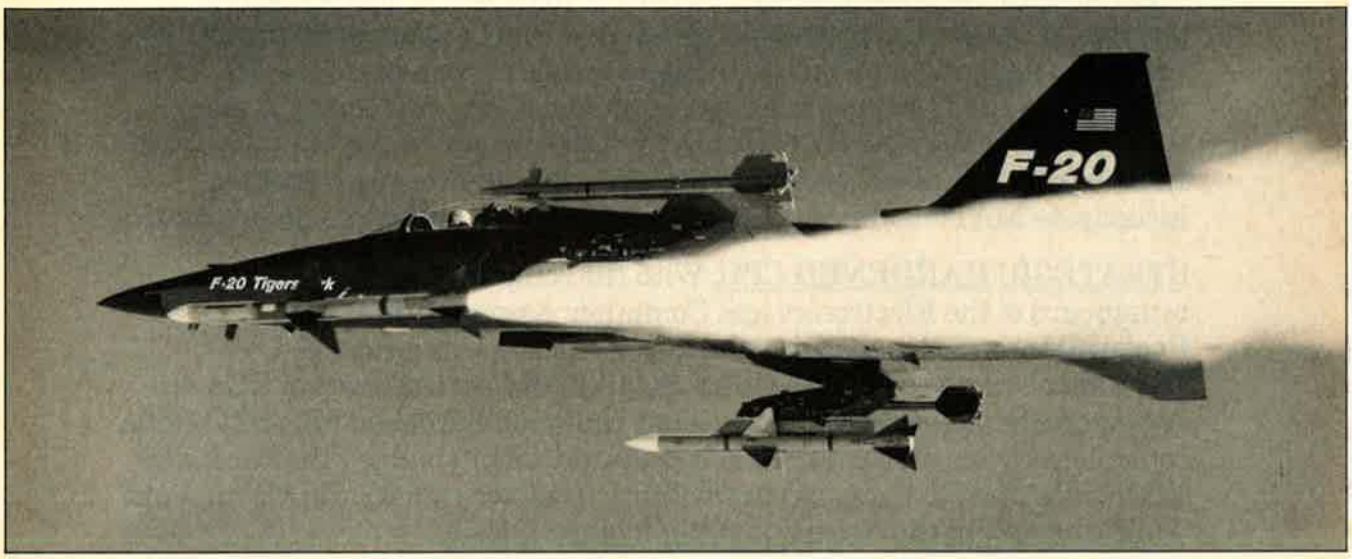
AEROSPACE WORLD

. . . PEOPLE . . . PLACES . . . EVENTS . . .

By Jeffrey P. Rhodes, DEFENSE EDITOR



Northrop's F-20 program was effectively canceled recently because of the Air Force's decision to use modified F-16s for the air defense mission, but the knowledge gained on the program will help in the company's Advanced Tactical Fighter efforts.

Washington, D. C., Dec. 1 ★ In the aftermath of the Air Force's decision to use modified F-16A aircraft for the air defense mission *(see also "Shaping the Force" on p. 94 of this issue),* Northrop Corp. announced in its third-quarter report to stockholders that the company "sees no need for further F-20 Tigershark program investments." This action effectively ends the company's effort to sell the single-seat F-20 fighter.

The F-20 program was begun in 1982 as an entirely company-funded project, and during that time Northrop invested approximately $1.2 billion in the airplane. Expenses were written off as they were incurred, and approximately $250 million will be written off in 1986 alone. This will, to quote the report, "complete all costs chargeable to the F-20 program."

In early 1980, the Carter Administration endorsed a policy to allow US firms to sell relatively low-cost, easy-to-maintain air defense fighters to "approved" nations. Northrop originally proposed an updated version of its highly successful F-5 Freedom Fighter (the F-5G), but by 1982, the plane had been redesigned to the point it was almost an entirely new aircraft. It was then given the F-20 designation.

Despite the airplane's outstanding performance and reliability standards, prior F-16 sales to overseas governments and the lack of an Air Force production program have precluded any foreign orders for the F-20.

Much of the knowledge gained by Northrop on the F-20 program will ultimately be applied to the company's YF-23A Advanced Tactical Fighter (ATF) efforts.

Two of the three F-20 airplanes built were involved in accidents, but neither of the mishaps was attributable to the aircraft itself. One crash came about because of pilot error, and the other accident was believed to have been caused by the pilot blacking out from pulling too many Gs (G-induced loss of consciousness).

Construction of the fourth F-20 aircraft has been halted with the plane being roughly twenty-five percent complete. The remaining example of the F-20 will be kept in ready, or flyable, storage. Future plans for this airplane were undecided at press time.

Employment at Northrop is expected to decline by approximately 2,000 people as a result of the ending of the F-20 program, although additional employees will be brought aboard as YF-23 work progresses. Total employment at Northrop will stabilize at roughly 12,000 people.

★ The AIM-120A Advanced Medium-Range Air-to-Air Missile (AMRAAM) successfully jumped two more hurdles in late October and early November. The missile has now recorded seventeen successful shots in twenty launches.

The test on October 24 also marked the beginning of Initial Operational Test and Evaluation (IOT&E) of the nearly twelve-foot-long missile. While previous tests were conducted as Development Test and Evaluation (DT&E) missions to verify the AIM-120's design and engineering, the IOT&E launches will ensure that the requirements of the actual users (the operational commands) are met. IOT&E is being conducted by the Air Force Operational Test and Evaluation Center (AFOTEC) at Kirtland AFB, N. M.

On this particular shot, the AIM-120A was fired from an F-15C flying at Mach 0.85 at 8,000 feet above

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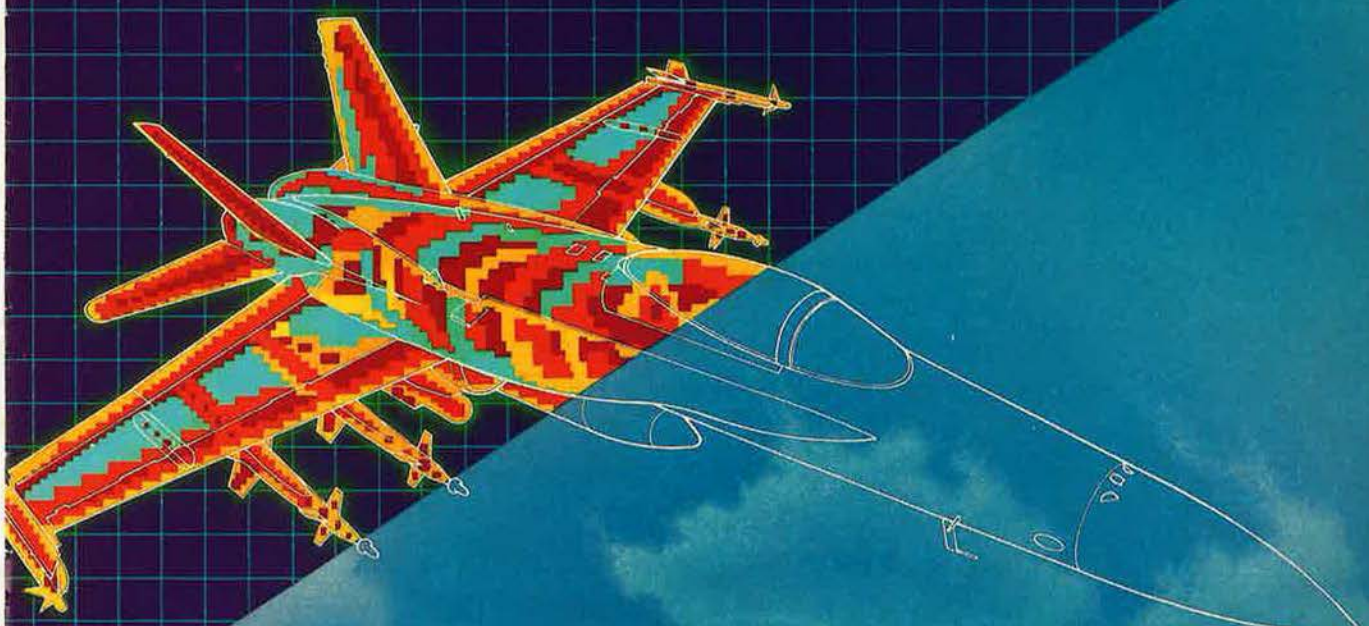

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AEROSPACE WORLD

ground level (AGL) in a look-down/shoot-down attack on a QF-100 drone at White Sands Missile Range, N. M. The drone was flying at Mach 0.80 at 600 feet AGL. The QF-100 was using electronic countermeasures (ECM) to try to confuse the missile, but after being ejector-launched, the missile passed within lethal range. The drone executed a 2-G evasive maneuver during the intercept.

While Brig. Gen. Ben Patterson, Lt. Col. Wallace Moody, and Maj. Murval Belson look on, SMSgt. George Cunningham briefs TAC Commander Gen. Robert Russ on the TPS-43E radar during the 117th Tactical Control Squadron's deployment to Langley AFB as part of a Joint System Training Exercise last summer.

This marked the first time an AMRAAM had been fired in an ECM environment.

The test on November 6 at the Pacific Missile Test Center at Point Mugu, Calif., demonstrated the missile's ability to differentiate between clustered targets.

An F/A-18 flying at Mach 0.97 at 10,000 feet above sea level ejector-launched the AIM-120 in a severe look-down/shoot-down nose attack on a pair of QF-86 drones traveling together at Mach 0.65 at 1,000 feet above the Pacific. After launch, the AMRAAM's active radar locked on each target and tracked both of the QF-86s. The missile's radar then chose one of the targets, rather than selecting a central point and flying between the drones. The QF-86 the missile decided on was hit.

The AIM-120A will replace the semi-active AIM-7 Sparrow missile in the Air Force and Navy inventories and should reach initial operational capability in 1990. Currently, the two services plan to procure 24,000 of the missiles.

★ Unlike the Air Force's much more visible Advanced Tactical Fighter (ATF) program, the Navy's Advanced Tactical Aircraft (ATA) has been shrouded in secrecy since its inception. Recently, though, the Navy announced the two teams of contractors who will build prototypes for a competitive flyoff that will likely take place around 1990.

Northrop, Grumman, and Vought will constitute one team, and they will be pitted against McDonnell Douglas and General Dynamics in the competition. The teaming arrangements for this program split up McDonnell Douglas and Northrop, which are joining forces to build the Air Force's YF-23A ATF prototype and also are building the Navy's F/A-18 Hornet fighter/attack jet. Grumman, Vought, and McDonnell Douglas all have many years of experience in building Navy airplanes.

The ATA is scheduled to enter fleet service in the mid-1990s and will replace the Grumman A-6 Intruder series of aircraft as the Navy's primary attack plane. Designed in 1957, the A-6 entered service in the early 1960s and did yeoman-like service in the Vietnam War.

The Air Force has agreed to study whether the ATA can be adopted for use as a possible F-111 replacement. The Navy currently plans to build in the neighborhood of 450 ATAs, but the specific number of aircraft and almost every other detail about the program is classified.

★ The teaming going on for the Air Force's ATF effort is not being confined to just the airframe manufacturers. The Westinghouse Development and Operations Divisions in Baltimore, Md., and the Texas Instruments Defense Systems and Electronics Group in Dallas, Tex., have joined forces to pursue contracts for the offensive radar and electro-optical systems for the ATF.

Westinghouse and Texas Instruments have submitted proposals to both airframe teams. Of the total contract awards of $691 million to each airframe team, $95 million will be earmarked for the radar and E-O systems.

Nature's most extreme forms of weather are being simulated to help the Air Force in its ongoing battle with the elements. Here a Bell D292 helicopter is subjected to 1,600,000 volts of electricity at Boeing Military Aircraft's plant in Seattle, Wash., in order to develop guidelines for better lightning protection.

AEROSPACE WORLD

The work will be divided, with Westinghouse taking the lead on the active aperture multimode radar, while TI will take the lead on the E-O systems. The total value of the avionics program for all 750 Advanced Tactical Fighters is expected to be $3 billion to $4 billion.

★ Traffic on Washington's belt highway or the Los Angeles freeway system is almost always heavy, but rush hour on those two roads is minor compared to what the taxiways at RAF Bentwaters and RAF Woodbridge looked like on October 6.

On that day, 105 Fairchild A-10 aircraft of the 81st Tactical Fighter Wing (which is split between the two closely situated bases) were launched in the space of forty-five minutes. The jets took off one at a time with roughly twenty seconds elapsing between takeoffs.

The 81st TFW believes this is an Air Force record for most fighters launched at one time.

The wing also set a record for number of aircraft fully mission-capable, with 115 of the unit's assigned 119 airplanes ready to fly. The 81st was going to launch eighteen aircraft from each of the four A-10 squadrons at RAF Bentwaters and the two squadrons at RAF Woodbridge for a total of 108, but three aircraft were pulled from the line at the last minute because of minor maintenance problems.

The aircraft flew approximately ninety minutes and then returned to base in four-ship formations. The mass launch was held in conjunction with Exercise Hammer, a NATO training exercise that combined more than 300 aircraft from four countries.

These A-10s of the 81st Tactical Fighter Wing took part in an exercise last October that saw 105 jets launched in the space of forty-five minutes from RAF Bentwaters and RAF Woodbridge in England. (USAF photo by SSgt. Cindy Haggart)

★ As part of the Department of Defense Authorization Bill passed on October 15, Congress approved a large number of items pertaining to personnel matters. Among the highlights were:

- A three percent across-the-board pay increase for all members of the armed services and civil servants effective January 1, 1987.
- In addition, a 1.3 percent cost-of-living allowance for retirees was added effective December 1, 1986, with payment appearing a month later. The bill also contains language that will protect inflation increases for military and federal civilian retirees from budget cuts.
- Extended job hiring preferences for military spouses to GS-5 and above from the current GS-8 and above level.
- Allowing members of the Selected Reserve or their dependents to use military commissaries up to fourteen days a year (one day per each day of active-duty training).

Also, the end-strength of the active Air Force was set at 606,800 people, the Air National Guard was pegged at 113,800, and the total number of Air Force Reservists capped at 79,600 people. In addition, the number of Selected Reservists the President can call up to involuntary active duty was raised from 100,000 to 200,000.

The Air Force was also authorized a thirteenth four-star general. The temporary rank was not tied to any specific position.

Lt. Col. Arthur C. "Ace" Carlson III, Commander of the newly formed 314th Tactical Fighter Training Squadron, proudly displays the new unit's emblem on one of the F-16s at Luke AFB, Ariz. The 314th will train fighter pilots as part of the 58th Tactical Training Wing. (USAF photo by SrA. Rusty Gordon)

★ The Model Installation Program (MIP), a group of principles that gives local commanders the responsibility and resources to do their jobs, is improving the Air Force. Here's how:

- By using local construction codes instead of military codes, which are more restrictive, Whiteman AFB, Mo., saved more than $185,000 on a family-housing carport roofing project.
- Hickam AFB, Hawaii, received ap-

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Its guidance system is a simple CO_2 laser, mounted on the aircraft. With only an aft-looking receiver on the missile, the amount of expensive "throwaway" hardware is held to an absolute minimum. And because HVM is a "wooden round" with no warhead, storage and handling are simpler, safer and cheaper.

Multiple Targets, Maximum Effect

The system can track and attack multiple targets simultaneously—any ground vehicle, fixed or mobile. In live fire tests an HVM was purposely aimed more than 100 feet off-target. Automatic guidance brought the missile to impact near the target center.

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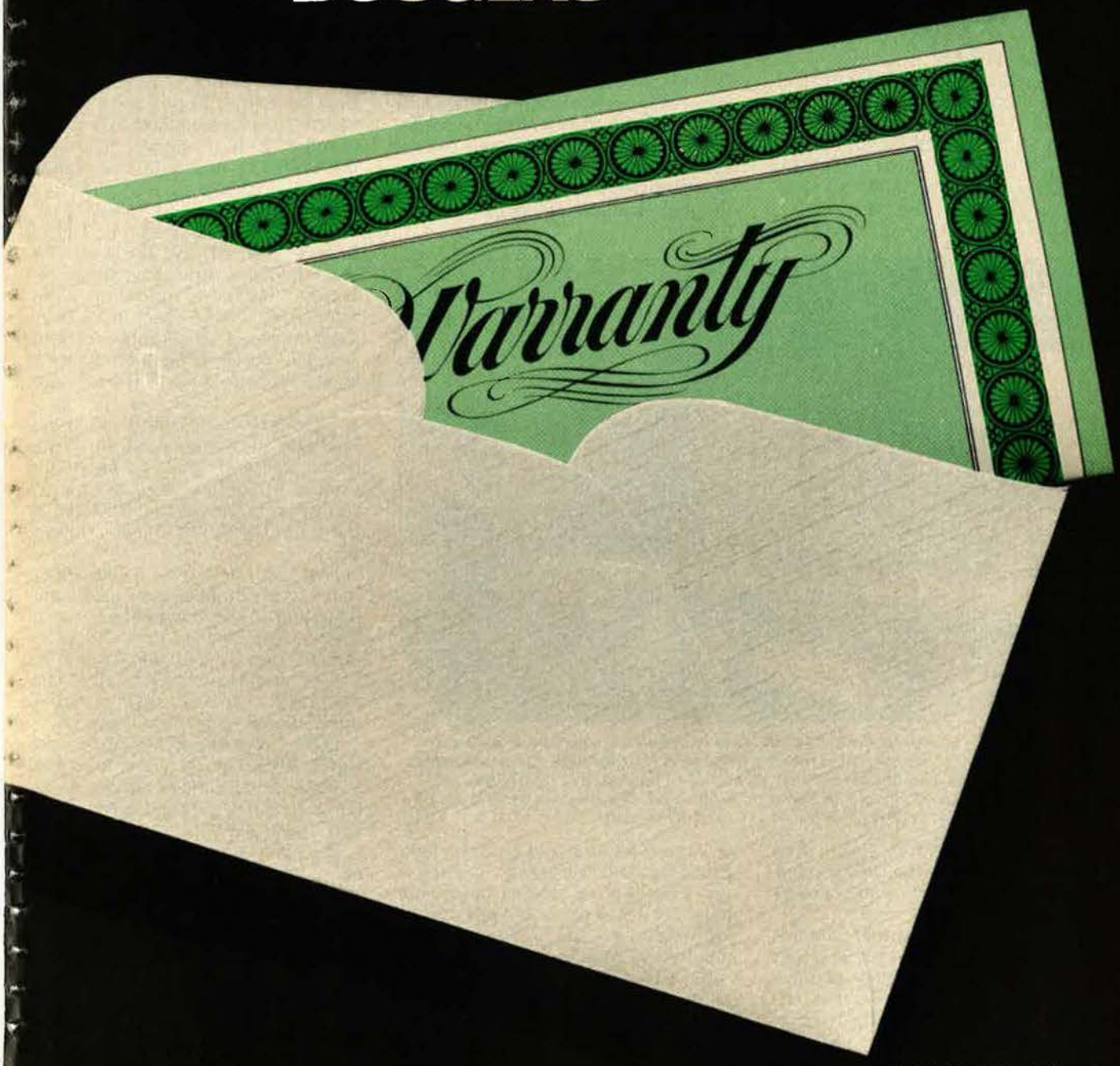


proval to purchase food service equipment locally rather than through government supply. This cut the lead time for buying new items by 100 days and greatly improved service to base airmen.

• Kirtland AFB, N. M., found that private contractors could buy and install appliances in family housing cheaper than through government sources. The base has saved more than $38,000 in the first year by using private contractors.

The program, which began in January 1984, has already generated more than 8,000 proposed initiatives and so far has all the makings of a success story.

Deputy Secretary of Defense William H. Taft IV signed the policy directive establishing a new, four-part management philosophy. The directive states, in part:

• The commanding officer of an installation is responsible for accomplishing the mission. He or she should be delegated the authority to decide how best to accomplish the mission and is accountable for all resources applied to the mission.

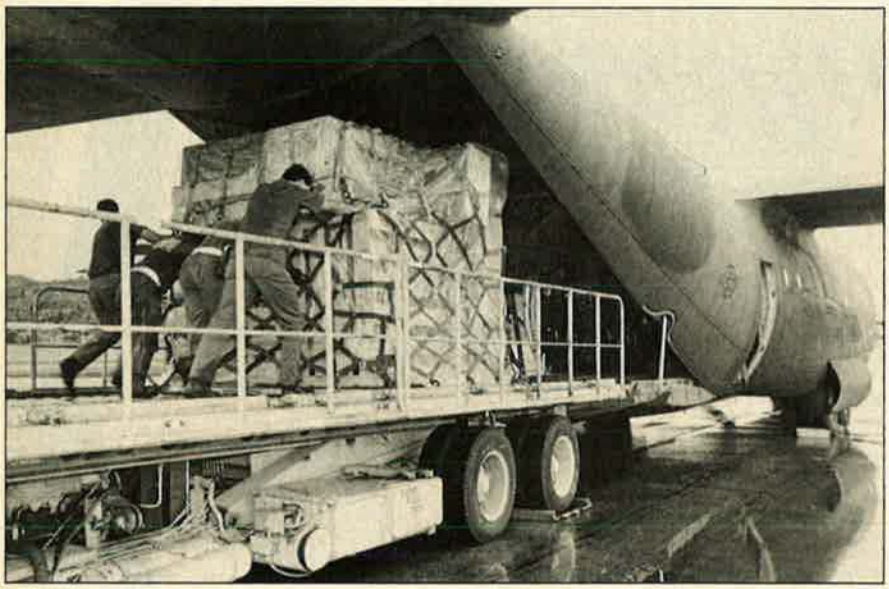
• Regulations that limit installation commanders' freedom to do their jobs are contrary to the DoD installation management policy and shall be canceled or revised.

• Installation commanders are free to buy goods and services wherever they can get the combination of quality, responsiveness, and cost that best satisfies their requirements—except where required to preserve essential wartime support capability or constrained by law or federal regulation.

• A share of any resources saved or earned at an installation should be made available to the commander, unless prohibited by law, to improve operations and working and living conditions at the installation.

According to Gen. Larry D. Welch, who spoke at the MIP Commanders Conference held October 21–23 at the Pentagon, the Air Force goal is to "establish a command-wide program by January 1987.

"I believe very strongly that the best way to get the best job done in the smartest possible way is to give a single leader the authority, the responsibility, the accountability, and the resources required to complete the job. And that's what the Model Installation Program is all about," concluded the General.



In response to a request by the US Ambassador to El Salvador, members of the 6th Aerial Port Squadron and the 193d Infantry Brigade at Howard AFB, Panama, loaded this C-130 Hercules with critical supplies as part of an operation to relieve the earthquake-devastated city of San Salvador, El Salvador. The missions were flown by the 166th Tactical Airlift Group, Air National Guard, Wilmington, Del.

AEROSPACE WORLD

★ If the 1986 Strategic Air Command Bombing and Navigation Competition had been a football game, the headline in the paper the next morning would have read "92d Bombardment Wing Wins in a Rout."

By winning five of the major trophies and nine awards overall, the 92d BW, based at Fairchild AFB, Wash., went on to claim the Muir S. Fairchild Trophy for Highest Competition Effectiveness. The last time the 92d had won the trophy given in honor of its home base's namesake, the Korean War had just ended—thirty-three years ago.

The 92d's haul of trophy hardware included the Saunders Trophy for tanker operations, the Mathis Trophy for Best High- and Low-Altitude Bombing, the William J. Crumm Linebacker Memorial Trophy for the Best B-52 Unit in High-Altitude Bombing, the Gen. Curtis E. LeMay Bombing Trophy, and the Gen. Russell E. Dougherty Short-Range Attack Missile Trophy. The 92d BW also won the trophies given to the Best KC-135 and B-52 Crews.

Other winners, with trophy name and category, included: Eighth Air Force—Gen. James H. Doolittle Trophy for Best Overall Results (Low-Level Bombing and SRAM); 2d BW, Barksdale AFB, La.—Richard H. Ellis Best KC-10 Unit Trophy and also Best KC-10 Crew Award; 380th BW, Plattsburgh AFB, N. Y.—Meyer Trophy for the F/FB-111 unit with the highest damage expectancy and also Best FB-111 Crew Award; 319th BW, Grand Forks AFB, N. D.—James F. Bartsch ECM Trophy; 7th BW, Carswell AFB, Tex.—Bruce K. Holloway Navigation Trophy; 340th Air Refueling Wing, Altus AFB, Okla.—Bennie L. Davis Most Improved Unit Trophy; and 27th Tactical Fighter Wing, Cannon AFB, N. M.—Best TAC F-111 Crew Award.

★ The Air National Guard's 152d Tactical Reconnaissance Group (TRG) based in Reno, Nev., garnered top honors in Tactical Air Command's worldwide air recce meet (RAM '86) at Bergstrom AFB, Tex., in early November.

The 152d, flying the RF-4C Phantom II, was one of sixteen teams participating in the competition, which focused on procedures and techniques used by multiservice and allied reconnaissance units. This was the first in a series of TAC-sponsored international recce competitions.

Teams representing units from USAF, ANG, the US Navy, the Naval Reserve, and the Royal Australian Air Force flew five different types of aircraft in the event.

The teams comprised aircrews, imagery interpreters, and maintenance personnel. Events spanned the entire spectrum of tactical recce from aircraft generation to photo reproduction and imagery interpretation.

Other categories and winners included: Top Air Crew—Maj. Patrick M. O'Rorke and Capt. Jay T. Stevenson, 124th TRG, Boise, Idaho; Top Maintenance Team—186th TRG, Meridian,

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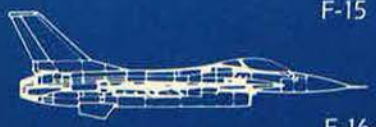

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Miss.; Top Imagery Interpretation Team—67th Tactical Reconnaissance Wing, Bergstrom AFB, Tex.; and Top Night Competition Team—67th TRW, Bergstrom AFB, Tex.

★ The twenty-sixth President would have said "Bully" if he had been in Newport News, Va., on October 25. The occasion was the commissioning ceremony for the Navy's fifteenth active-duty aircraft carrier, the USS *Theodore Roosevelt* (CVN-71).

Built at a cost of $2.46 billion, the 96,000-ton *Roosevelt* was completed seventeen months ahead of schedule by the Newport News Shipbuilding and Drydock Co. Construction took six years. The vessel, 1,092 feet long and twenty-four stories high, is the sister ship of the USS *Nimitz* (CVN-68), the USS *Dwight D. Eisenhower* (CVN-69), and the USS *Carl Vinson* (CVN-70). Two other carriers, the USS *Abraham Lincoln* (CVN-72) and the USS *George Washington* (CVN-73), are under construction and will be commissioned in the early 1990s.

During builder's trials in September without aircraft on board, the ship's two nuclear reactors provided enough power to the four turbines to move the *Roosevelt* at speeds exceeding thirty knots. The four 66,000-pound, twenty-four-foot-diameter propellers formed a wake nearly 260 feet wide. The ship was also put through turns greater than thirty degrees.

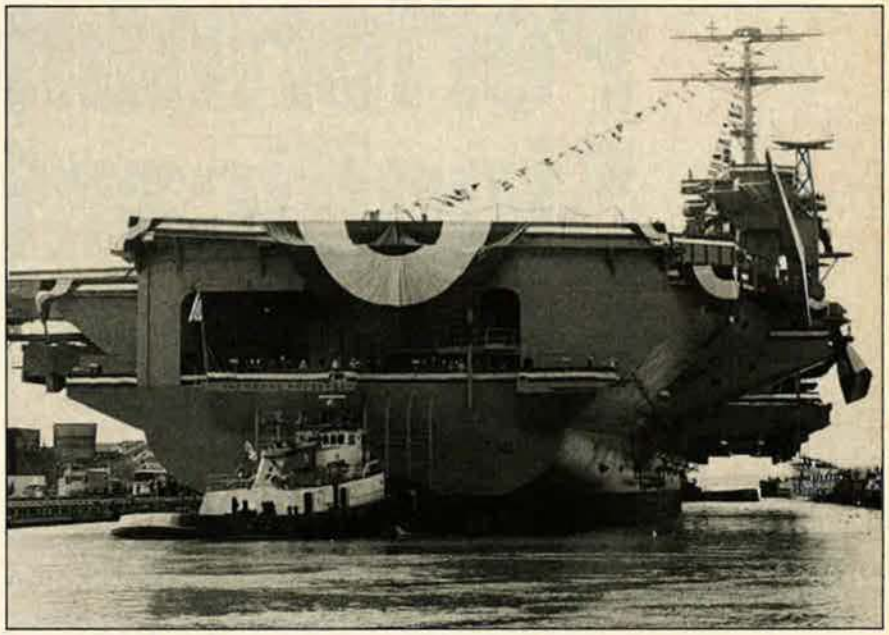
The *Roosevelt,* which has a 4.5-acre flight deck, will carry eighty-five aircraft and have a complement of close to 6,000 men. Capt. Paul W. Parcells, an F-4 pilot who flew more than 150 combat missions in Vietnam, is the ship's first commanding officer. The USS *Roosevelt's* first scheduled deployment will be to the Mediterranean in 1988.

★ In a recent speech before the New York Society of Security Analysts, Gen. Robert T. Herres, then Commander in Chief of the North American Aerospace Defense Command and soon to be Vice Chairman of the JCS, made some then-and-now comparisons of NORAD forces to show how the US posture has shifted from defending against an air-breathing threat to defending by means of a nuclear deterrent.

General Herres noted that in 1962, five percent of the DoD budget was dedicated to strategic defense. The NORAD forces included 2,600 dedicated fighter-interceptors, more than 270 air defense artillery batteries, more than 400 surface-to-air missiles, almost eighty airborne radar aircraft, and 207,000 people.

Today, NORAD's forces consist of 264 dedicated interceptors, mostly in the Air National Guard and only fifty-eight of those in a rapid response posture; no air defense artillery and no SAMs; only a handful of airborne

AEROSPACE WORLD



An impressive sight in port, the newly commissioned carrier USS* Theodore Roosevelt *(CVN-71) will be even more awe-inspiring on the high seas. The* Roosevelt *will carry eighty-five aircraft and have a complement of close to 6,000 men. The new carrier was completed seventeen months ahead of schedule.

SENIOR STAFF CHANGES

RETIREMENTS: Gen. Robert W. **Bazley;** AFRES M/G Sloan R. **Gill;** M/G William H. **Greendyke.**

CHANGES: B/G Charles G. Boyd, from DCS/Plans, Hq. USAFE, Ramstein AB, Germany, to Vice Cmdr., 8th AF, SAC, Barksdale AFB, La., replacing M/G Samuel H. Swart, Jr. . . . **B/G Robert A. Buethe, Jr.,** from Dir., Medical Plans and Resources, Office of the Surgeon General, Hq. USAF, Bolling AFB, D. C., to Command Surgeon, Hq. TAC, Langley AFB, Va., replacing B/G Rufus M. DeHart, Jr. . . . **B/G Maralin K. Coffinger,** from Command Dir., NORAD, Combat Ops. Staff, Cheyenne Mountain Complex, Colo., to Dir., Pers. Plans, DCS/Pers., Hq. USAF, Washington, D. C., replacing retired M/G William J. Mall, Jr. . . . **B/G Rufus M. DeHart, Jr.,** from Command Surgeon, Hq. TAC, Langley AFB, Va., to Dir., Professional Affairs and Quality Assurance, Office of the Surgeon General, Hq. USAF, Bolling AFB, D. C., replacing retired M/G William H. Greendyke.

B/G George B. Harrison, from Chief, Joint Ops. Div., J-3, OJCS, Washington, D. C., to DCS/Plans, Hq. USAFE, Ramstein AB, Germany, replacing B/G Charles G. Boyd . . . **AFRES M/G James E. McAdoo,** from Vice Cmdr., Hq. AFRES, Robins AFB, Ga., to Cmdr., 14th AF (AFRES), Dobbins AFB, Ga., replacing AFRES M/G Alan G. Sharp . . . **AFRES M/G Alan G. Sharp,** from Cmdr., 14th AF (AFRES), Dobbins AFB, Ga., to Vice Cmdr., Hq. AFRES, Robins AFB, Ga., replacing M/G James E. McAdoo . . . **B/G William T. Williams IV,** from Spec. Ass't to DCS/L&E, Hq. USAF, Washington, D. C., to Command Dir., NORAD, Combat Ops. Staff, Cheyenne Mountain Complex, Colo., replacing B/G Maralin K. Coffinger. ■

warning and control aircraft; and 37,000 people, including personnel in eleven ANG interceptor squadrons. Air defense's share of the defense budget is *up* to 2.3 percent (from an all-time low of 1.5 percent in 1980).

★ **NEWS NOTES**—After much congressional wrangling, **$2.5 million in unused Army funds** will be reprogrammed or directed for the **construction of a new building for the Army Aviation Museum** at Fort Rucker, Ala. Officials at Fort Rucker will be able to allocate the money over a period of several years. The time-

Gen. John P. McConnell (center), the sixth Air Force Chief of Staff, died of cancer on November 21, 1986. He was seventy-eight. A 1932 graduate of West Point, General McConnell was Vice Commander of SAC and Deputy Commander of the US European Command before serving as Chief of Staff from 1965 to 1969. In this photo taken shortly after he assumed that post, General McConnell is flanked by Gen. Curtis E. LeMay (right) and Maj. Gen. Benjamin D. Foulois, Air Corps Chief from 1931 to 1935.

AEROSPACE WORLD

table for construction had not been set at this writing.

Speaking of things Army, **Beretta USA recently passed the 25,000 mark in its delivery of 9-mm pistols.** As of November 14, the Maryland-based company had delivered 26,400 of the total 320,000 9-mm pistols ordered by the Army as part of a $76 million contract. The company says the guns show even greater reliability than the test versions.

This two-seat version of the Harrier, the TAV-8B, will be used by the Marine Corps to train its pilots in vertical and short takeoff and landing.

A subsidiary of the Italian firm Aeritalia, **Officine Aeronavalia Venezia,** will soon **convert four Boeing 707 commercial airliners into tankers for the Italian Air Force.** In addition, the four aircraft will also be used for transporting cargo.

The **Navy recently awarded an $84.5 million contract** to United Technologies' Sikorsky Aircraft for **initial production of five combat Search and Rescue/Special Warfare Support (HCS) helicopters** for the Navy and **two Medium-Range Recovery (MRR) helicopters** for the Coast Guard. The Sikorsky HCS/MRR is a close derivative of the SH-60F Seahawk. Eventually, eighteen of these helicopters will go to the Navy, while the Coast Guard will get thirty-five of the type.

The **Federal Aviation Administration** (FAA) recently awarded a nearly $59 million contract to **Beech Aircraft Corp. to purchase nineteen Super King Air 300s** that will be used to check the accuracy of more than 8,000 electronic and visual navigation and landing aids in the US and its territories. The new aircraft will replace older and fuel-hungry aircraft acquired in the early 1970s. The inspection fleet currently logs more than 22,000 flight hours per year. The new King Airs are all to be delivered by the end of 1988.

The two-seat trainer version of the Marine Corps's vertical takeoff and landing Harrier II attack jet, **the McDonnell Douglas TAV-8B, made its first flight on October 21** over the company's St. Louis, Mo., plant. Chief Experimental Test Pilot Bill Lowe was at the controls for the one-hour flight. The hop consisted of a short takeoff, stall maneuvers, simulated landings, and a two-minute hover. Lowe took the Harrier II to 40,000 feet and flew at a top speed of 400 knots. The Marine Corps plans to acquire twenty-eight TAV-8Bs.

And finally, the **US Board of Geographic Names has decided to name a 6,100-foot peak** in the Santa Catalina Mountains of Arizona **Airmen Peak** "in honor of all airmen who have died in military aircraft accidents in the Tucson area." The effort to name this peak was headed by retired USAF chaplain Lt. Col. Lawrence V. Tagg. At least seventy-five airmen have died in aircraft accidents in the vicinity of the peak. ■

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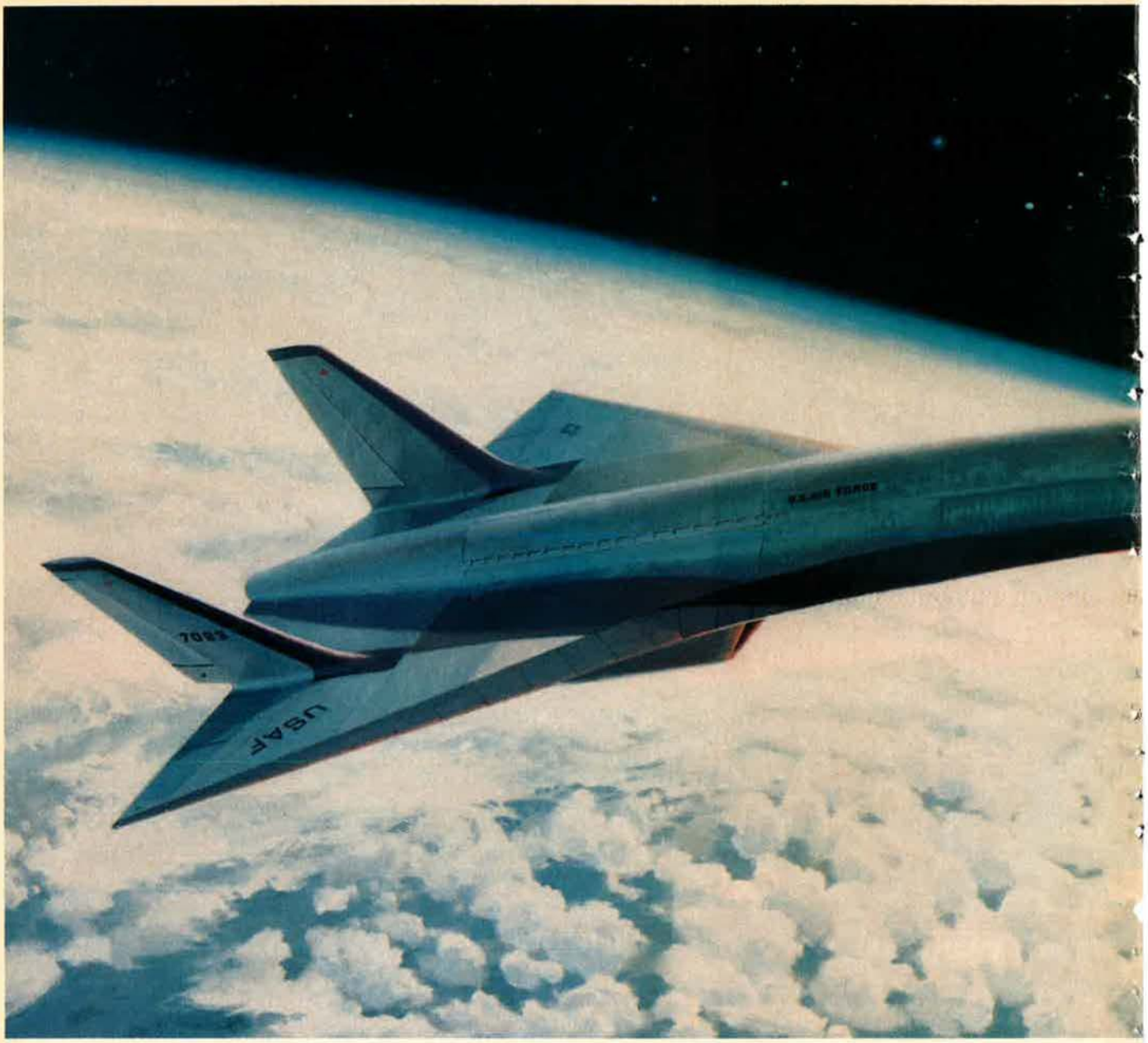

"WE'RE on the threshold of something marvelous in aviation. The era of the starfighter is upon us. I'm not talking about technologies of the year 2100. I'm talking about technologies that are with us right now."

Lt. Gen. William E. Thurman, Commander of Air Force Systems Command's Aeronautical Systems Division at Wright-Patterson AFB, Ohio, made that statement not long ago in reference to AFSC's role in developing the hypersonic National Aerospace Plane (NASP), a joint undertaking of the Defense Department and the National Aeronautics and Space Administration in which ASD has much of the action.

General Thurman's context was much broader, though, in the sense that the work on the aerospace plane does not stand in splendid isolation from all else that ASD is doing or has ever done in developing modern, high-performance combat aircraft for the Air Force.

The NASP promises to be a breathtakingly unprecedented flying machine, at home in air or space, streaking through the upper atmosphere at twenty-five times the speed of sound or thereabouts, its airframe, engines, and avionics integrated into a coherent system of thoroughly interdependent elements.

For all its potentially peerless attributes, the NASP will not emerge as a technological creature wholly alien to the aeronautical world as we know it today. Its technologies will have filial connections to those of the fighters of this generation and the next.

The F-15, more than a decade in service and still the best air-superiority fighter in the world, heads the family. Its latest variant, the F-15E dual-role fighter newly in production, will do both the air-to-ground and air-to-air missions behind enemy lines better than any US fighter ever.

The F-16, singularly adept at ground attack and no slouch in the air-to-air regime, either, has demon-

"The era of the starfighter" has been inaugurated by the program to develop the National Aerospace Plane (NASP), a hypersonic flying machine for air and space. (© Keith Ferris 1986)

This generation of fighters and the next lead naturally into development of the true aerospace plane.

Era of the Starfighter

BY JAMES W. CANAN, SENIOR EDITOR

strated that "smaller" is no longer synonymous with "lesser" in terms of fighters' combat ranges.

Late last October, USAF decided to modernize its air defense fighter force with modified F-16As already in service in tactical squadrons. Their combat-range capability was an important consideration in their selection over the competing F-20, Air Force officials said.

The F-16As destined for conversion to the air defense mission will be replaced in ground-attack squadrons by the newer, more capable, and more versatile F-16Cs. They and the F-15Es will eventually be equipped with the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system that ASD has escorted through some technological thickets to the point of full-scale production. *(See also "Fighting Around the Clock" on p. 52 of this issue.)*

Next comes the Advanced Tactical Fighter (ATF), the apple of ASD's eye and legatee of just about everything ASD and its contractors have learned in creating and improving the F-15 and the F-16.

Northrop (teamed with McDonnell Douglas) and Lockheed (teamed with General Dynamics and Boeing) were chosen last October by USAF to build two ATF prototype aircraft each. Prototypes will be flying two years from now.

All these fighters are the NASP's progenitors. The NASP's technologies of fuels, engines, structural materials, aerodynamic shapes, avionics, and—perhaps most importantly—systems integration will have had their origins, however brightly or dimly, in ASD's work on the technologies of the F-15, the F-16, and the ATF.

Among innumerable examples of this are the research programs of ASD and its contractors on high-strength, heat-resistant alloys and cooling techniques for advanced fighter engines, on nonmetallic materials for engines and airframes, on the integration of aircraft avionics, on the use and integration of experi-

mental aerodynamics and avionics as in the Advanced Fighter Technology Integration (AFTI)/F-16 and X-29 forward-swept-wing aircraft programs, and on variable-camber wings as in the AFTI/F-111 program.

AFTI/F-111 officials at ASD claim that the F-111s on the Libya raid of last April could have been back home an hour earlier, or could have forgone two of their aerial refuelings, had they been equipped with the mission-adaptive wings (MAWs) now being successfully tested in the ASD program.

Among other ASD projects germane to the development of the ATF and probably to the NASP as well are those on very-high-speed integrated circuits (VHSIC) as part of the rapid advances in microchip technology, on software that is so important to the automation of aircraft, on cockpit technologies that enable pilots to take full advantage of such automation, and on artificial intelligence (AI)—a technology that General Thurman says "is becoming synonymous with advanced aeronautics" and that ASD is just now beginning to get in hand.

The NASP's developers will borrow from ASD's books on all these projects. Moreover, it is likely that the NASP program itself will contribute technological insights to other ASD programs, most notably to the ATF program somewhere along its way into the twenty-first century.

There are those who say that the advent of the presumably world-beating NASP will mean the end of fighters as we know them today and that the ATF will be the last of their long, evolutionary line.

Rearranging the Molecules

ASD is taking nothing for granted in this regard. Its laboratories are nurturing technologies applicable to both the NASP and the ATF programs, but they are also continuing to pursue technologies that may someday apply to flying machines not yet envisioned.

For example, ASD's Aero Propulsion Laboratory and Materials Laboratory are looking beyond the ATF in their research on highly advanced turbine engines and on exotic materials, respectively, for superswift jet aircraft that would not necessarily transcend the atmosphere in the manner—or with the hybrid rocket/scramjet air-breathing engines—now planned for the NASP.

Both laboratories are in the business of rearranging the molecules of Mother Nature's chemical elements. Their goals are endothermic "designer" fuels that will absorb heat rather than give it off and materials of enormous strength, of malleable ductility, and of mighty resistance to heat.

Such materials and fuels would be an unbeatable combination in the powerplants of high-performance aircraft, and the materials could be made into aircraft skins virtually impervious to heat and stress.

In one portentous project, the two laboratories are working together, as an Aero Propulsion Lab paper puts it, "to demonstrate a revolutionary advancement in turbine engine technology through the 1990s."

Their goal is to devise fighter engines capable of doubling the thrust-to-weight ratios of the engines now being developed by General Electric and Pratt & Whitney, also in prototype-construction competition, for the ATF.

Those ATF engines will greatly surpass the engines of the F-15 and the F-16 in terms of their thrust-to-weight ratios measured at supersonic speed and high altitude. They will enable the ATF to cruise supersonically over long distances without using fuel-gulping afterburners, an impossibility with existing fighter engines.

All such advances in the propulsion world will lead to dramatic improvements of USAF's warfighting prowess.

"We're not going to be range-limited any more," General Thurman asserts. "We'll be able to pack much more energy into fuels. This has tremendous implications for aircraft designs."

Among other things, it means that "our younger officers, in their career lifetimes, will probably see airplanes the size of F-15s going in and out of space," the ASD Commander asserts.

ASD itself is on afterburners in preparing for this and for more in the aeronautical arena.

"We've never had a better research program in our labs, and we're focusing our lab efforts on applied research," General Thurman explains. "There's a new excitement, a vibrancy, at Wright Field, because our people are working directly on the technologies that we'll need in the airplanes we're going to field in the coming decade and in the early years of the 2000s."

The principal draws upon those

Lt. Gen. William E. Thurman, Commander of Aeronautical Systems Division, reflects the upbeat spirit at ASD, now in its "glory days." Here, he checks out a cockpit-design engineering device configured for LANTIRN system technology.

technologies are the NASP program, the ATF program, and the Strategic Defense Initiative (SDI) program, in which USAF is a featured player.

General Thurman calls these programs "huge technological kickers" and includes among them, as well, the VHSIC program and the Air Defense Initiative (ADI) program that USAF sees as a necessary complement to SDI.

Serving as clearly delineated aimpoints for ASD's scientists and engineers, all such programs "give us focus for what in the past we always saw through a glass darkly," General Thurman declares.

ATF Avionics Integration

A prime example of how ASD's major systems development programs are now enfolding technologies once confined to its laboratories is that of avionics integration in the ATF.

ASD's Avionics Laboratory has worked for several years on the Pave Pillar program, in which its contractors defined a generic architecture for the automation and integration of aircraft avionics subsystems—combining, for example, fire controls and flight controls, along with navigation systems, electronic warfare systems, propulsion controls, radars, and cockpit controls and displays.

This program encompasses the Avionics Lab's development of the Integrated Communications, Navigation, and Identification Avionics (ICNIA) system, a project aimed at combining into a single, highly reliable radio all of the variegated communications that modern combat aircraft must rely on and manage.

The Avionics Laboratory completed the design specifications for the Pave Pillar system and has now handed it over to the ATF program office for development and incorporation into the fighter.

The eventual extent of such incorporation will be determined in the competition between the two ATF contractor teams. Each has been assigned by the Air Force to build and test ATF avionics-suite prototypes along with—and apart from—their aircraft prototypes.

"It may take longer to bring on the avionics prototypes than it will to bring on the airframe and engine prototypes," General Thurman says. "Avionics may turn out to be the long pole in the [ATF] tent."

ASD's experience with the B-1B bomber taught it not to take for granted that a new aircraft's avionics will need less time in development, solid advances in microchip technology notwithstanding, than will its airframe and engines.

In the B-1B, says General Thurman, "we packed all the offensive avionics in the front of the airplane and all the defensive avionics in the back and expected it all to work together when we turned on the switches."

Lockheed and Northrop now head contractor teams competing in the development of the Advanced Tactical Fighter (ATF), as depicted by a Lockheed artist. The ATF program, a blue-ribbon ASD endeavor, is centered on construction of airframe, avionics, and engine prototypes and is scheduled to eventuate in an operational ATF around the mid-1990s.

Instead, it turned out, for example, that some of the bomber's transmissions were picked up by its receivers. This entailed rearrangements and better integration of its avionics systems.

Regarding the transition of technologies into systems, some Air Force officials are concerned that the major, blue-ribbon systems programs at ASD are preempting altogether too many of the laboratories' advanced development projects, perhaps prematurely. Some also fear that the Air Force, in its increasing emphasis on applied research amid a budget crunch, is drifting away from basic research.

Both trends threaten the labs and, in consequence, their development of the technologies that USAF will need for far-future systems distinct from those now soaking up technologies and resources, such critics claim.

General Thurman doesn't buy it. "We're spending more money on

basic research at ASD than we ever have," he declares.

The General also notes that ASD is responsible for working up nearly three-fourths of the seventy advanced technologies and advanced systems concepts that AFSC's Project Forecast II study selected as having the potential to "revolutionize the way the Air Force carries out its mission in the twenty-first century, guaranteeing continued technological supremacy over any potential adversary."

Thanks to Forecast II

Keith Collier, ASD's deputy for development planning, tips his hat to the Forecast II study for having "provided us with a very rich set of identified technology potentials." His shop is mating Forecast II's technologies and systems concepts with what it perceives to be USAF's future requirements for them in terms of missions and is reshaping its studies accordingly.

Among the topics of such studies are cruise missile defense, nonnuclear strategic forces, unmanned systems, and "mission/flight systems integration, which anticipates that the next-generation avionics integration will be an order of complexity out beyond that of the ATF," Mr. Collier says.

Forecast II lends leverage to all this. AFSC's commitment to solid support and funding of the development of Forecast II technologies and systems bodes well for USAF's research community and should not be taken lightly, General Thurman claims.

"We're in the glory days of ASD right now," the General asserts. "On just the white [unclassified] side, we have more aircraft programs than we've ever had—the NASP, the ATF, the F-15E, the F-16C and D, the air defense fighter, the C-17, and the T-46 [trainer] or some variant of it, depending on how the Air Force decides to go."

The F-15E is now virtually a bird in hand. The first dual-role fighter, its engines and cockpit displays somewhat at variance with those of the production-line F-15Es that will follow, was scheduled to roll out last month at the McDonnell Douglas plant in St. Louis, Mo.

Production of the F-15Es will proceed at a measured pace, centering on five test-bed models, through most of 1987, and will start hitting its stride about a year from now.

The Air Force plans to buy 392 F-15Es for four operational wings and one training wing well into the 1990s. Destined for the demanding deep-interdiction mission, they are expected to be superior in many ways to the F-111s that they will replace over the next four to six years—most especially, perhaps, in their ability to fight their way out of trouble in air-to-air combat.

The F-15E's dual-role versatility has been put to the test in the fighter's simulator at McDonnell Douglas.

Col. Roy B. Marshall III, chief of the projects division of ASD's F-15 program office, recalled that it was "impressive how quickly we could go from air-to-air to air-to-ground" in that simulator.

"As we were going into the target, the simulator operators brought up a MiG-23," Colonel Marshall said. "We got radar contact, negated the MiG-23, went back down in the weeds, and continued our bombing attack. We were satisfied."

Optimally, each F-15E would carry four radar-guided, launch-and-leave AIM-120A Advanced Medium-Range Air-to-Air Missiles (AMRAAMs) and four infrared-homing AIM-9L Sidewinder missiles.

Colonel Marshall and Lt. Col. Edward J. Atkins, the F-15E program manager at ASD, acknowledge that some work needs yet to be done on making the fighter's avionics gear compatible and on integrating its software in a timely manner.

The F-15E will be "software-intensive," loaded with digital, programmable avionics, including the Joint Tactical Information Distribution System (JTIDS) and the Tactical Electronic Warfare System (TEWS).

The integration of all such systems is by no means easy, but "we don't see any real show-stoppers ahead," Colonel Marshall says.

Prospects for the F-15E

Powered either by P&W F100-220 engines or GE F110 engines, the F-15Es will be built for the carriage of conformal fuel tanks to give them the range they will need for their far-ranging interdiction forays beyond enemy lines.

The 81,000-pound (fully loaded) F-15E's range and advanced avionics will enable it to do something that the 68,000-pound F-15C was not built to do in the air-to-air regime, namely, to escort ground-attack fighters beyond the Forward Edge of the Battle Area (FEBA).

The ATF was designed from scratch—in its propulsion system, aerodynamics, and avionics—to do just that, without conformal fuel tanks, and to do it far better.

Cockpit technologies are at their contemporary zenith in the "missionized" forward and aft crew stations of the F-15E.

The front cockpit has two monochromatic displays, one color display, and one wide-field-of-view, holographic head-up display (HUD). The rear cockpit has two color displays and two monochromatic displays. All displays in both cockpits can show the fighter's attitude, altitude, and airspeed, plus information pertaining to its armament, forward-looking infrared (FLIR) navigation, radar altimeter, terrain-following radar, fire-control radar, and communications systems. A voice warning system will alert the crew to danger when the fighter dips down too low.

By mid-1988, the F-15E will be the only variant in production. Production of the F-15Cs and Ds, now entering its final phase, will have ended.

All USAF attack aircraft will benefit from ASD's AFTI/F-16 program. F-16Cs are being equipped with flight controls that the program has successfully tested, and the F-15Es will draw from its avionics innovations to some extent.

Such improvements, with more to come in the operational Air Force, will make it easier for F-16C pilots to handle LANTIRN, for example. Moreover, it is no stretch of the imagination to assume that AFTI/F-16-induced advances in digital, fly-by-wire flight controls, in aircraft maneuverability, and in a host of cockpit technologies, such as voice controls and voice warning systems, will find their way into the ATF and even—in forms much farther advanced—in the starfighters of General Thurman's foreseeable future.

Easing the Tough Tasks

In its current phase, the AFTI/F-16 program is concentrating on trying out the Automated Maneuvering and Attack System (AMAS) to ease the tough tasks of low-flying attack pilots.

Among the integrated technologies involved in AMAS are an IR sensor/tracker that provides precise target information with respect to the aircraft's position, a digital weapons interface called "standard avionics integrated fuzing" because it enables the fire-control system to fuze weapons automatically just prior to their release, and cockpit displays of terrain maps that are projected both on film and by means of digital electronics.

At this writing, AMAS features have been tested in nearly 200 flights of the AFTI/F-16. One of those features, a ground collision-avoidance system, has been validated while turning at five Gs at 200 feet, a bomb-run maneuver that the AFTI/F-16's qualities of aerodynamics and avionics can handle with hardly any sweat.

The AFTI/F-16's combination of terrain-avoidance and digital terrain-mapping systems may well turn out to be the biggest boon ever for such hill-hugging attack aircraft as the F-16Cs and the F-15Es.

The Marines and the Army—and the British, too—are interested in the AFTI/F-16 digital terrain management and display system's potential for improving their night-attack capability.

"The great thing about the system is that its data doesn't become obsolete," says Lt. Col. Donald H. Ross, ASD's AFTI/F-16 program manager. "They're not going to blow away the hills that we have on our digital maps."

Despite its successes, the AFTI/F-16 program, at this writing, is facing a severe drawdown and maybe even the termination of its funding at the hands of the Air Force.

This is also true of the AFTI/F-111 program for testing the mission-adaptive wing.

That program has demonstrated that variable camber wings have the potential to make a major difference in flight efficiency and maneuverability and that such wings have a place in the Air Force's operational future. However, the program has not progressed to the point where the wings on the test-bed F-111 are controlled in the fully automatic mode.

Such testing is scheduled to begin in a few months. It may be curtailed for lack of funding, however, to the regret of program officials. "We're really just scratching the surface of what we can do with the MAW system," says Ron DeCamp, ASD's AFTI/F-111 program manager.

It is possible that both AFTI test programs have already contributed just about all that they need to contribute, for now, to USAF's understanding of the technologies they have explored. Now it may be time for USAF to concentrate on those technologies in a more pragmatic manner, namely, in the ATF program, some officials believe.

The AFTI/F-16's spin-off for the ATF seems clear and substantial. Less clear is the spin-off to be expected from the AFTI/F-111 program.

A McDonnell Douglas technician adjusts the wind-tunnel model of the F-15 short-takeoff-and-landing (STOL) and maneuvering demonstrator aircraft being developed by the company for ASD. It is scheduled to begin test flights in early 1988.

Applying the Lessons Learned

USAF wants the ATF to be capable of relatively short takeoffs and landings, given the wartime prospect of damaged runways in operational theaters. Consequently, the ATF designers will probably draw from lessons learned in yet another blue-ribbon ASD program, one that will demonstrate "STOL and maneuver technology" in a test-bed F-15 that is moving closer to production.

The ATF's engines are expected to be capable of reversing and vectoring their thrust in order to enhance the aircraft's maneuverability as well as to give it STOL capability. The key to this will be engine nozzles of the type to be tested on the F-15 STOL demonstrator aircraft.

Pratt & Whitney, one of the two competing ATF engine contractors, will supply two of its F100-220 engines for the modified F-15 and is now building the nozzles to go with those engines, with ground-testing of the whole system scheduled to begin later this year.

P&W expects that its nozzles will be capable of vectoring thrust as much as twenty degrees up or down.

GE, too, is involved in the STOL test-bed aircraft program. Its work has to do with coupling the controls of the thrust-vectoring nozzles and the canards with the conventional flight controls of the F-15, thereby making it possible for the pilot to handle the whole affair as a package of controls, not as controls in isolation from one another.

Among other technologies to be tested aboard the aircraft will be a STOL "mode guidance" system (featuring cockpit displays that will show the pilot the best pathway for landing on a bomb-damaged run-

way), a low-visibility, precision-touchdown system, and a landing gear system that couples nosewheel steering and braking controls with flight controls and thrust-reversing controls.

ASD's Advanced Fighter Technology Integration (AFTI) F-16 heads out for yet another test of its highly sophisticated flight-control avionics and cockpit technologies. AFTI/F-16 innovations are being incorporated in current production fighters and will show up heavily in the avionics of the ATF.

The demonstrator aircraft is expected to be capable of taking off from a 1,500-foot runway with full internal fuel and a 6,000-pound payload and of landing in that distance or less in the rain, under a 200-foot ceiling and crosswinds of up to thirty knots, with half-mile visibility and no landing aids.

Its radar and inertial navigation system will enable it to make such landings in daylight. For night landings, it will be equipped with a LANTIRN navigation pod and HUD.

"By the end of this year [1987], all flight units should have been delivered, and we will begin installing them in the airplane on our way to meeting our first flight date in April 1988," says David Selegan, who is ASD's deputy manager of the program.

"We are very fortunate," Mr. Selegan continues, "in that everyone involved in the program has put first-class people on it—first-class not only technically, but also socially. That's a big, big factor in this program because it's an integration program. We have broken ground in the relations between engine and airframe contractors and subcontractors that's never been broken before, because our integration of everything—such things as the landing gear with the flight-control system—has never been done before."

Hallmark of the ATF

Such integration will be the hallmark of the Advanced Tactical Fighter. The prototyping approach to its airframe, engines, and avionics as separate entities prior to final assembly of the competitive ATF flying machines should provide clear perspective, from the standpoint of actual hardware, on how to put them all together.

"The prototyping approach has changed the program in several ways," explains Col. Albert C. Piccirillo, the ATF program director. "We'll have prototype ATF airframes and engines flying almost two years earlier than originally planned."

The idea in the beginning, since abandoned, was to have several contractors compete on paper and with isolated hardware and then to choose one of them to build an ATF model for flight demonstration and testing.

As of now, ASD plans to have both the Lockheed-Boeing-General Dynamics YF-22A ATF prototype and the Northrop-McDonnell Douglas YF-23A ATF prototype flying by the end of 1989.

"The flight prototype will be a major part of the program," Colonel Piccirillo explains. "We need flight testing to demonstrate the proper balance among the critical ATF characteristics of supersonic cruise, high maneuverability, low [radar and IR] signatures, and excellent fighter handling qualities prior to pinning down the design for full-scale development and production."

All this will be mighty challenging. General Thurman's thoughts on it are as follows:

"In the past, the trade-offs were relatively simple. Questions of maneuverability, size, range, and speed could all be analyzed in the context of propulsion systems and aerodynamics.

"Now, we have to look at performance—maneuverability—against low observables. They aren't mutually supportive. The things you do to increase maneuverability may not be the things you do to lower your observables. The design team can't just say we're going to make the fighter highly maneuverable by putting a great big tail on it.

"So the problem of designing a fighter these days is tremendously complicated."

The saving grace in all this is the computer. "Computer power allows us to analyze those trade-offs and make them work," General Thurman says. "The exciting thing to me, as an old aerodynamicist, is to go out to an aircraft design shop and watch as they put their designs together on a big screen, with a computer.

"They lay down a design, and someone sitting there, maybe from the manufacturing side of the house or the maintenance side, says, 'Hey,

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you can't do that, because the airplane would be tough to build or to keep in shape.'

"Then they change it, move the lines around on the screen, and they say, 'There, how about that.' Someone says, 'Well, I want to make this little aerodynamic change right there,' and someone else says, 'Hold it, what are the implications of that change on the observability—the radar cross section or the IR cross section—of the aircraft?' "

This sort of computer-generated dialogue and teamwork, as it were, "now allows us to get an F-16C with superb performance and ninety-five percent availability," General Thurman adds.

Three Types of ATF Prototypes

The development of all three types of ATF prototypes—airframe, engines, and avionics—will tell the Air Force a great deal about how to make the trade-offs and still come up with a fighter of great speed, maneuverability, and range and of low radar and IR cross sections.

The avionics prototypes "will be just as important as the flying prototypes," Colonel Piccirillo declares, adding that they "will be ground-based at first, and they'll take into consideration the insertion of new technologies, such as VHSIC, using a common-core architecture and distributed processing. Later in the program, both contractor teams will be flying their avionics prototypes in large, airliner-type test-beds."

Centered on all its prototypes, the ATF program's design demonstration/validation phase should take about four more years, and then the fighter will proceed—with the winning contractor team having been selected—into full-scale development on the way to production and operational service around the mid-1990s.

The initial, demonstration phase of the program will require an Air Force expenditure of about $2.5 billion; the full-scale development phase, about $7 billion; and the production phase, about $35 billion for 750 of the fighters, according to Thomas E. Cooper, Assistant Secretary of the Air Force for Research, Development, and Logistics. All prospective expenditures are quantified in terms of the buying power of the dollar in Fiscal Year 1985.

Dr. Cooper sees the integration of the ATF's avionics as the program's biggest challenge, but also regards it as holding the promise of "tremendous payoff."

The engines being developed for the ATF are already well along and are "the pacing items in the prototyping program," Colonel Piccirillo says.

ASD anticipated that the ground-demonstration version of the GE YF120 engine for the ATF would be up and running by the first of this year. The Pratt & Whitney YF119 engine ran for the first time last October.

Both powerplants are in large measure the products of technologies developed in the ASD Aero Propulsion Laboratory's Joint Advanced Fighter Engine (JAFE) program over the past few years.

That program has been folded into the engine portion of the ATF program itself. But this does not mean that the Aero Propulsion Lab has gone out of the business of developing advanced fighter engine technologies, not by a long shot.

"We're out to double the thrust-to-weight [ratio] of the ATF-generation engines—and to maintain the same level of reliability—by the year 2000," asserts Walker Mitchell, deputy director of the Aero Propulsion Lab. "Our technology program is embedded in Project Forecast II—we're a big player in that—and it is much broader than just looking forward to the next ATF. We're looking at hypersonic airplanes and missiles, among other things."

Endothermic fuels are a major consideration in all this. They are being researched in the lab's aviation fuel technology program, and they have enormous implications for air-breathing engines of the future.

"We call them designer fuels," Mr. Mitchell explains, "because we're rearranging molecules to get the characteristics that we want out of them. They absorb heat instead of giving it off."

In connection with this, high-performance aircraft and missiles may one day burn gaseous hydrogen compounds instead of liquid fuel, Mr. Mitchell says.

This is feasible in turbine engines, he says, "because they don't care what they're burning."

The laboratory is involved in a number of technology programs under the heading of "high-speed propulsion." They are aimed at "rapidly developing an Air Force capability for high-speed flight, including turboramjet engines for Mach 5 interceptors, hydrogen-fueled engines for hypersonic cruise vehicles or space boosters, and new engine options for high-speed missiles."

One of the lab's aspirations is a supersonic combustion ramjet (scramjet) engine of the sort slated for the National Aerospace Plane.

Hand in hand with the Aero Propulsion Lab's endeavors are those of ASD's Materials Laboratory. The lab is in pursuit of "intermetals," such as titanium aluminide, and, farther out, of carbon/carbon materials and ceramic composites that would far surpass today's composites and superalloys in strength and resistance to heat.

"Nickel-based superalloys are the backbone of turbine engine technologies," explains Larry Hjelm, assistant chief of the Materials Laboratory's metals and ceramics division. "They date back to the early 1950s. Incremental improvements in them have allowed us to double the thrust-to-weight ratio of fighter engines, but we can't take them any further, so we're looking for alternatives."

Titanium is one such alternative, but it is much too costly. Fused with aluminum in titanium aluminide intermetals, it becomes inexpensive enough to buy, in relatively small quantities, for engine components and for airframes.

The intermetals can stand temperatures that far exceed the melting points of titanium itself, let alone the melting points of nickel-based alloys.

The Materials Lab is also exploring the rapid solidification of aluminum and of other metals to make their molecules reform in unnatural, stronger patterns.

All such work is being driven by ASD's "activity in hypersonics," Mr. Hjelm says. Such activity "will carry our work along well past the aerospace plane," he adds, "and we expect to get some benefit from the NASP program." ■

Fighting Around the Clock

USAF's promising new LANTIRN navigation and targeting system will turn night into day for its attack aircraft, as demonstrated in this flight test of a LANTIRN head-up display (HUD).

The LANTIRN navigation and targeting system is at the point of full-scale production and is looking good.

LAST year, the Air Force designated the F-15E as the first fighter to be outfitted with the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system, probably at the beginning of 1989. The dual-role fighter is a natural for LANTIRN. The system will come in mighty handy on those deep, difficult interdiction missions—one aircraft at a time, in most cases—and the F-15E's two-man crew will be able to assimilate the work load associated with LANTIRN more easily than would a single pilot.

Mounted underneath the fuselage, LANTIRN's targeting and navigation pods will almost certainly have some effect on the F-15E's flight dynamics—especially when the fighter flies fast and low en route to land targets.

"Accommodating the pods may be a challenge, but the fighter was designed with LANTIRN in mind, and we don't see any problems at this point," says Col. Roy B. Marshall III, chief of the projects division of Aeronautical Systems Division's F-15 program office.

LANTIRN is also slated for deployment on 300 F-16Cs. Late last summer, Air Force Chief of Staff Gen. Larry D. Welch disclosed plans to put a derivative of LANTIRN on B-1B bombers, too, "a couple of years from now."

Col. James A. Fain, Jr., director of ASD's strike systems program office, claims that LANTIRN will enable USAF's ground-attack aircraft to "fight around the clock and exercise our airpower in about any battle we choose."

Radical Impact

"Our ability to fight at night will

have the same radical impact on tactical conventional warfare as did the tank, the machine gun, and the parachute," he continues.

Colonel Fain flew fighters in the Vietnam War. Recalling the enemy's penchant for moving supplies and reinforcements under cover of darkness, he claims that "if we'd had LANTIRN, we'd have stopped them dead."

Having brought LANTIRN through some tough times to the point of full-scale production, Colonel Fain describes it as "a very complex system that requires state-of-the-art computers and electronics, and it has to be built with high reliability if it's going to withstand the shake, rattle, and roll it'll get on high-performance fighters. There's no reason why we can't do this. The components we're using are now very reliable."

The system's navigation pod is less technologically complex than its targeting pod. It embodies a wide-field-of-view FLIR (forward-looking infrared) sensor and a terrain-following radar. Its HUD (head-up display) is the pilot's "night window," showing him nighttime scenes outside of his aircraft as if they were actually visible to him in the adequate light of early evening, with twilight just beginning to gather.

The targeting pod is a technological and engineering masterwork. It contains a stabilization system, a FLIR system with wide and narrow fields of view, a laser designator/ranger, a dual-mode automatic target tracker, an automatic infrared-guidance handoff system for the Maverick missile, and sufficient space and the electrical fittings for an automatic target-recognition system yet to be incorporated.

Both pods are integrated with aircraft flight controls, cockpit displays, and fire controls for both guided and unguided weapons.

The navpod never had serious technical problems, but its reliability left something to be desired in the early days of its development. It is now considered sturdily reliable, and its full production was approved late last year.

USAF plans to produce 700 navpods. The first of them is scheduled for delivery to the Air Force this coming April.

Testing the Targeting Pod

The targeting pod has been a different, more difficult story. It required a lot of labor by ASD, by LANTIRN's prime contractor, Martin Marietta, and by several subcontractors to get the pod into shape to come through Initial Operational Test and Evaluation (IOT&E) about a year ago.

That testing was rigorous. Some of it was conducted in humid and rainy conditions that taxed the targeting pod to the utmost. In its aftermath, the Air Force insisted on a little better performance from the FLIR subsystem's wide field of view and from the dual-mode automatic tracker.

The problems were not considered to be serious enough to preclude the targeting pod's initial low-rate production, however, and it is now under way.

Colonel Fain claims that the pod's problems have been corrected and that it will do much better in FOT&E (Follow-on Test and Evaluation) flights that are scheduled to begin next month and to end in March or April.

If the pod prevails, it will almost certainly be certified for full-scale production—and ASD will be justified in taking great satisfaction from the success of a technology-stretching program that was once sorely troubled and seemed destined to flop.

"We've come a long way in the last two years," Colonel Fain declares.

Some Air Force officials have questioned whether LANTIRN will be too much for pilots in single-seat attack aircraft to cope with in the company of their many other demanding duties.

This point bears particularly on the Air Force's plan to put LANTIRN on 300 F-16Cs.

Colonel Fain notes, however, that test pilots have handled LANTIRN quite well while flying solo "in some very tough environments."

—JAMES W. CANAN

LANTIRN navigation and targeting pods mounted underneath the fuselage of an F-16. LANTIRN will have a "radical impact" on USAF's ability to wage conventional warfare and will be deployed initially on F-15E dual-role fighters about two years from now.

The Soviet MiG-29 is the new yardstick against which to measure the adequacy of Western fighters.

JANE'S

Aerospace Survey 1987

BY JOHN W. R. TAYLOR
EDITOR IN CHIEF
JANE'S ALL THE WORLD'S AIRCRAFT

NO CHIEF designer from Moscow contributed a paper to the Jane's conference on "Future Combat Aircraft," staged in the London lecture theater of the Royal Aeronautical Society during the week of the 1986 Farnborough Air Show. There was, however, little need for a symbolic empty chair at the table to remind delegates of those who were missing.

Just two months earlier, on July 1, the Soviet Air Force had displayed in public for the first time six of its latest-generation counterair fighters—MiG-29s, known to NATO by the reporting name "Fulcrum." What was learned then provided a yardstick against which to measure the adequacy of the West's current hardware and future fighter programs.

Those who had gathered at Kuopio-Rissala airfield in Finland on that July day had been briefed to expect a formation of MiG-29s on a goodwill visit from Kubinka air base, near Moscow. They were prepared for disappointment, as the Soviet Union is seldom impatient to show its latest military equipment. Despite there being about 150 Fulcrums in service by mid-1986, the general public's knowledge of the type was limited to what could be gleaned from a single fuzzy satellite photograph that had appeared in a US congressional report and from a subsequent succession of artists' impressions of varying authenticity.

Fulcrum Revealed

This proved to be the day when all, or nearly all, was to be revealed. In immaculate formation, the six MiGs raced overhead and broke away for landing, at a frustrating distance from the small band of photographers who had learned of the promised visit. As the MiGs taxied toward their prepared parking area, those with binoculars were surprised to note that the fighters' engine air intakes appeared to be blanked off. This was, of course, impossible—or was it?

Close inspection of video showed, later, that the intakes were closed by doors when the nosewheel of each aircraft made contact with the runway on touchdown. Clearly, this was an ingenious way of preventing the low-slung gaping mouths of the big turbofans from hoovering up ice, snow, slush, stones, and assorted foreign objects from the kind of runways that Warsaw Pact air forces are expected to use year-round.

When the intake doors are closed, the MiG-29's engines take in air through louvers above the wingroot leading-edge extensions. On the original satellite photograph, these louvers had been interpreted by most people as smoke stains left by a gun firing from each wingroot. Study of the few close-up pictures, taken by official Finnish Air Force photographers, showed only one orifice for a gun, in the port wingroot. Nor could this be the expected twin-barrel 23-mm GSh-23, as fitted to MiG-21 Fishbed and MiG-23 Flogger interceptors, as the orifice is circular and too small for twin barrels. Only later was it learned that the gun is a six-barrel Gatling type, needing just a single hole forward of the barrel that happens to be in the firing position. Despite all the engine air ducting in the wingroot, the gun is a formidable 30-mm weapon, as installed in the MiG-27 Flogger and Sukhoi Su-24 Fencer, but ammunition must be limited.

No underwing weapon pylons were fitted to the aircraft of the display team from Kubinka. The Department of Defense has referred to six underwing hardpoints for the latest medium-range AA-10 and close-range AA-11 air-to-air missiles or for other stores for a second-ary attack role. Some of these external loads have been observed on operational MiG-29s photographed over the Baltic Sea by Scandinavian fighter pilots, but details may not yet be published. All we know about the AA-10 is that US Assistant Secretary of Defense Donald Latham has described it as superior to the not-yet deployed AIM-120A AMRAAM. Maybe, however, it is superior only because it *is* deployed.

The visit to Kuopio confirmed Secretary Latham's warning that the new generation of Soviet counterair fighters would be fitted with infrared search/track (IRST) sensors, of the kind installed long ago on F-106s but since omitted from US fighters. Such a device could be seen on each MiG-29 under a transparent dome forward of the windscreen. Added to a large pulse-Doppler look-down/shoot-down radar, said to embody considerable Hughes Aircraft expertise acquired by covert means, and a reported helmet-mounted sight to which the weapon system is slaved, it all adds up to an impressive combat aircraft packaged into F/A-18 Hornet dimensions.

Unanswered Questions

Some of the questions one would like to ask remain unanswered. How efficient is the IRST, and can it pick out fast, low-flying aircraft and cruise missiles against background radiation? How advanced is the cockpit? How much of the airframe is made of low-observable lightweight composites? Is there really a gentle Soviet voice that warns the pilot automatically if he nears the limits of safe flight? What is the TBO of the R-33D turbofans and the TBMF of the avionics? First impressions suggest only limited use of composites, and it is unlikely that the IRST offers the thermal imaging necessary to deal adequately with transonic targets in nap-of-the-earth flight.

It is easy to be mesmerized by the first sighting of a new combat aircraft that represents such a massive advance beyond the technology standards of its predecessors. Some commentators have gone so far as to suggest that a MiG-29 could destroy an F-15 without revealing its presence to the victim, by avoiding radar and radio emissions and using its IRST for both navigation and tar-

Formation of MiG-29 Fulcrums, the latest-generation Soviet counterair aircraft. Six of these impressive fighters made a goodwill visit to Finland on July 1, 1986. *(Swedish Air Force)*

get search/track. This assumes a degree of thermal imaging that is almost certainly beyond the capability of the MiG's sensor and a standard of IR navigation that is no more than a future possibility.

In the same way, the sight of the high-positioned canopy of Fulcrum prompted some writers to commend the pilot's exceptional field of view. A closer study shows that, despite the downward-sloping nose, his forward view is degraded by a bulky head-up display and the IRST. Downward, his field of vision is cut off by the large wingroot extensions. The high sill of the canopy, and its small size, restrict sideways and rearward vision. Compared with the pilot of an F-15 or F-16, the pilot has quite a poor outlook.

Every aircraft is a collection of compromises riveted and bonded into something flyable, and the MiG-29 is no exception. The flying display given by the team from Kubinka revealed none of the "wandering" displayed by MiG-21s

Westland's BERP III rotor, which made possible the new world's absolute speed record for helicopters.

in similar maneuvers or any need for the wingroot notches and folding ventral fin that assist directional control of the MiG-23 known as Flogger-K. Bearing in mind that another of the Soviet Union's new counterair fighters, the Sukhoi Su-27 Flanker, appears to be a scale-up of the same configuration, it seems that some central authority (probably the TsAGI Central Aerodynamics and Hydrodynamics Institute) is now dictating the basic design parameters of each complete generation of new designs in the way that the Sukhoi and Mikoyan Bureaus were instructed to produce tailed deltas in similar large and small sizes (the Su-9 Fishpot and MiG-21 Fishbed) in the mid-1950s.

The Su-27 provides proof that the Soviet Union possesses no magic formula by which to get new aircraft off the drawing board and into operational service overnight. The first photographs of a prototype published in the 1985–86 *Jane's* appear to have been taken nearly ten years ago, yet even today there is only one small front-line unit equipped with production Su-27s. Dozens more have apparently been sitting around the factory at Komsomolsk, waiting for aerodynamic, avionics, and engine fixes.

Helicopter Ups and Downs

Nor is there reason to believe that the two new Soviet attack helicopters—the Mil Mi-28 Havoc and Kamov Hokum—are entering series production as quickly as DoD once predicted. The numbers in flight test continue to be small and, with AH-64A Apaches rolling off the assembly lines at Mesa, Ariz., in growing numbers, the US could soon begin to match the Warsaw Pact's formidable battlefield helicopter capability if it injected more urgency into the LHX program.

Sikorsky's 1986 rescue package for Britain's Westland Helicopters company raises an interesting possibility in this respect. Most of Westland's more successful products have been based on Sikorsky designs since 1947, so it was difficult to imagine what the US manufacturer would gain from its injection of capital. Then, on August 11, 1986, a Westland Lynx fitted with the company's new BERP III (British Experimental Rotor Programme) blades set a world's absolute speed record for helicopters by averaging 216.45 knots (400.87 km/h; 249.09 mph) over a 15/25 km course, subject to FAI confirmation. This exceeded by 17.5 knots the former record set by a Soviet Mi-24 Hind, lending weight to Westland's claim that the new blades, with their high-performance airfoil and paddle-shape tips, increase rotor efficiency by up to forty percent.

Speeds from hover to 300 knots are expected from the Sikorsky S-72 X-wing demonstrator.

If, now, the US Army decided in favor of the Sikorsky/Boeing Vertol team in the competition for the LHX development contract and Sikorsky's new UK associate contributed a BERP rotor system, this might provide a quick riposte to DoD's gloomy comment that "Hokum will give the Soviets a sig-

nificant rotary-wing air-superiority capability. The system has no current Western counterpart."

The past year has already brought several significant new advances in US helicopter technology. Sikorsky has fitted an X-wing to one of its S-72 rotor systems research aircraft, and trials at NASA's Dryden Flight Research Center at Edwards AFB, Calif., were to begin in the autumn. With a likely speed range from hover, with the X-wing rotor turning, to 300 knots (555 km/h; 345 mph) with it stopped, the S-72 could point the way to a whole new family of agile and versatile battlefield aircraft.

Meanwhile, the V-22 Osprey series of tilt-rotor aircraft, by Bell and Boeing Vertol, is taking shape under a $1.714 billion seven-year development contract approved by the US Naval Air Systems Command on May 2, 1986. *(See also "The Amazing Osprey" on p. 80 of this issue.)* Total value of the R&D program, including government-furnished equipment and support, is $2.5 billion. First flight is scheduled for June 1988, and, if all progresses as planned, the Marine Corps will start to receive its 552 Ospreys four years later, primarily for combat assault and assault support. The Air Force is hoping to approve manufacture of eighty for special operations duties by 1993. The Army wants 231 for multimission duties, and the Navy is thinking in terms of fifty for search and rescue, plus 300 more for antisubmarine missions.

There have been unconfirmed reports of similar aircraft under development by the Soviet Mil Bureau, and it would be astonishing if Marat Tishchenko's design team made no attempt to match the V-22. In its basic form, it will combine all the attributes of a helicopter with an ability to haul 6,800 kg (15,000 lb) externally or carry twenty-four combat-equipped troops at speeds greater than 260 knots (480 km/h; 300 mph). The airframe will be all-composites. Complex mechanisms will permit the wing to be stowed and the rotors folded to create a compact rectangular package for storage on the flight and hangar decks of aircraft carriers. Clearly, the Osprey could represent a milestone in aerospace progress as important as the Wright biplane, the pioneer World War II jet fighters, Harrier, and Concorde.

Renewed Emphasis on Conventional Arms?

If, as we must hope and pray, the 1986 summit talks in Reykjavik signal a start of genuine and massive reductions in nuclear weapons, the importance of conventional combat equipment, and particularly aircraft, will increase enormously. There were three major warnings of the urgency of such decisions during 1986. The first of them resulted from the explosion in the Soviet nuclear power station at Chernobyl in the spring, causing not only immediate deaths but a fear that spread across large areas of Europe as a radioactive cloud made food supplies inedible and affected the well-being of people and livestock.

In October, North America was reminded of the immense, invisible, destructive force poised at permanent readiness off its coastline when a Soviet *Yankee*-class submarine, armed with sixteen nuclear missiles, also suffered an explosion and sank.

Further food for thought had been provided by one of the speakers at the AFA's National Convention in Washington in September 1986. He told his audience that pilots of USAF air defense F-15s had twice, already, that month encountered Soviet Bear bombers over international waters. It is easy to dismiss these huge missile carriers as lumbering relics of the propeller age. In fact, they have remained in production for more than thirty years because there is still no aircraft that can perform more efficiently the variety of tasks on which they are employed. Most important of these tasks, until the supersonic Blackjack can take over, is to carry out regular simulated attack missions against North American targets, probing the defenses as they do so. Although they carry no visible weapons on such missions, close contact with the Bears must be an awesome experience for pilots who formate on them and know their destructive potential.

Close contact with a Bear-H cruise-missile carrier is an awesome experience for Air Force fighter pilots off the northern coast of Alaska. *(US Air Force)*

Jane's "Future Combat Aircraft" conference gave delegates a first-ever opportunity to study and discuss in detail, at a single session, four of the principal single-seat fighters that are under development to perform the counterair mission in the 1990s. Dassault-Breguet's Rafale has since been described in the December 1986 *Jane's All the World's Aircraft* "Supplement" in AIR FORCE Magazine. The smaller Israeli Lavi and Swedish Saab JAS 39 Gripen have been designed to meet the specific defense requirements of their individual countries, with US turbofans and with wings of

composites construction supplied initially by Grumman and British Aerospace respectively. Both types have had to overcome problems, beginning with opposition at home from politicians and public who resented high expenditure on nationally built aircraft when similar types could be bought for less money overseas.

In fact, countries that maintain determined neutrality or pursue controversial policies can never rely on buying from abroad what they need for their primary defense. Even those components of their own aircraft that must be imported are often delayed while manufacturers give priority to their home market or while the government of the foreign suppliers deals with economic or political opposition to the transactions.

The prototype Lavi will probably have made its first flight by the time these words are printed. The Gripen will be rolled out on April 26 to mark the Saab company's fiftieth birthday. Both are single-seat deltas, with canards and a single tail fin. Both have an advanced cockpit and heavy weapon load, including a large-caliber gun. The Mach 1.8 Lavi is the larger and more powerful, but still spans only 8.78 m (28 ft 9⅔ in), making it much smaller than a MiG-29. One of its most impressive features will be an ability to get off the ground in about 1,000 ft (305 m). The Gripen will not quite match that short-field performance, but has the inherent advantage of being designed to use Sweden's numerous hard-to-spot highway airstrips.

Whither V/STOL?

It is impossible to overstate the importance of eliminating the need for long concrete runways. Intelligent peacetime targeting of a tactical missile force could leave the enemy without usable runways or potential runways within minutes of the start of any conflict. This is no wild surmise. During the Indo-Pakistan War, a squadron of fighters at Dacca was rendered totally inoperable when its runway was destroyed. The aircraft themselves remained relatively safe behind concrete enclosures, but could play no part in the fighting. Anyone who believes that it would be simple to fill craters in runways should remember that modern cluster weapons include many kinds of delayed action antipersonnel and antivehicle submunitions to make such attempts extremely hazardous and costly. Except for the US Marine Corps, which has accepted enthusiastically the V/STOL Harrier, no air force has yet exhibited a full understanding of what this implies in terms of operational capability.

The McDonnell Douglas/British Aerospace Harrier II—perhaps the only type of combat aircraft (except for helicopters) that would be able to operate after a preemptive strike on NATO runways in Europe.

In some respects, the four-nation Eurofighter for the mid-1990s makes the least concession to short-field operation of any of the four types discussed at the Jane's conference. It will be an impressive fighter, able to fly at Mach 1.8 and carry four and a half tons of ordnance. It will embody low-observable (stealth) technologies and will be built substantially of composites and new lightweight metal alloys. Its multinational designers describe it as extremely agile and optimized for air-to-air roles, with secondary ground attack capability, but to do these things it has first to get off the ground.

Whether or not it succeeds in doing this figuratively, which requires agreement on the physical features, timing, and cost of the 250 aircraft required by West Germany, 200 for Italy, 100 for Spain, and 250 for Great Britain, would the Eurofighter be able to leave the ground literally in war? Its claimed STOL capability comprises a design take-off and landing distance of 500 m (1,640 ft) with full internal fuel and two AMRAAM plus two ASRAAM or Sidewinder missiles. Would this be good enough, even if it is achieved?

One must hope that it will, but it is significant that McDonnell Douglas is aiming for better field performance for the much larger F-15 STOL demonstrator, using the type of two-dimensional thrust-vectoring jet nozzles specified for USAF's next-generation Advanced Tactical Fighter (ATF). Readers will be fully aware that, in November 1986, Lockheed and Northrop were designated prime contractors to build prototypes of the ATF under the designations YF-22A and YF-23A respectively.

That these are the manufacturers responsible for America's "F-19" and ATB stealth aircraft may be coincidental. All that emerged at the time of the announcement was a remark by Lockheed's ATF program director that his company's fighter will be a single-pilot twin-engine aircraft that will carry all its missiles internally. There will be two prototypes of each design, and each manufacturer can choose whether the competing Pratt & Whitney YF119 and General Electric YF120 turbofans will be interchangeable in

his aircraft or whether one engine will be used in one prototype and the other in the second aircraft. The prototypes must be built and tested within a fifty-month demonstration and validation period, at the end of which one will be selected to progress to a five-year full-scale development phase, leading to initial operational capability in the mid-1990s.

Artists' impressions of the ATF published to date are certain to embody considerable disinformation. The thrust-vectoring jet nozzles are about the only feature that is anticipated with any confidence, and it remains to be seen whether this degree of V/STOL capability will be considered adequate in ten years' time.

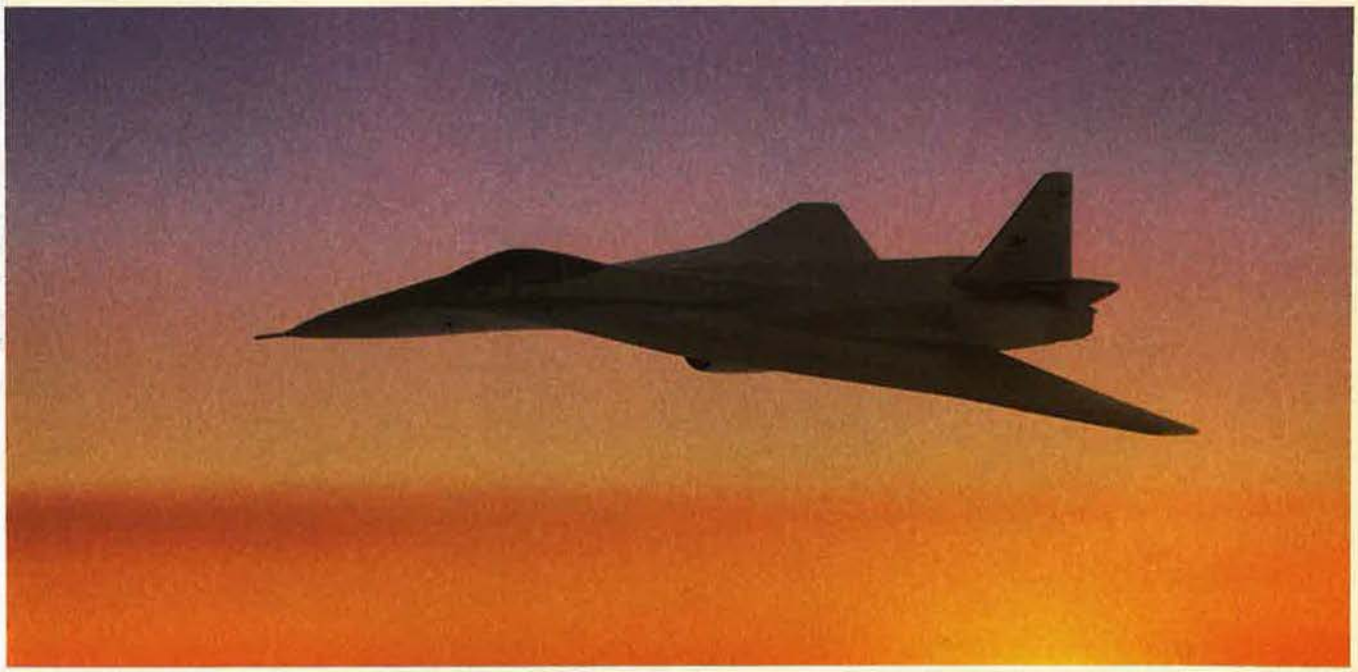
Significantly, in the month prior to the ATF announcement, NASA's Ames Research Center awarded Pratt & Whitney a three-year study contract that could lead to a supersonic research demonstrator capable of true short takeoff/vertical landing (STOVL) operation by the early 1990s. The plan is to integrate a derivative of an advanced technology engine, such as the PW5000 (forerunner of the ATF's YF119), into four candidate propulsion system concepts. These will comprise ejector augmentation, remote augmented lift, hybrid tandem fan, and vectored thrust (as on the Harrier). As the Soviet Union can be expected to have a new generation of fighters by the mid-1990s, it will be interesting to see if its designers decide to reduce risk by benefiting from Harrier experience and if this will disadvantage an ATF using a more limited STOL technique.

Maintaining Quality in Service

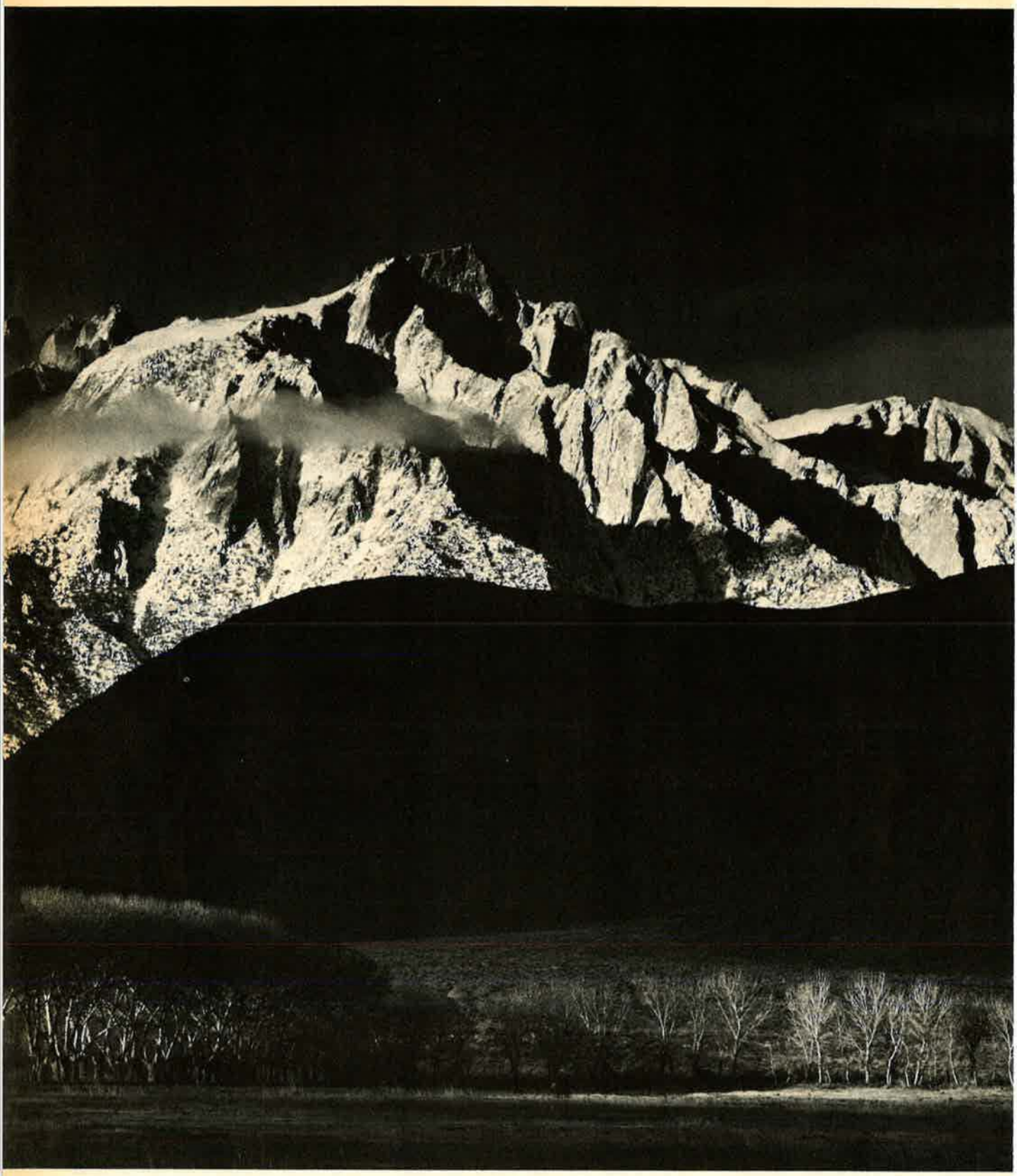
Building new combat aircraft of the highest quality for the Air Force is, of course, only one side of the coin. The other involves maintaining that quality when they are in service. At the beginning of the 1980s, *Jane's* quoted figures showing the alarming standards of combat readiness then being recorded by the US air forces. According to Defense Secretary Harold Brown, an average forty-two percent of USAF tactical aircraft were not mission-capable at any particular time. The relatively unsophisticated A-10 Thunderbolt II came out best, with 32.6 percent of the 243-strong front-line force grounded on average throughout the year. At the other extreme, 65.6 percent of the eighty-six F-111Ds were normally not mission-capable. Nor was the US Navy in a much healthier state, with an average 47.1 percent of its 292 F-14A Tomcats unavailable throughout the year and unimpressive availability of its other five major combat types.

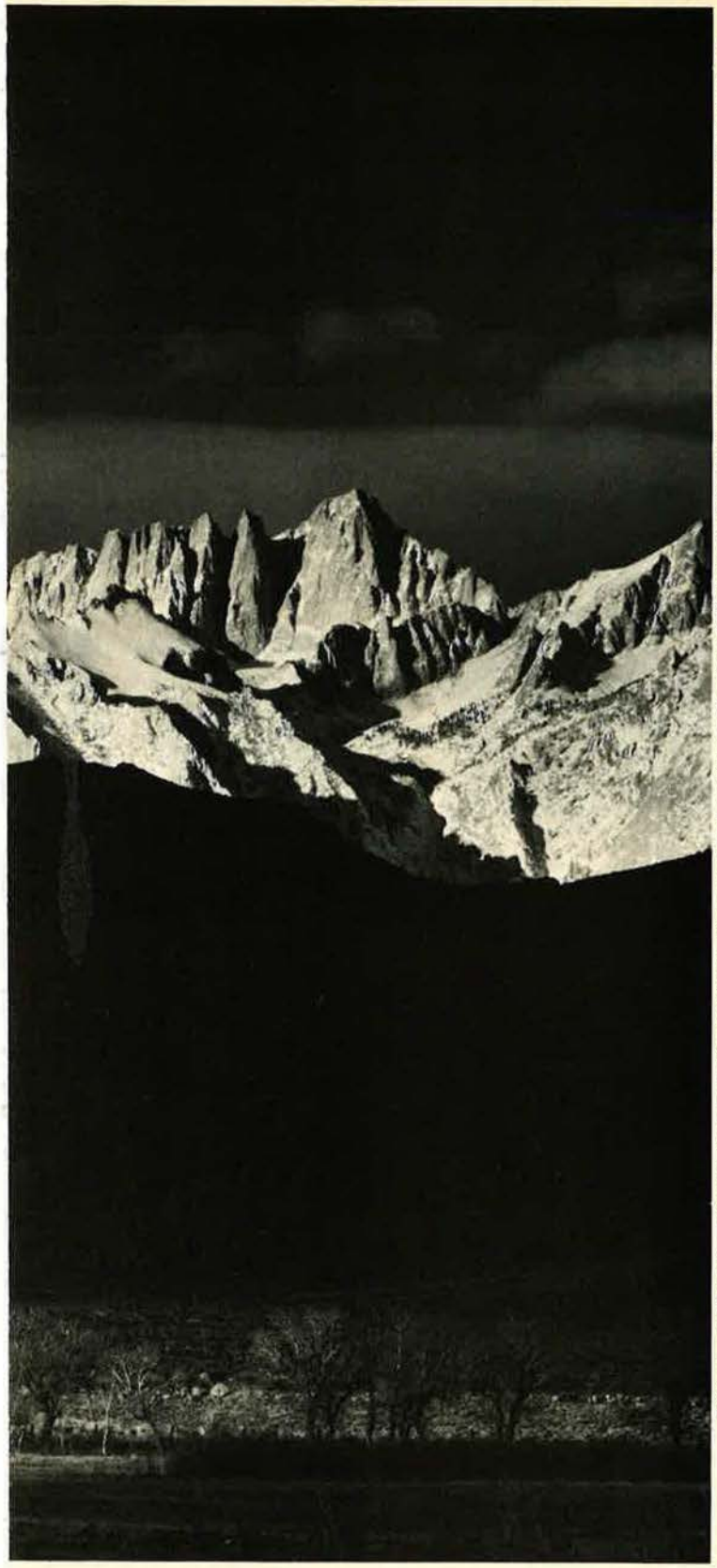
Bearing in mind the 2½ to 1 numerical superiority that has always been enjoyed by the Warsaw Pact air forces in Europe and the huge efforts made by the Soviet Union to close the technology gap between East and West in recent years, an invitation to study the current state of readiness at Tactical Air Command's Langley AFB, Va., last spring promised to be interesting. So it proved.

As well as being the headquarters of TAC, Langley houses the 1st Tactical Fighter Wing. The sight of seventy-two F-15s lined up wingtip to wingtip on the ramp was a little disconcerting to a visitor from terrorist-conscious Europe. In other respects, the whole base inspired a sense of efficient confidence. *Jane's* hosts were the 27th Tactical Fighter Squadron, commanded by Lt. Col. Bill Rutledge, with twenty-four F-15s, thirty pilots, and the 230/260 ground personnel of the 27th AMU, led by Capt. Karen Kiever. Each aircraft was logging an average twenty-two sorties a month, compared with fourteen in 1980, with about two minutes per sortie at supersonic speed during attack and disengagement phases. The proportion of aircraft rated nonmission-capable through lack of spares had fallen from thirty percent to 5.6 percent in six years. Those nonmission-capable through maintenance



Artist's impression of the Advanced Tactical Fighter (ATF), USAF's next-generation vehicle. Northrop and Lockheed have been selected to build prototypes, which will carry the designations YF-22A and YF-23A. *(Erik Simonsen)*





Winter Sunrise, The Sierra Nevada, From Lone Pine, California. Photograph by Ansel Adams. Courtesy of The Trustees of The Ansel Adams Publishing Rights Trust. All Rights Reserved.

Like the Sierra Nevada, Rockwell International's five decades of aviation excellence are a national asset.

Rockwell International

...where science gets down to business

Aerospace / Electronics / Automotive
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backlog had reduced from forty percent to eight percent. The abort rate was five percent.

Lt. Gen. Robert E. Kelley, Vice Commander of TAC, admitted that Langley is a little above average, but estimated that the command as a whole would log 738,000 flying hours in 1986, with Holloman, Luke, and Nellis AFBs each contributing more flight time than the entire Pacific Air Forces. Nine of the command's eighteen wings completed 1985 without an accident. The total of accidents was fifteen, representing 2.1 per 100,000 flying hours. By comparison, the rate in the days of the F-104 was thirty per 100,000 hours.

Gentlemen, you can be proud of your Air Force.

Even the Hawks of the RAF's Red Arrows aerobatic display team can carry weapons for airfield defense and light attack duties.

Cutting Corners and Costs

Sadly, the concept of "making better use" of tightening defense budgets by supporting a first-line fighter force with less costly aircraft continues to gain favor in the West. The Royal Air Force has completed acceptance of eighty-eight of its Hawk advanced jet trainers that have been modified to carry a pair of Sidewinder air-to-air missiles underwing for use in airfield defense and limited attack duties. The Hawks are intended to operate as units of a mixed fighter force, shepherded to their targets by a pathfinding F-4 Phantom, which would find and identify the enemy for them. This has proved effective in exercises. However, the Soviet Union have shown no inclination to copy the cut-price approach to airpower.

At the time of the ATF contract announcement, USAF also stated its intention of ordering modification kits to convert 270 F-16As to an air defense fighter (ADF) standard as they are replaced by F-16C/Ds in active USAF squadrons. In their modified form, the F-16s will have upgraded avionics to improve their capability against cruise missiles and pylons for two 600 US gallon fuel tanks plus two or four AIM-7 Sparrow/AIM-120 AMRAAM missiles in addition to the standard pair of Sidewinders and a 20-mm gun. There is no provision for AN/ALR-69 radar warning receivers, nor is there any for AN/ALE-40 chaff dispensers.

Some representatives of the eleven Air National Guard units whose F-4C/Ds and F-106A/Bs will be replaced by the F-16 ADFs are less than happy at the prospect. They feel that the new aircraft might be adequate for point defense against hostile fighters, but will lack the range, radar, and punch needed to deal with the kind of cruise missiles that Bear and Blackjack will be able to launch at the US from standoff ranges in the next decade. Congress, on the other hand, having got the cost-cutting bit between its teeth, has also decided to meet USAF's requirement for a close air support/battlefield interdictor by awarding LTV a $35 million initial contract for a program under which 340 Air National Guard A-7s may be upgraded to A-7 Plus standard.

The ADF decision almost certainly sounds the death knell for Northrop's F-20 Tigershark, on which the company has spent more than $1 billion of its own money. With the prime contract for development of the Advanced Technology Bomber (ATB) already in the bag and the prospect of an eventual $35 billion for 750 ATFs, Northrop is unlikely to shed many tears.

It should be added that the massive funding involved in some of these new programs will be spread over large sections of the industry. Northrop is teamed with McDonnell Douglas in its work on the YF-23A; Lockheed's partners on the YF-22A are headed by Boeing and General Dynamics. Nevertheless, it seems certain that the US industry will undergo some con-

An Air National Guard air defense fighter (ADF) F-16 refuels in flight. Not all of the eleven ANG units slated for F-16s are pleased by the prospect of acquiring these aircraft.

traction. First to go, now that economics have virtually killed the T-46A next-generation trainer, will probably be Fairchild Republic's plant at Farmingdale, Long Island, from which came the P-47 Thunderbolt of World War II, the F-84s of Korea, and the F-105 Thunderchiefs, the mighty 'Thuds' of Vietnam.

British Airways' order for sixteen new-technology 747-400s, with options for twelve more, represented the largest dollar-value contract ever received by Boeing.

Widening International Collaboration

As readers may remember, such thoughts persuaded one correspondent to the "Airmail" column of AIR FORCE Magazine to object to the writer's remark in last year's "Jane's Aerospace Survey" that 1985 had been a good year for Europe's Airbus Industrie. He believed that Airbus was not making money and was simply taking jobs away from Seattle and Long Beach. No doubt he was even more resentful on learning, last October, that one of his national operators, Northwest Airlines, had placed an initial order for ten Airbus A320s for delivery in 1990–91 and might eventually purchase up to 100 of these aircraft at a total cost of $3.2 billion.

It may ease his entirely understandable feelings to know that they were matched by the puzzlement of folk on this side of the Atlantic when their national carrier, British Airways, awarded Boeing a contract for sixteen 747-400s for delivery in 1989–90, with every likelihood of ordering twelve more for delivery in 1991–94. Total value of the deal would then be $4.1 billion, making it the largest single prospective contract that even Boeing had received by the summer of 1986.

With a little careful browsing through *Jane's*, anyone can discover that engine pods for the Boeing 747 and 757 are made by Shorts in Belfast, wings for Shorts' own Model 360 are manufactured by Fokker in the Netherlands, fuselages for Fokker airliners come from Dassault-Breguet in France, wings for Dassault-Breguet's Falcon business jets from CASA in Spain, and so on, all around the world. Such work-sharing helps to reduce employment peaks and troughs. As a result, aerospace people tend to have friends in almost every country that builds aeroplanes—a fact of life that would benefit all mankind if politicians could share it.

International collaboration is creating an ever wider pattern of aerospace activity throughout the world. Korea, Singapore, and Thailand are countries that did not appear in *Jane's* a decade ago, but they must become increasingly important as centers of manufacture in the fastest-growing aviation business area on earth.

The usual process is to begin with servicing, repair, and license assembly, progress to license-manufacture from locally built components, and then to development and production of indigenous designs. China's advance along this path is now leading to interesting designs, like the F-8 II fighter described in the December 1986 "Jane's Supplement" and a four-turboprop flying boat that is illustrated in the Addenda to the 1986–87 edition of our Yearbook.

Promavia of Belgium is a new company with big ideas. After gaining financial support from the state and USAF agreement to provide one of the Garrett F109 turbofans developed for the T-46A program, it commissioned Dott. Ing. Stelio Frati of General Avia, Italy, to design for it a side-by-side two-seat trainer known as the Jet Squalus. This is being offered to USAF as an alternative to the T-46A, which may seem a remote prospect. However, the combination of a Frati design, an engine developed especially for the job to be done, and extremely low initial and operating costs might just appeal to a cash-conscious Congress.

Two other aircraft manufacturing nations have made headline news during 1986, in different ways. For years, de Havilland Canada has been recognized as a world leader in producing aircraft for safe, unhurried STOL transportation. Among countless benefits in every part of the world, it has made feasible a fixed-wing STOLport for London business in the heart of the city's old dockland. The reward for DHC in 1986 was to be put up for sale by its government and acquired by Boeing to fill the bottom end of a range of airliners now extending from twenty to more than 500 seats. This may ensure the continued development of a unique family of small transports. It is, nevertheless, sad that Canada itself could not find the money and enthusiasm to keep this highly innovative company, founded in 1928.

Lightplane Industry Decline

Even more sad is to study what has happened to America's lightplane industry during the past year. Champion Aircraft's family of sporting and utility monoplanes has

disappeared from the pages of *Jane's*. Piper suspended production of most of its piston-engine models in February 1986, then resumed manufacture of the entire line in June and even began studies for new models. By then, however, Beech had abandoned its two- and four-seat Sundowner/Sierra lightplanes, and Cessna had reduced its product range from a once-unrivaled total of more than sixty models and variants to just seven, none of them piston-engined.

There was one well-remembered occasion, in 1932, when this company's listing in *Jane's* occupied only four lines of text under its name and address. In this brief paragraph, the colorful Editor of the time stated that "the Cessna Aircraft Co. has produced a number of cantilever cabin monoplanes of exceptionally clean design, but has presumably succumbed to the depression and the Company is now believed to be inactive." That belief was to prove misplaced by a factor of more than 175,000 aircraft built up to 1986.

It is to be hoped that Cessna will again fight its way back to a prominent position in general aviation manufacturing on the basis of such fine products as its turboprop Caravan I utility transport and turbofan Citation business jets, but this will not be easy. As explained in last year's "Aerospace Survey," product liability insurance now adds an average $92,000 to the price of every Cessna sold in 1986 and $80,000 to every Beechcraft. Cessna's Chairman, Russell Meyer, warned a US Senate subcommittee: "We are on the threshold of seeing an entire industry essentially destroyed because of the uncontrolled impact of the product liability environment, which has lost any reasonable relationship to either negligence, proximate cause, or measurable damages."

Beech Aircraft President James S. Walsh told the same subcommittee of a Beech study that had shown that, of the total amount the company spent each year in defense of its products and in settlement of claims, less than seventeen percent ever reached the hands of anyone injured or the survivors of persons killed in Beech aircraft. The rest of the money went to courts, lawyers, insurance companies, and other parties involved in litigating cases.

Robert J. Wyma of Piper's parent company, Lear Siegler, added that "today, Piper pays more for product liability insurance than it does for labor to build its airplanes, and ours is historically a labor-intensive industry." This matters because so many of the trainers and support aircraft used by air forces come from the general aviation manufacturers that are now under threat.

At such a time, one must admire the courage of small companies like Christen, which has used computer-aided design (CAD) techniques to produce an entirely new tandem two-seat lightplane known as the Husky. Intended as a thoroughly modern successor to the Piper Cub, it is expected to capture part of the market left wide open by the big three. If, as hoped, sales build up to twenty-five Huskies a year, supplementing current annual production of thirty-seven or thirty-eight Pitts Specials, Christen's labor force in Afton, Wyo., could increase from forty-eight to sixty.

Christen's new Husky, a two-seat lightplane. The aircraft is a product from a small company that has made effective use of computer-aided design (CAD) techniques.

Sport Aircraft

Small beer, perhaps, but our business started with just two brothers and a Wright biplane. It has to be said, still, that few people really fly. According to ICAO, the number of passengers who traveled by air on scheduled services during 1985 was 891,000,000. But sitting in an armchair in a pressurized cylinder, eating and drinking and watching a movie, is not flying. The kind of aircraft in which people *really* fly—homebuilts, racing aircraft, microlights, air recreation vehicles, small rotorcraft, and suchlike—have been put together in a new section of the 1986–87 *Jane's* entitled "Sport Aircraft."

A few customers will complain because these "nonprofessional" types fill 202 pages of a 970-page book intended for a highly professional readership. This overlooks the fact that most professionals find the Sport Aircraft pages refreshing, interesting, and valuable. In any case, what would one call a *Jane's* denuded of homebuilts, sailplanes, or even RPVs? *Some of the World's Aircraft? Most of the World's Aircraft?*

It is a sobering thought that if homebuilts had not been permitted space in Fred T. Jane's original 1909 edition of *All the World's Air-Ships*, he would have included only the Short-built Wright biplane, Voisin biplane, and one or two others like the Blériot monoplane, a homebuilt that made the first international airplane flight over water, from

France to England in 1909, and then went on in production form to carry the pioneer UK Coronation airmail in 1911, become the first real aerobatic display aircraft, and perform the first wartime aerial reconnaissance mission for the Royal Flying Corps in 1914.

Burt Rutan's modern homebuilt canards (themselves now casualties of the product liability crisis) clearly influenced designs like the Starship, on which so much of Beech's future well-being may depend. Study of those 202 Sport Aircraft pages in *Jane's* will reveal countless other interesting facts to the careful reader, including little-publicized military applications of certain types—although the best stories can seldom be told.

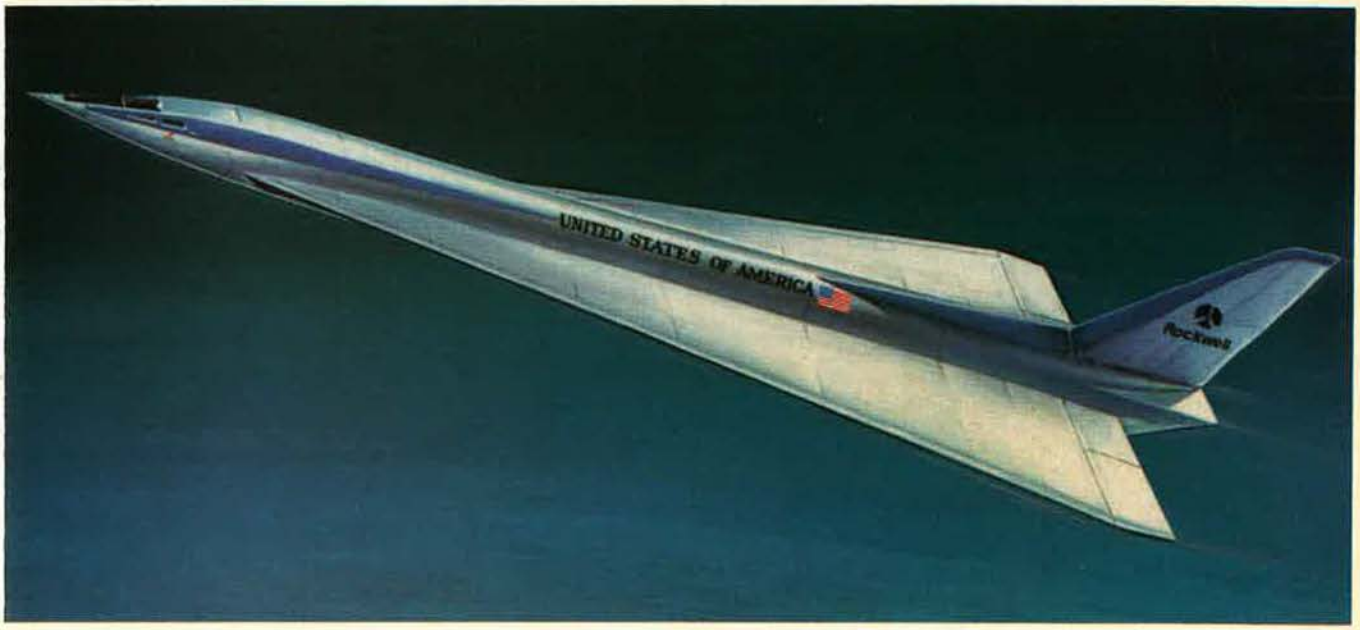
The Space Half

At the other end of the spectrum of sophistication, what can be said that is new about the "space" half of "aerospace"? President Reagan has ordered a new Shuttle Orbiter to replace the tragic *Challenger*. The Soviets are making progress with the task of putting together their orbiting space station, but seem to be displaying less urgency now that America's astronauts are temporarily grounded. The US still expects to have a space station in orbit by the mid-1990s, but it will be less elaborate than what was once planned. The emphasis is switching increasingly to military use of space.

One of the most exciting features to appear in print last year, in AIR FORCE Magazine or anywhere else, was surely James W. Canan's "Mastering the Transatmosphere" in the June 1986 issue. Unless incited to complain, ordinary folk usually feel pride, rather than resentment, when their taxes buy something as world-beating, awe-inspiring, and strangely beautiful as the US National Aerospace Plane. That is why it is quite excusable to paint models of projects like this in "Orient Express" colors rather than make it appear to be a potential transatmospheric orbital weapon carrier, which may be a great deal more likely. As one leading member of US industry commented: "It is still a little early to send grandma to Australia in a ballistic missile."

It is good that NASA Langley had in its wind tunnels in 1986 working models of supersonic ramjets (or scramjets) that might one day propel the National Aerospace Plane. It is equally good that Aérospatiale should be studying for more near-time use a second-generation Concorde to carry 200 passengers for 8,000 km (4,320 nm; 4,970 miles) at Mach 2.2. It was a combination of the Royal Aircraft Establishment's wing expertise and French enthusiasm for a "Super Caravelle" supersonic transport that launched the Concorde program a quarter of a century ago. The 200-seater will cost a great deal of money, but who in the last thousand years would have built a great cathedral, or a bridge, if it had been expected to show a financial profit from day one?

Some things *have* to be done, or civilization grinds to a halt. Continuing to provide supersonic air transportation, for a much wider cross-section of the public, after Concorde has reached retirement age is one of them. ■



Rockwell impression of a National Aerospace Plane (NASP), a hypersonic vehicle able to fly into space straight from an airfield. The program has strong White House backing and is shaping up as one of the most technologically and operationally tantalizing aerospace projects ever undertaken.

John W. R. Taylor has served more than twenty-five years as Editor of the world-renowned Jane's All the World's Aircraft. *A Contributing Editor of* AIR FORCE *Magazine with his bimonthly "Jane's Supplements," he also compiles or edits the galleries of aerospace weapons for both the USAF Almanac and Soviet Aerospace Almanac issues of this magazine. Mr. Taylor was trained as an architect and later worked as an aircraft designer under Hawker's legendary Sydney Camm. He has written more than 200 books and thousands of articles on aviation subjects and is a Fellow of the Royal Aeronautical Society, the Royal Historical Society, and the Society of Licensed Aircraft Engineers and Technologists.*

What's Happening at ASD

NAME AND MISSION	STATUS	CONTRACTOR
Deputy for Aeronautical Equipment (AE)		
Chemical/Biological Defense This program provides Air Force-unique chemical defense equipment, including individual and collective protection, detection, warning, and decontamination equipment/material necessary to conduct sustained combat operations in a chemical warfare environment.	RDT&E and Production	Many
Combat Identification Systems This program acts as the DoD executive agent for combat identification systems and evaluates active and passive identification techniques for application to USAF weapon systems platforms. It is currently developing Mark XV IFF as a secure, antijam, high-reliability, triservice, and NATO-interoperable replacement for the current Mark XII IFF.	Demonstration/Validation	Bendix; Texas Instruments; Veda, Inc.
Modular Automatic Test Equipment (MATE) System MATE is a standardized USAF management system governing procedures, architecture, and hardware and software tools for acquisition of systems employing automatic test equipment (ATE). The objective is to preclude proliferation and reduce the life-cycle cost of system-peculiar ATE.	Continuing	Many
Avionics Subsystems Acquisition of standardized avionics systems for use in several aircraft systems is being undertaken in this effort. Programs include standard and precision inertial navigation units, standard central air data computer, standard ground collision avoidance system, and standard flight data recorder.	RDT&E/Production	Many
Productivity, Reliability, Availability, and Maintainability Program (PRAM) PRAM will increase combat capability while reducing current and potential USAF operations and support costs by (a) improving the reliability, maintainability, and supportability of USAF operational systems, subsystems, and equipments as well as the productivity, effectiveness, and efficiency of USAF maintenance and support organizations; (b) exploiting lower life-cycle cost alternatives in systems configurations through use of current technology components and adaptations of common equipment for multiple requirements and applications; and (c) developing new RDT&E approaches that better accommodate life-cycle cost considerations in system development, such as improved specifications, standards, and testing techniques.	Continuing	Many
Life Support This program provides centralized management to develop life-support equipment and subsystems, such as improved aircrew helmets, flight clothing, and survival equipment, to assure maximum aircrew capability throughout all mission environments, including emergency situations.	Development/Production	Many
ACES II Ejection System ACES II is a standardized, state-of-the-art ejection system for such high-performance aircraft as the A-10, F-15, F-16, and B-1B.	Production	Douglas Aircraft; Weber Aircraft
Common Support Equipment Development and production of equipment to support Air Base Survivability, Base Recovery After Attack, and ground-support equipment capable of supporting several types of aircraft are being undertaken. Current programs include camouflage, concealment and deception, aircraft ground mobility system, portable airfield lighting, ground power generator, large aircraft start system, and universal aircraft towbars.	RDT&E/Production	Many
Advanced Avionics Integrated Communication, Navigation, and Identification Avionics (ICNIA): This effort involves an interdivisional (ASD/ESD) program office that is conducting pre-FSD studies in support of ATF and examining potential for other applications. ICNIA will use modular avionics architecture with hierarchical software design, shared processing, and graceful degradation attributes. It is planned for use of VHSIC technology and line-replaceable modules, aimed at significant increases in R&M with reduction in size and weight.	Continuing	None
Deputy for Airlift & Trainer Systems (AF)		
AC-130U Development of twelve new side-firing gunships to replace the aging, increasingly unsupportable AC-130s currently in the USAF inventory is being undertaken. This program will emphasize substantial improvements in reliability and capability over existing AC-130 gunships. The aircraft will include a highly accurate gun suite, which can be slaved to forward-looking infrared (FLIR), Low-Light-Level Television (LLLTV), or strike radar, allowing for operations at night and/or in adverse weather. ECM equipment will enhance survivability in a low- to medium-threat environment. Although the primary mission for the AC-130U is precision fire support, it will have the flexibility to perform other SOF roles, including escort, surveillance, search, rescue, and armed reconnaissance/interdiction.	Source Selection	To be determined
MC-130H Combat Talon II This program addresses the shortfall in Combat Talon I special operations aircraft by the addition of twenty-one aircraft with integrated avionics, improved navigation accuracy, terrain-following radar, and electronic countermeasures. The aircraft will be assigned to MAC's Special Operations Forces.	Production	IBM; Lockheed-Georgia
C-17A This program will carry out the development and acquisition of the C-17A airlift system for the rapid deployment of today's modern Army from the CONUS directly to overseas areas of conflict and for airlift of outsized cargo over both intertheater and intratheater ranges close to the forward areas. This direct-delivery dimension, combined with an outsized airdrop capability, will significantly enhance airlift support to combat forces in the field and improve the mobility of our general-purpose forces.	Full-Scale Engineering Development	McDonnell Douglas
KC-10A This effort entails the acquisition of an advanced tanker/cargo aircraft possessing both refueling and cargo mission capability to augment the existing KC-135 tanker fleet by providing rapid deployment of tactical aircraft and their support equipment and personnel to any point worldwide. Sixty aircraft are planned; forty-eight had been delivered as of September 1986. All qualification and continuation training for SAC KC-10 aircrews is at three main operating bases.	Production/Deployment and Training	McDonnell Douglas; McDonnell Douglas Training Systems Inc.

NAME AND MISSION	STATUS	CONTRACTOR
:-20A/B ne C-20 will replace the aging C-140B fleet and provide the Special Airlift Mission (SAM) fleet with ntercontinental range and ability to operate from short runways. Two Gulfstream G-III aircraft are also being rocured and modified to Navy requirements under the Air Force C-20 contract. Acquisition of these aircraft, esignated C-20D, was directed by Congress to fulfill the Navy requirement for a low-density transport aircraft r government officials, cargo, and medevac transport capability.	Production/Deployment	Gulfstream Aerospace
:-5B ne acquisition of fifty C-5B aircraft will partially fulfill the immediate need for additional intertheater airlift apability to support national strategy goals and the mobility requirements of a modern-day Army. Delivery nd acceptance by USAF of the first C-5B occurred in December 1985. This aircraft is basically a C-5A with onfiguration changes intended to improve reliability. The C-5B will provide airlift of substantial payloads, ncluding outsize cargo, over intercontinental ranges.	Production/Deployment	Lockheed-Georgia
ir Force One eplacement of the two aging VC-137 Presidential airlift aircraft with two new, wide-body, off-the-shelf, FAA-ertified aircraft will greatly enhance the ability to support the worldwide travel requirements of the President f the United States. The basic 747-200B aircraft will be modified to an executive configuration to include a tate-of-the-art mission communications system.	Production/Modification	Boeing Military Airplane Co. (BMAC)
C-135 Improved Aerial Refueling System (IARS) his program will develop and test new and improved aerial refueling systems and subsystems to improve pon the 1950s technology of the current KC-135 Air Refueling (AR) system.	Development	XAR Industries
-46A evelopment and production of a training aircraft to replace the aging, operationally deficient T-37B are being ndertaken. T-46A system characteristics include fuel-efficient twin F109-GA-100 turbofan engines, a pres-urized cockpit, ACES II ejection system, improved performance, better adverse weather capability, greater ange, and reduced maintenance costs.	Full-Scale Engineering Development/Lot One Production	Fairchild Republic; Garrett
oint Vertical Lift Airlift (JVX) (CV-22A) he CV-22 program will fill the need for an aircraft with increased Special Operations Forces (SOF) capabili-es by using the tilt-rotor design demonstrated on the Bell XV-15 and other advanced technologies. The CV-22 ill have the maneuverability and lift capability of a helicopter and speed of a fixed-wing aircraft. The CV-22 is ntended to complement the SOF HH-53 and MC-130 aircraft.	Full-Scale Engineering Development	Bell-Boeing
irdrop Program he development, test, and production of new, improved airdrop systems in coordination with the Joint echnical Airdrop Group are being carried out in this program. Activities include development and production f the C-130/C-141 Centerline Vertical Restraint System to enhance container delivery system airdrop apability and conduct of system studies of improved airdrop concepts for existing and future aircraft.	Development/Production	Ver-Val Enterprises
-130H Domestic and Foreign Military Sales he C-130H Domestic and Foreign Military Sales Program provides cargo, search and rescue, and tanker ircraft for both US domestic and foreign users.	Production/Deployment	Lockheed-Georgia
-12F/C-21A his program replaces the CT-39 aircraft, acquired in the late 1950s and early 1960s, with 120 off-the-shelf usiness-type jet aircraft. This fleet of 120 aircraft is composed of eighty jet (C-21A) aircraft and forty urboprop (C-12F) aircraft.	Acquisition	Gates Learjet (C-21A); Beech Aircraft (C-12F)
-22B Air National Guard Support Aircraft his program oversees the acquisition, modification, and refurbishment of four commercial Boeing 727 ircraft to be operated by the Air National Guard for use as operational support airlift aircraft.	Modification	Boeing
Deputy for Avionics Control (AX)		
ost-Effective Avionics his effort will (a) ensure cost-effective, supportable, mission-capable avionics; (b) reduce life-cycle cost, ncrease availability and reliability, and improve effectiveness by assisting in insertion of promising technolo-ies into existing and future avionics; (c) reduce and control unnecessary proliferation of avionics by eveloping and advocating the use of architectural and interface standards, such as MIL-STD-1553, -1589, 1750, -1760, -1815, and DOD-STD-1788; and (d) promote rational standardization by using USAF-desig-ated standard and AFSC/AFLC-preferred avionics subsystems in new and modified aircraft avionics base-nes.	Continuing	Systems and Applied Sciences Corp.; Proprietary Software Services; ARINC Research Corp.; The Analytic Sciences Corp.; Oneida Resources, Inc.
Deputy for B-1B (B-1)		
eputy for B-1B argest of ASD programs, with a baselined budget of $20.5 billion (in FY '81 dollars), the B-1B program rovides Strategic Air Command with a new, highly survivable, long-range penetrating heavy bomber. Modernization of this vital leg of the strategic triad allows aging B-52s to move to full-time cruise-missile tandoff roles. The first operational B-1B entered testing at Edwards AFB, Calif., in October 1984. First delivery SAC at Dyess AFB, Tex., was on July 2, 1985, with Initial Operational Capability occurring on September 30, 986. The full complement of 100 B-1Bs will be delivered in 1988.	Development/Production/Deployment	Rockwell International; Boeing Military Airplane Co.; Eaton Corp., AIL Div.; General Electric
Deputy for Engineering (EN)		
vionics Integrity Program (AVIP) he Avionics Integrity Program (AVIP) is an ASD initiative to improve the readiness and life characteristics of vionic products. AVIP is patterned after the Aircraft and Engine Structural Integrity Program (ASIP/ENSIP). wo documents have been developed by AVIP and released for use in avionics development: A standard (MIL-TD-1796) for a management program and a product-specific MIL-PRIME process specification (MIL-v-87244). Ultimately, the suppliers and integrators of avionics will be required to prepare an avionics integrity naster plan (AIMP) that will be submitted as a separate document with any proposal for avionics develop-nent. The AIMP will be evaluated as a major source-selection criterion and be incorporated into the levelopment contract.	Ongoing	None

NAME AND MISSION	STATUS	CONTRACTOR
Senior Engineering Technology Assessment Review (SENTAR) A SENTAR panel has been established as the focal point for review of the AFSC Laboratories' Advanced Technology Development (6.3) programs, including both ongoing efforts and proposed new starts. The panel will assess the objectives of the programs, the technical approach, the potential payoff to aeronautical systems and subsystems, the proposed technology transition criteria, and the readiness of technologies for transition to ASD development and acquisition programs. Panel assessments will place emphasis on focusing new 6.3 programs so as to establish the technology base for applications to future aeronautical weapon systems and equipment developed under the cognizance of ASD.	Ongoing	None
Product Assurance A strong commitment to excellence is reflected in ASD's product assurance activities as well as in its corporate Quality Improvement Strategy. These initiatives also form the basis for ASD's implementation of Air Force-wide R&M 2000 initiatives. The concept of "product assurance" implies a balanced attention to quality, reliability, supportability, producibility, and value in the design of new aeronautical systems. A Product Assurance Engineering Division within the Directorate of Systems Engineering consolidates the specialists from these disciplines. A collocated Lead Product Assurance Engineer assists each SPO's Chief System Engineer in assuring that product assurance is considered in the requirements-setting, source-selection, and design-review processes. Additionally, a "corporate" product assurance office provides overall policy guidance, promotes teamwork across organizational lines, makes independent assessment of specific programs, and administers the system of program health indicators installed to provide in-depth product assurance visibility now demanded by ASD and AFSC commanders.	Ongoing	None
MIL-PRIME Program The MIL-PRIME program is an initiative to enhance the streamlining of the acquisition process by improving the quality of the specifications and standards put on contract. The goal of the program is to eliminate over-specification through the process of tailoring documents to the specific weapon systems needs. This will be done by imposing requirements in terms of performance parameters and limiting the contractual application of documents referenced in specifications and standards. Each MIL-PRIME document consists of a specification or standard that can be tailored to the needs of a specific acquisition situation. An associated handbook contains rationale, guidance, and lessons learned for each requirement and its associated verification. By the end of 1986, more than fifty MIL-PRIME development documents will have been written.	Ongoing	None
Very-High-Speed Integrated Circuits (VHSIC) Exploitation In order to maximize the benefit of developing VHSIC technology, the Deputy for Engineering is making a concerted effort to facilitate early application of available VHSIC parts into the development of new weapon systems. A comprehensive training program is being developed and will familiarize engineers with available VHSIC parts and their capabilities. Every effort will be made to perform the necessary tradeoffs to assure that the tremendous advantages of this new technology can be realized as quickly as possible.	Ongoing	None
Generic Integrated Maintenance and Diagnostics (GIMADS) The purpose of the GIMADS program is to integrate all aspects of an air vehicle's diagnostics capability. The objective is efficient and effective maintenance at reduced cost and increased air vehicle availability. The program includes a systems engineering approach and management process to integrate diagnostics with other aspects of the air vehicle design and mature this diagnostics capability as the air vehicle is developed, tested, and deployed. To provide the technical basis for the many cost-benefit decisions required, GIMADS will investigate new ways of applying emerging technologies to solve many existing and anticipated diagnostic problems.	In source selection	To be determined
Value Engineering This proven program seeks to reduce both acquisition and logistic support costs while maintaining or improving performance. This objective is accomplished by using conventional DoD value-engineering incentive techniques coupled with special emphasis on innovative approaches to insert latest state-of-the-art technology into current production systems. Recently, the Deputy Secretary of Defense has made application of value engineering mandatory on major systems entering first or second production options. Program managers are budgeting one-half of one percent of total procurement authority to fund high-payoff proposals.	Ongoing	None
Air Transportability Engineering The Air Transportability Test Loading Agency (ATTLA) is the Air Force focal point for all requests for all transportability engineering analyses and aircraft test loading as part of the DoD Engineering for Transportability Program. ATTLA provides criteria and guidance to program offices on air transportability matters during all stages of system acquisition and development of equipment. It also analyzes technical data for suitability for airlift certification.	Ongoing	None
Crew Station Design Facility (CSDF) This facility uses full-mission, real-time simulation as a human engineering tool to conduct man-in-the-loop studies to assess crew work load and evaluate cockpit layout and instrumentation. These efforts are in support of ASD program office development efforts. The facility currently consists of an F-16C, an A-10, and a C-135 simulator, each with their associated visual and motion systems. A small cadre of government employees designs and conducts the studies, while contractor personnel operate, maintain, program, and modify the simulators.	Ongoing	Singer-Link
Thermal Management Control (TMC) This is an ASD initiative to achieve better layout of electronic equipment, optimize thermal design, and achieve more efficient use of the airframe environmental control system. TMC is being implemented through required thermal/reliability trade studies, design analyses, and verification tests. These required efforts have been defined and are being incorporated into all new ASD programs. TMC requirements have been included in AVIP and MIL-PRIME documents for avionics and the environmental control system.	Ongoing	None
Aircraft Structural Integrity Program (ASIP) The program is undergoing continued updating to reflect the current programmatic aspects of the system acquisition process. MIL-STD-1530A is being revised in the MIL-PRIME format to be consistent with the general aircraft structures specification, MIL-A-87221. Efforts to expand the applicability of MIL-A-87221 to include design and qualification requirements for advanced materials and design concepts are also continuing.	Ongoing	None
Engine Structural Integrity Program (ENSIP) A draft Air Force regulation covering the implementation of the Engine Structural Integrity Program is currently undergoing review. The key technical and programmatic requirements of ENSIP are being addressed in all ongoing engine development efforts.	Ongoing	None

NAME AND MISSION	STATUS	CONTRACTOR
Electromagnetic Pulse Survivability Military Standardization Program (EMSP) The purpose of this program is to develop specifications and standards for aircraft hardness to electromagnetic pulse (EMP) and also to coordinate technology developments from various USAF hardware and research programs to develop an electromagnetic transient survivability baseline for aircraft systems and subsystems.	Ongoing	None
Deputy for Reconnaissance/Strike and Electronic Warfare (RW)		
Low-Altitude Navigation and Targeting Infrared for Night System (LANTIRN) LANTIRN is an integrated system consisting of navigation pod, targeting pod, and head-up display, which displays forward-looking infrared (FLIR) video. It provides the tactical air forces with the capability to conduct close air support and interdiction missions at night and under adverse weather conditions.	Production	Martin Marietta
Precision Location Strike System (PLSS) PLSS accurately locates and classifies enemy radar emitters and can provide near real-time target location to tactical attack units for precision attacks against all types of enemy air defense systems.	Prototype	Lockheed Missiles & Space Co.
EF-111A Upgrade Program This program focuses on updating the ALQ-99E processing and jamming subsystem of the EF-111A Tactical Jamming System (TJS) to counter radar threats through the 1990s. The primary role of the EF-111A TJS is to screen attack aircraft from radars supporting hostile defensive weapon systems.	Full-Scale Development	Eaton Corp., AIL Div.
Tactical Air Reconnaissance System (TARS) TARS will develop and acquire electro-optical (EO) and infrared sensors, digital recorders, and a reconnaissance management system and data link for use on RF-4C aircraft, unmanned reconnaissance vehicles, and pods for fighter aircraft.	Full-Scale Development	None
Tactical Countermeasures Dispenser Upgrade (AN/ALE-47) The ALE-47 program will provide a dispensing system capable of interfacing with radar warning receivers, jammers, tail warning systems, and other aircraft systems to provide threat adaptive programming of expendables in multiple threat environments.	Full-Scale Development	None
Tactical Reconnaissance System (TRS) Ground Segment The Tactical Reconnaissance System technical concept features an integrated tactical reconnaissance sensor suite (on a TR-1 air vehicle) and a data link, both up and down, for communication of information and data. It prepares exploitation reports in near real time and rapidly disseminates these reports via common user and dedicated communications circuits.	Operational	Ford Aerospace
TRS Side-Looking Airborne Radar/Advanced Synthetic Aperture Radar System (ASARS) ASARS-2 is a high-resolution radar-imaging system designed to be flown on the TR-1 aircraft. It produces high-quality imagery at long standoff ranges in strip-mapping and spotlight modes. Real-time image processing and exploitation is accomplished on the ground through ASARS-deployable processing station (ADPS) and ASARS exploitation cell (AEC) of the TRS Ground Station.	Production	Hughes Aircraft Corp.
Electronic Warfare Area Reprogramming Capability (EW ARC) The EW ARC is a highly interactive man/computer operation that provides the Air Force users the ability to produce validated EW system change packages (mission data) when required. Its purpose is to provide the users the ability to quickly and accurately modify EW systems mission data (threat tables, priorities, setting, etc.) in response to a change in the threat environments.	Full-Scale Development	Teledyne
F-4G Wild Weasel Performance Update Program (PUP) The purpose of the PUP is to maintain the defense suppression capability of the F-4G Wild Weasel into the 1990s through a new signal processor, receiver group, and an increase in frequency coverage.	Full-Scale Development	McDonnell Douglas
Infrared Search and Track System (IRS&T) IRS&T is designed to detect and track distant airborne threats based on thermal signatures. It can be used either independently or as a complement to the radar.	Demonstration & Flight Test	General Electric
ALQ-131(V) ECM Pod Receiver/Processor Component The pod receiver and processor will provide additional threat identification capability for the AN/ALQ-131(V) Block II electronic countermeasures (ECM) pod.	Production	Westinghouse
TR-1 Aircraft The TR-1 is a high-altitude, subsonic, long-endurance aircraft based on the current (1979) U-2 configuration. It is able to perform in any weather under all light conditions and can provide continuous near real-time (NRT) battlefield standoff threat assessment and penetration surveillance and analyses.	Production	Lockheed
Have Charcoal The purpose of this program is to develop improved infrared countermeasure jammers to protect high-value Air Force aircraft from selected infrared-seeking missiles.	Full-Scale Development/Production	None
Technique 101 Subsystem/F/FB-111 Monopulse CM Technique 101 will provide improved electronic countermeasures into the 1990s through demonstration and integration of advanced countermeasures techniques.	Full-Scale Development	Raytheon
USAF Electronic Warfare Evaluation Simulator This facility upgrade will provide the capability in an indoor laboratory environment to simulate numerous radar threats.	Upgrade	General Dynamics
Integrated Electronic Warfare System (INEWS) INEWS is a joint Air Force/Navy program to design, develop, and deploy a next-generation electronic warfare system on combat aircraft of the 1990s. In the current phase, the program will demonstrate maturing technologies that can provide both alert and response functions across the full electromagnetic spectrum. INEWS will be integrated with the avionic subsystems of the Air Force's Advanced Tactical Fighter (ATF) and the Navy's Advanced Tactical Aircraft (ATA).	Demonstration/Validation	TRW/Westinghouse; Sanders/GE
MJU-10/B IR Flare The MJU-10/B flare provides IR antimissile diversionary protection for the F-15 aircraft.	Production	Kilgore Corp.; Tracor
Damage Information Recording System (DIRS) DIRS is a high-resolution, airborne/ground-based sensor system capable of locating, identifying, and classifying airfield damage. It is also able to identify a minimum operating strip (MOS) following a conventional attack.	Full-Scale Development	None

NAME AND MISSION	STATUS	CONTRACTOR
Airborne Self-Protection Jammer (ASPJ) (ALQ-165) F-16 Integration ASPJ Is a joint Navy/Air Force program to develop an internal electronic countermeasures capability for self-protection of tactical aircraft. The system enhances mission success and aircraft survivability when confronted by modern, diversified, radar-controlled weapon systems.	Full-Scale Development	ITT/Westinghouse
Deputy for Tactical Systems (TA)		
Advanced Tactical Fighter (ATF) The ATF program will develop the Air Force's next-generation, air-superiority fighter for operational service starting in the mid-1990s. The ATF concept will be validated during the demonstration/validation phase, starting in FY '87, to include ground-based avionics prototypes and flying prototypes to be known as the YF-22A and YF-23A. The next-generation fighter concept is expected to include advanced propulsion, flight-control, and fire-control technologies; significant avionics integration; advanced system survivability features; "designed-in" supportability characteristics; and superior subsonic and supersonic maneuverability as well as nonafterburning supersonic persistence and a greatly increased combat radius. The program also includes the development/demonstration of two advanced technology fighter engines under the ATF Engine (ATFE) project. The prototypes of these engines are known as the YF119-PW-100 and the YF120-GE-100.	Demonstration/Validation	ATF: To be determined; ATFE: General Electric and Pratt & Whitney
F-15E Dual-Role Fighter This two-seat version of the F-15 will provide capability for long-range, night, and adverse-weather delivery of air-to-ground munitions as well as enhanced air-to-air ability. Primary improvements include advanced cockpit technology, LANTIRN, ring-laser gyro inertial navigation system, digital light control system, conformal fuel tanks, a nine-G airframe, and a configured engine bay capable of accepting either the General Electric F110-GE-100 or Pratt & Whitney F100-PW-220 engine.	Development/Production	McDonnell Douglas Aircraft
F-15 Multi-Staged Improvement Program (MSIP) MSIP provides improvements to ensure F-15 air superiority into the 1990s. Improvements include a Programmable Armament Control Set (PACS), improved (speed, memory, supportability) central computer, MIL-STD-1760 incorporation, improved (speed, memory, ECCM, supportability) radar, and an expanded Tactical Electronic Warfare System (TEWS).	Development/Production	McDonnell Douglas Aircraft
Tactical Electronic Warfare System (TEWS) Intermediate Support System (TISS) TISS will provide the user with a test system capable of supporting the new state-of-the-art TEWS suite (ALR-56C and ALQ-135 bands, 1.5 and 3). TISS will also support the existing TEWS and contains growth provisions for future TEWS updates. Stimulus/measurement capability through 40 GHz and digital testing up to 32 MHz are two examples of the extended capabilities of this full-MATE (Modular Automatic Test Equipment) system.	Development/Production	McDonnell Douglas Aircraft
Mobile Electronic Test Set (METS) METS is an initiative to enhance operational supportability and reduce the acquisition cost of the F-15E Avionic Intermediate Shop (AIS) by adaptation and modification of existing state-of-the-art test equipment currently used to support AV-8B avionics. State-of-the-art features include bubble memory, plasma display, touch panel control, and microcomputer-based architecture that allows the METS and its ancillary equipment to test twenty-two line-replaceable units (LRUs) to be packaged into portable cases (two-person lift). This and other logistics features reduces the airlift requirements by two C-141Bs for the F-15E during deployments.	Full-Scale Development	McDonnell Douglas Aircraft
Air Force Infrared (IR) Maverick (AGM-65D) The AGM-65D is an air-to-ground, launch-and-leave missile that is rocket-propelled and precision-guided by an infrared sensor. This day-and-night, limited-adverse-weather munition is designed primarily to counter armored fighting vehicles and fortified structures.	Procurement	Hughes Aircraft Co.; Raytheon
Navy Infrared (IR) Maverick (AGM-65F) AGM-65F is similar to the Air Force AGM-65D, but with software optimized for use against ship targets, a larger warhead, and delayed fuzing.	Procurement	Hughes Aircraft Co.; Raytheon
Marine Corps Laser Maverick (AGM-65E) This missile shares the delayed fuzing and larger warhead features of the Navy IR missile (AGM-65F), but uses a laser seeker for positive identification of targets in a close air support environment.	Procurement	Hughes Aircraft Co.
F-5E/F Tactical Fighter Aircraft This includes procurement programs primarily for Foreign Military Sales. One effort is currently buying aircraft for Bahrain.	Acquisition	Northrop Corp.
RF-5E Reconnaissance Aircraft This program is carrying out the procurement/development for Saudi Arabia of specially configured RF-5E aircraft, Long-Range Oblique Photography (LOROP) cameras, and Photographic Processing and Interpretation Facilities (PPIF).	Procurement/Development	Northrop/Goodyear Aerospace Corp.
F-20 Tigershark Aircraft A contractor-developed/funded fighter, the F-20 is designed primarily for Foreign Military Sales. One aircraft is currently undergoing extensive flight test at Edwards AFB, Calif., in anticipation of future sales. Foreign and USAF/USN personnel have participated in demonstration flights over the past three years.	Development	Northrop Corp.
Ground Collision Avoidance System (GCAS) GCAS is an in-house-developed, lead-computing, terrain-clearance warning system for use by A-10 aircraft during hard maneuvering close to the ground. This system provides CFIT protection for ± 150° bank angle maneuvers and accelerated dives (semiinverted loaded pulls) as well as steady dives and rising terrain. Production and modification are being managed by Sacramento ALC.	System Refinement and Tactical Environment Testing	Fairchild Republic Co.
Deputy for Development Planning (XR)		
Advanced Fuels for Future Air Force Systems This effort will identify advanced fuels that may be utilized in future Air Force weapon systems.	Preconcept Definition	To be determined
Future Aerospace Electrical Power System New electrical power generation and distribution system concepts for various classes of future Air Force aerospace vehicles/weapon systems are being identified in this study.	Preconcept Definition	To be determined
Aeronautical Applications of HPM Technology This program will prepare ASD for timely and efficient utilization of high-power microwave technology.	Preconcept Definition	To be determined
Development of Nonlinear Radar Concept This program will develop concepts for exploiting the nonlinear part of the generalized radar cross section.	Procurement	Intelligent Signal Processing

NAME AND MISSION	STATUS	CONTRACTOR
ansatmospheric Aeronautical Systems is program will conduct preliminary design synthesis and analysis to identify technology requirements and erational capabilities and to improve understanding of transatmospheric systems for potential future ssion applications.	Preconcept Study	In-house
ir Interdiction Design Analysis is analysis will examine the operational capabilities and design impacts implicit in the consideration of oss-service utilization of future USAF and USN fighter/attack aircraft.	Ongoing	In-house
econnaissance Attack Fighter-Trainer (RAF-T) sign synthesis and analysis tasks examining alternatives and aiding in development of design objectives an advanced Reconnaissance Attack Fighter-Trainer are being conducted in this effort.	Ongoing	In-house
econnaissance-Attack-Fighter Training System is program is developing concepts for an advanced jet pilot training system to train Air Force student pilots re efficiently and effectively for transition from the trainer to the twenty-first century operational fighter-tack-recce aircraft.	Preconcept Definition: Phase I, Study Complete; Phase II, System Concept Study Contract Award 1987	Phase I: Battelle Columbus Laboratories; Phase II: To be determined
reliminary Aircraft Design Technology chniques and methodology to facilitate design analysis of future aeronautical systems leading to improved derstanding and visibility of design alternatives are being developed in this effort.	Ongoing	In-house (Dynamic Engineering Inc.)
ruise Missile Defense Mission Analysis is analysis will examine the need for strategic atmospheric defense and identify and evaluate the effective-ss of aeronautical systems concepts to defend against the post-1995 air-breathing threat.	Preconcept Definition	Battelle; others to be determined
dvanced Tactical Transport Mission Analysis is analysis will develop a comprehensive data base to support MAC preparation of Statement of Operational ed for a next-generation tactical airlifter and to establish the capability to perform continuing analyses as cessary in the mobility mission area.	Preconcept Definition/ Source Selection	Science Applications Int'l Corp.; General Research Corp.; Boeing; McDonnell Douglas; Lockheed
ar-Term Fighter Force Modernization Investigation is investigation will determine how best to maintain the F-15, F-16, A-10, and F-111 as first-line fighters rough the early twenty-first century. This force modernization effort will identify key new technologies and ll develop plans to incorporate these technologies into current tactical aircraft.	Defining Configuration Options	Science Applications Int'l Corp.; General Dynamics; McDonnell Douglas; Fairchild
ilitary Airlift Survivability Study (MASS) ASS will conduct a vulnerability analysis of current airlifters and perform a cost tradeoff study of possible tions to increase survivability against current and future threats. The long-term objective is to develop a data se of "lessons learned" on survivability enhancements to be included in the design of future airlifter aircraft.	Defining Configuration Options	Illinois Institute Technology Research Institution; Subcontractors: Lockheed; Boeing
anguard nguard is the AFSC Development Planning process and methodology that plans for the research, development, and acquisition of future USAF weapon systems. Through analysis, Vanguard identifies deficiencies in e capabilities of current and programmed forces to counter the present and projected threat over a twenty-ar time span. Goals are established to eliminate these deficiencies.	Ongoing	In-house
trategic Offense 21 is program will identify future strategic aeronautical systems and supporting technologies. Key emphasis ll be placed on holding relocatable targets "at risk," countering a reactive threat, and surviving in an tended-conflict scenario.	Preconcept Definition	Systems Research Laboratories; Frontier Technology; Goleta
trategic Penetration Investigation Feasibility Analysis of Penetration Aids is effort will investigate practical means to maximize the ability of strategic aeronautical systems to survive emy defensive actions.	Preconcept Definition	Boeing
emming mming is to investigate a deceptive, active countermeasure against homing guided missiles.	Preconcept Definition	Perceptronics
oost Glide Vehicle (BGV) is program will determine the mission utility and best characteristics for an operational BGV weapon stem.	Preconcept Definition	Systems Research Lab; Frontier Technology Inc.
pecial Operations Aircraft is program is to define survivable system concepts and to determine needed technology developments for special operations vehicle.	Preconcept Definition	To be determined
dvanced Propulsion System (APS) PS will examine potential propulsion system concepts for an advanced turbine engine in the 6,000–12,000-ound thrust class to support a possible new jet trainer and a small tactical aircraft for the year 2000.	Preconcept Definition	To be determined
erial Refueling Tanker Master Plan is effort will establish future aerial refueling requirements and applications, assess current force capability future roles, and develop a comprehensive plan to meet future needs through current force modification and/ new airplane acquisition.	Preconcept Definition	To be determined
actical Air-to-Surface System is program will investigate future tactical air-to-surface weapon systems to perform post-2000 air interdic-on missions. Results will provide advanced tactical aircraft and weapon system concepts delineating stem and operational requirements needed to operate effectively in the projected threat environment.	Preconcept Definition	To be determined
nmanned Atmospheric Reconnaissance and Targeting System e purpose of this effort is to identify applications for unmanned atmospheric vehicles, to analyze mission quirements, and to develop vehicle characteristics necessary to perform identified missions.	Preconcept Definition	To be determined
trategic Nonnuclear Force Projection is program will evaluate current and planned worldwide force-projection missions, define systems needed perform those missions, and recommend alternatives to the current methods to fulfill defined needs.	Preconcept Definition	To be determined

NAME AND MISSION	STATUS	CONTRACTOR
Aeronautical/Space Assets Interface Analysis This analysis will identify opportunities and define concepts to enhance aircraft mission capabilities through a data exchange between aeronautical systems and existing and future space-based systems. The results of this effort will be recommendations and functional requirements for future aeronautical and space system interface concepts with high-potential payoffs. A follow-on effort is planned to develop and refine the most promising system concepts.	Preconcept Definition Ongoing/Follow-on Effort in Planning	Battelle Memorial Institute; others to be determined
Mission/Flight Systems Integration Study This study will develop electronic system concepts and architectures that will provide the basis for integration of new electronic technology to enhance mission effectiveness in the next generation of aeronautical systems.	Preconcept Definition	To be determined
Follow-On Wild Weasel Recommendations for Wild Weasel airframe and configuration for use in the 1990s and beyond are being developed in this program.	Preconcept Definition	McDonnell Douglas; General Dynamics; VERAC
High-Reliability Fighter Concept This program will develop configurations for future tactical fighters with minimum-maintenance and self-sufficiency characteristics. A specific goal is to develop concepts enabling a tactical fighter to operate autonomously and fully mission-capable for 250 flight hours with little or no maintenance.	Preconcept Definition	Northrop; McDonnell Douglas
Embedded Trainer Concept for Tactical Aircraft This effort will define and assess concepts for integrating various training functions with an operational aircraft. In-flight training for air-to-air and air-to-ground engagements, missile employment/defense, and electronic warfare could be accomplished with real-time feedback. Embedded computer-generated threats, targets, and weapons could potentially provide a quantum advance in continuation training.	Preconcept Definition	Quest & Dynamic Research Corp.; Genera Dynamics; McDonnel Douglas Aircraft
Deputy for F-16 (YP)		
F-16 Multimission Fighter The F-16 Fighting Falcon is a single-engine, lightweight, high-performance, multimission fighter capable of performing a broad spectrum of tactical air warfare tasks, including air-to-air and air-to-surface combat. Improvements added through the Multinational Staged Improvement Program (MSIP) will result in F-16C/D models with the capability to employ advanced systems, such as the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system and the Advanced Medium-Range Air-to-Air Missile (AMRAAM). In addition to the US and its F-16 consortium partners (Belgium, the Netherlands, Denmark, and Norway), F-16s have been ordered by Israel, Egypt, South Korea, Pakistan, Venezuela, Turkey, Singapore, Thailand, Greece, and Indonesia.	F-16A/B: Production/ Deployment; F-16C/D: Production/Deployment	General Dynamics (prime); Pratt & Whitney (F100 engine), General Electr (F110 engine); SABC (final assembly—Belgium), Fokker (fina assembly—Netherlands); Fabrique Nationale (Belgium), Kongsberg (Norway), Philips (Netherlands) F100 engine
Deputy for Advanced Technology Bomber (YS)		
Advanced Technology Bomber This program is carrying out the engineering development of an advanced manned penetrating bomber employing low-observables technologies, with an Initial Operating Capability in the early 1990s.	Development	Northrop; Boeing; Vought; General Electric
Deputy for Simulators (YW)		
F-15E Weapons System Trainer (WST)/F-15C/D Operational Flight Trainer (OFT) Ongoing production of the F-15C/D OFTs will result in a total buy of fourteen simulators. Development of the F-15E WST has begun and will lead to production of six F-15E simulators.	Continuing Development	Goodyear
F-16A/C This program involves the procurement of forty-four Operational Flight Trainers (OFTs), fifteen Digital Radar Landmass simulators, thirty-four Electronic Warfare Training devices, and five Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system simulators.	Continuing Development & Acquisition	Many
Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) System Part Task Trainer (PTT) The development and production of PTTs in F-15E and F-16 configuration to train aircrews in LANTIRN switchology, symbology, and modes of operation will be undertaken in this effort.	Planning	To be determined
Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) System Simulator The LANTIRN simulator will be developed to provide a real-time simulation of the LANTIRN pods. It will provide mission training when integrated with the F-16 OFT.	Development	Singer
EF-111A Operational Flight Trainer (OFT) Development and procurement of two OFTs to support EF-111A Tactical Jamming System (TJS) training are being carried out.	Production	AAI
Guided Bomb Unit (GBU-15) Air Ground Missile (AGM-130) A standalone Part Task Trainer (PTT) is being developed to provide training for tactical weapon system officers in GBU/AGM launch and guidance tasks. Three PTTs will be used for the F-4E and one for the F-111.	Development	Honeywell
Generic Infrared Training System (GIRTS) This program will involve the development/procurement (quantity seventy-five) of standalone devices to support imaging infrared training.	Planning	To be determined
B-1B Simulator System (SS) Development/production of a training system is being carried out to meet the training needs of all B-1B crew members. Included are five Weapon System Trainers (WSTs), which simulate all four crew positions, two Mission Trainers (MTs), which simulate only the offensive/defensive positions, and Cockpit Procedures Trainers (CPTs).	Development and Acquisition	Boeing
C-17 Aircrew Training System (ATS) This program will develop and acquire a totally contracted, ground-based Aircrew Training System capable of producing and maintaining fully qualified C-17 aircrews (pilots and loadmasters) and maintenance engine-run personnel. The contractor will operate, maintain, and support all components and guarantee the performance of all aircrew graduates.	Planning	None

NAME AND MISSION	STATUS	CONTRACTOR
-5 Aircrew Training System (ATS) oduction of an aircrew training system is ongoing to meet the training needs of all C-5 crew members. cluded are Weapon System Trainers (WSTs), Cockpit Procedures Trainers (CPTs), and Computer-Aided structions (CAI) that train all four crew positions. The contractor guarantees a trained crew member.	Production	United Airlines Services Corp.
-130 Aircrew Training System (ATS) is program will develop a total aircrew training system for all C-130 courses and will convert to contracted ining.	Planning	To be determined
-5/C-141 Aerial Refueling Part Task Trainer (ARPTT) velopment of one prototype and production of six units that provide fundamental visual, audio, flight-ntrol, and buffet cues necessary for realistic air refueling training are being undertaken.	Continuing Development and Acquisition	Reflectone
C-135 Operational Flight Trainer (OFT) is effort involves the refurbishment of MB-26 CPTs with a digital system and the enhancement with a visual stem that provides peripheral cues for engine-out training. KC-135R and KC-135A configurations will be veloped. There are production options for a total of nineteen OFTs.	Development	Boeing
-52 Offensive Avionics System (OAS) Block II velopment and production of nine B-52 Weapon System Trainer (WST) and four Offensive Station Mission ainer (MT) modification kits are being undertaken.	Ongoing	Singer-Link
-130 Weapon System Trainer (WST) Visual System his program involves the production of nine follow-on units to the highly successful visual systems at Little ock AFB, Ark., and Pope AFB, N. C. Two of these systems are being procured for United States Navy/United ates Marine Corps. Units include integration of C-130 Operational Flight Trainers (OFTs), real-world visual ata base for low-level tactical training, Low-Altitude Parachute Extraction System (LAPES) training, assault nding practice, and night-vision goggle operation.	Production	General Electric
dvanced Tactical Fighter (ATF) his program addresses the Aircrew Training System concept and Front-End Analysis for full-scale develop-ent for the next-generation manned tactical fighter aircraft.	Planning	None
ir Defense Aircraft (ADA) he procurement of an Air Defense Aircraft Training System will be carried out to supply both initial and long-rm training for air defense aircrews.	Planning	None
imulator Development Activity Project 2325) his effort involves the engineering development of aircrew flight simulator technology and investigation of aining issues to satisfy current training requirements.	Ongoing	Many
tandard DoD Simulator Digital Data Base/Common Transformation Program Project 2851) his joint development project was initiated through the Joint Logistics Commanders to develop a standard mulator cartographic data base and common transformation programs.	Preacquisition	To be determined
lodular Simulator Design Program (Project 2968) his is an ongoing research project that will explore ways to take advantage of microcomputers and high-peed data communications in modular flight simulators.	Preacquisition	To be determined
da Simulator Validation Program (Project 3147) his program will develop design and cost metrics for future simulator acquisitions using the Ada higher-order nguage.	Ongoing	Boeing MAC/Burtek
anker-Transport-Bomber Trainer (TTB) his effort will result in the procurement of twenty-six Operational Flight Trainers (OFTs) using already existing, f-the-shelf capabilities to allow initial and continuation training of TTB crews.	Planning	To be determined
-141 Aircrew Training System (ATS) he purpose of this program is to develop a total Aircrew Training System for all C-141 courses that will be onverted to contracted training. The contractor will guarantee a trained crew member.	Planning	To be determined
astle Combat Crew Training System (CCTS) Modernization his effort will implement training enhancements at Castle AFB, Calif. Included are new navigator trainers, omputer Based Training (CBT), selected contractor instruction, and Contractor Logistics Support (CLS).	Planning	To be determined
pecial Operations Forces (SOF) Aircrew Training System (ATS) total Aircrew Training System for MC-130H and AC-130U crew members will be developed. The contractor ill guarantee a trained crew member.	Planning	To be determined
V-22 Aircrew Training System (ATS) his program will develop a total Aircrew Training System for Air Force-unique CV-22A mission training. The ontractor will guarantee a mission-qualified crew member.	Planning	To be determined
Deputy for Strategic Systems (YY)		
hort-Range Attack Missile (SRAM) II his program is to accomplish the development and manufacture of a Short-Range Attack Missile to augment nd ultimately replace the AGM-69A SRAM A. The SRAM II will have greater range, improved lethality, and etter reliability and maintainability.	Pre-Full-Scale Development Activity (Competitive Proposal Phase)	To be determined
trategic Mission Data Preparation System (SMDPS) Phase II Software his software development will upgrade and expand existing B-52 automated flight-plan-generation capabili-es to include B-1 and B-52 OAS Block II and CSRL.	Deployment	Boeing Military Airplane Co.
GM-86B Air-Launched Cruise Missile (ALCM) his program entails the acquisition of the ALCM, including development and production of performance nprovements and integration with the CSRL *(see below)* and B-1.	Deployment	Boeing Aerospace Co.
round-Launched Cruise Missile (GLCM) ocurement of the Ground-Launched Cruise Missile weapon system is ongoing to perform the theater nuclear ission. GLCM will enhance deterrence by increasing nonstrategic nuclear capability, improving survivabili-through mobility, and increasing flexibility in the employment of dual-capability aircraft.	Production	General Dynamics/ Convair Div.; McDonnell Douglas Astronautics Co.

NAME AND MISSION	STATUS	CONTRACTOR
Common Strategic Rotary Launcher (CSRL) CSRL is a rotary launcher for internal carriage of weapons on the B-52H and the B-1B. The CSRL development program will develop a multipurpose launcher that is capable of uniform or mixed weapons payloads and that can accommodate current and projected cruise missiles, short-range attack missiles, and gravity weapons.	Full-Scale Development/Production	Boeing Military Airplane Co.
ALQ-172 Electronics Countermeasures (ECM) Set This program involves major modification of the ALQ-117 ECM set on B-52H aircraft to provide an ECM defense against agile and monopulse surface-to-air-missile and advanced interceptor threats.	Production	ITT Avionics Div.
OAS Block II Software This effort involves a software program that optimizes the B-52's capability to meet increased weapon system requirements. Block II will increase present capabilities and allow the addition of the new Strategic Radar, the Common Strategic Rotary Launcher, and future weapon systems intended for integration on the B-52.	Full-Scale Development	Boeing Military Airplane Co.
Attack Radar Set (ARS) This program upgrades the reliability, maintainability, and supportability of the F/FB-111 Attack Radar Set, correcting the current decreasing trend in the availability of the attack radar.	Full-Scale Development/Production	General Electric Co.
Terrain-Following Radar (TFR) This program upgrades the reliability, maintainability, and supportability of the F/FB-111 Terrain-Following Radar and will increase the Mean-Time-Between-Failures (MTBF) of the TFRs.	Full-Scale Development/Production	Texas Instruments
Digital Flight Control System (DFCS) Replacements for the electronic portion of the F/FB/EF-111 flight-control system will be acquired to correct safety deficiencies and improve reliability and maintainability. The development effort is scheduled for contract start in FY '87.	Full-Scale Development	To be determined
Deputy for Propulsion (YZ)		
F101-GE-102 Engine for the B-1B This effort involves the development and acquisition of the F101-GE-102 engine for the B-1B bomber. This engine shares a common core with the F110 fighter engine.	Production	General Electric
F110-GE-100 Engine for the F-15 and F-16 Development and acquisition of the F110-GE-100 engine for the Alternate Fighter Engine (AFE) program are being carried out. This engine will be installed in new F-16C/D aircraft and potentially in new F-15Es. Production procurements will be competed each year with the P&W F100-PW-220 for a share of the F-15/F-16 market.	Production	General Electric
F100-PW-220 Engine for the F-15 and F-16 This is an evolutionary program to improve F100 durability and operability for the Alternate Fighter Engine competition. Increased durability to 4,000 TAC cycles or nine years' operation is accomplished through the improved life core. Operability improvements gained from the digital electronic engine control (DEEC) provide the -220 with unrestricted throttle movement throughout the flight envelope. The -220 is in production for incorporation into the F-15C/D/E and F-16C/D.	Production	Pratt & Whitney
F109-GA-100 Engine for the T-46A This effort is to acquire the F109-GA-100 turbofan engine to power USAF's T-46A next-generation trainer aircraft. This engine has both reduced fuel consumption and low noise level.	Full-Scale Development	Garrett
F100 EMD/IPE (Engine Model Derivative/Increased Performance Engine) for the F-15 and F-16 Improved performance versions of existing fighter engines will be required to improve F-15 and F-16 system capability into the 1990s. The F100 EMD program is demonstrating an increased-performance version of the Pratt & Whitney F100 engine. Follow-on full-scale development of a derivative F100 engine is in progress.	Advanced Development/Full-Scale Development	Pratt & Whitney
F110 IPE for the F-15 and F-16 The F110 IPE will demonstrate an increased performance version of the F110-GE-100. This engine will compete with the F100 IPE for F-15 and F-16 aircraft through the late '80s and early '90s.	Advanced Development	General Electric
F119-PW-100 and F120-GE-100 for the Advanced Tactical Fighter (ATF) Currently in the demonstration and validation phase, this program is developing two new, state-of-the-art engines. The basic engine concepts and technologies are being demonstrated in a ground-test effort. Flight-quality prototype engines are being developed to power the prototype ATF aircraft competitors (YF-22 and YF-23) during flight testing in Fiscal Year 1990.	Advanced Development	General Electric; Pratt & Whitney
T406-AD-400 Engine for the CV-22A (JVX) The purpose of this program is the acquisition of the 6,000-shaft-horsepower Allison T406 engine (triservice program) for the Joint Services V-22 multimission VTOL aircraft. The USAF version of the JVX, designated CV-22A, is intended to support Special Operation Forces (SOF) in the 1990s and beyond.	Full-Scale Development	Allison
F112 Engine for the Advanced Cruise Missile This is a small turbofan engine for an advanced cruise missile.	Ongoing	Williams International
FJ44 Engine An altitude demonstration of the FJ44 engine is being conducted at Arnold Engineering Development Center. This engine could be considered for future applications in the 1,300–1,800-pound-thrust class.	Demonstration	Williams International
Engine Component Improvement Program This program provides continuing engineering support for all air-breathing engines used in manned aircraft in the Air Force inventory. This effort is directed toward correcting safety of flight conditions, improving durability/reliability/maintainability, developing repair procedures, and reducing the life-cycle cost of engines. Twenty-one families of engines are currently being supported.	Continuing	All major engine contractors
Automated Ground Engine Test Set (AGETS) AGETS is diagnostic ground-support equipment being developed and procured for the F100-PW-100 and F100-PW-200 engines. It is a computer-aided integrated test system that automatically acquires measurement data during F100 engine operation. This data is used to perform engine control system trim adjustments and identify and isolate faulty engine components. AGETS will reduce trim time and fuel usage by about fifty percent and greatly enhance engine diagnostic capability.	Production	Pratt & Whitney
Propulsion Technology Modernization (Tech Mod) Tech Mod advances and implements state-of-the-art technology into manufacturing systems. It increases productivity and efficiency, thereby reducing acquisition cost. Tech Mod advances all manufacturing activities, specifically focusing on test, assembly, heat treatment, coatings, conventional and nonconventional	Ongoing	General Electric; Pratt & Whitney; Garrett Turbine Engine Co.; Wil-

NAME AND MISSION	STATUS	CONTRACTOR
achining, tooling, materials handling, manufacturing and management information systems, and advanced ging, castings, and bearings.		liams International; Teledyne CAE
117-PW-100 (PW2037) Engine for the C-17 iis program will acquire the commercial PW2037 turbofan engine to power the C-17A aircraft. This fuel-icient engine provides 37,600 pounds of thrust.	Development	Pratt & Whitney
103-GE-102 Engine for Air Force One igine management support is being provided for the procurement of the commercial General Electric F6-80C2B1 engine, which will power the new, wide-body Boeing 747-200B Air Force One aircraft.	Procurement/Deployment	General Electric
113-RR-100 Engine for the C-20A iis effort provides engine management support for procurement of the commercial Rolls-Royce Spey 511-8 igine. This engine is being used to power the C-20A Special Airlift Mission aircraft (C-SAM).	Procurement/Deployment	Rolls-Royce
T6A-42 Engine for the C-12F igine management support is being provided for procurement of the commercial Pratt & Whitney PT6A-42 rboprop engine. This engine is being used to power the C-12F Operational Support Aircraft (OSA).	Procurement/Deployment	Pratt & Whitney
FE-731-2A Engine for the C-21A igine management support is being undertaken for procurement of the commercial Garrett TFE-731-2A rbofan engine. This engine is being used to power the C-21A Operational Support Aircraft (OSA).	Procurement/Deployment	GTEC
T8D-7B Engine for the C-22 iis program provides engine management support for the procurement of the commercial Pratt & Whitney T8D-7B turbofan engine. This engine is being used to power the C-22 Air National Guard Support Aircraft.	Procurement/Deployment	Pratt & Whitney
F39-GE-1C Engine for the C-5B ie TF39-GE-1C engine has reentered production after more than ten years and is used to power the C-5B rcraft. This high-bypass turbofan provides 41,100 pounds of thrust.	Acquisition/Operational	General Electric
Air Force Wright Aeronautical Laboratories (AFWAL) Avionics Laboratory (AA)		
ery-High-Speed Integrated Circuits (VHSIC) iis is a joint triservice program to develop two new generations of silicon integrated-circuit technology and ovide MIL-STD-qualified chips, brassboard modules, pilot production lines, computer-aided design tools, id initial system brassboard demonstrations for insertion into DoD systems. This work will extend the US tegrated circuit capability by one to two orders of magnitude in density and throughput while incorporating e latest built-in-test circuits for high-performance, compact, reliable, maintainable electronic systems.	Phase 1: In Qualification Phase 2: In Development	Phase 1: Honeywell, Hughes, IBM, TI, TRW, and Westinghouse Phase 2: Honeywell, IBM, and TRW
ave Pillar ie purpose of the Pave Pillar program is to design and demonstrate the next-generation integrated avionics stem architecture that will enable significant improvements in availability, cost of ownership, and mission fectiveness while reducing the requirements for avionics intermediate shops. The advanced fault-tolerant chitecture will accomplish this objective using common modules, fusion algorithms, and such advanced liable technologies as VHSIC and fiber optics.	Design	Boeing; General Dynamics; Grumman; Lockheed; McDonnell Douglas; Northrop; Rockwell
HSIC 1750A Computer iis is an expandable, modular computer system consisting of a MIL-STD-1750A processor module, bulk emory module, external input/output module, and support equipment module. It is classified as a VHSIC sertion program to develop computer building-block modules. Advantages over current very-large-scale tegrated circuit technology, besides the expandable, modular architecture, include two to four times roughput improvement, greater environmental operational capabilities, significantly reduced size, and eater reliability.	Development	TRW; Westinghouse
ommon Signal Processor (CSP) iis is a development program for a modular, high-performance, reliable, VHSIC-based, digital signal ocessor for next-generation avionics. It can be configured and programmed to satisfy a wide range of plications, such as radar, communications, electronic warfare, and electro-optical systems.	Development	IBM
dvanced Target Acquisition Sensor (ATAS) ie objective of this program is to develop and demonstrate second-generation forward-looking infrared nsor technology for targeting and reconnaissance applications. The capability being developed will be a ajor improvement over current operational systems.	Development	Hughes Aircraft
ltra-Reliable Radar (URR) ie URR program will demonstrate an advanced airborne radar with a mean-time-between-critical-failures MTBCF) rate that is an order of magnitude greater than that of current radars. The development model radar ill utilize advanced technologies, such as electronically scanned active element arrays, VHSIC-based mmon signal processing, and Pave Pillar-compatible fault-tolerant architectures.	Development	Westinghouse
ntegrated Communication Navigation Identification Avionics (ICNIA) ie objective of this triservice program is to demonstrate that multiple existing and planned near-term mmunication, navigation, and identification functions in the 2 MHz to 5 GHz frequency band can be tegrated into one airborne radio system for use in tactical aircraft and helicopters. The fault-tolerant, odular architecture will utilize advanced technologies, such as VHSIC, and extensive software programability to greatly increase reliability and operational availability while significantly reducing weight, size, id cost in comparison with discrete systems.	Development	TRW
ntegrated Inertial Reference Assembly (IIRA) iis program will improve the system functional reliability through the development of a multifunction inertial ference system capable of satisfying the performance and survivability requirements of navigation, flight ntrol, and weapon delivery. The development system will utilize strapdown ring-laser gyros and VHSIC-ased MIL-STD-1750A processor modules and a fault-tolerant architecture to increase greatly mean-time-etween-mission failures.	Source Selection	To be determined
ir-to-Air Attack Management iis program will demonstrate, via man-in-the-loop simulation, improved survivability and lethality of single-at fighter aircraft in a multitarget air-to-air combat scenario. These objectives will be met by increased pilot tuation awareness and controlled work load that will be provided by innovative control and display chnology integrated with advanced fire-control algorithms.	Definition	To be determined

NAME AND MISSION	STATUS	CONTRACTOR
Coronet Prince Prototype This program will package existing countermeasure technology into an aircraft pod and demonstrate its effectiveness against ground-based optical/electro-optical tracking systems. The prototype pod will be suitable for use on high-performance tactical and special-purpose aircraft. Its performance during aircraft maneuvers and its effect on aircraft operation will be evaluated to establish a baseline design for a full-scale development program.	Design	Westinghouse Electric Corp.
Silent Attack Warning System (SAWS) This advanced development program will provide hardware to demonstrate a state-of-the-art infrared detection system for missile and aircraft warning. Key to this new development is improvement in the false alarm rate and detection probability over earlier IR threat-warning systems.	Design	General Electric; Honeywell; Texas Instruments
Cruise Missile Advanced Guidance (CMAG) This program is to develop and demonstrate advanced missile guidance technology capable of providing precision autonomous terminal guidance for standoff missiles. Guidance concepts may employ CO_2 laser radar measurements and pattern recognition to provide midcourse guidance to high-value fixed and mobile targets.	Development	General Dynamics; McDonnell Douglas
Panoramic Cockpit Control and Display System (PCCADS) This program will demonstrate the technology to automate and simplify many of the display and control functions for fighter aircraft. This new approach will use essentially the entire fighter cockpit instrument panel as an electronically controlled display.	Development	McDonnell Douglas
Survivable Penetration and Attack This program is to develop the techniques and functional software to provide for an integrated offensive and defensive avionics system for survivable penetration and (air-to-ground) target attack. Program emphasis includes multiple sensor blending, pilot-in-the-loop simulation, covertness, adaptive mission tailoring, and full sortie capability with the goal of improving survivability and mission success.	RFP Preparation	To be determined
Embedded Computer Resources Support Improvement Program This program will develop and demonstrate software supportability technologies to be incorporated into the software support capability at the ALCs. An extendable, modular, and flexible prototype of a next-generation support capability will be developed to provide the software support tools and environment required for the rapid turnaround of mission critical computer software.	Development	To be determined
Advanced Graphics Avionics Display System (AGADS) The AGADS program will develop a brassboard prototype graphics generator capable of supporting advanced pictorial display formats. Emphasis will be on generation of three simultaneous color raster scenes in real time and within a specified volume constraint. Demonstration of AGADS will include a flight-management algorithm, terrain/cultural data bases, threat data, and randomly generated "pop-up" threats.	Development	Lear Siegler, Inc.
EW Reliability Improvement Program This task will demonstrate the ability to increase mean time between failures (MTBF) of candidate EW subsystems by one to two orders of magnitude. Approach is to freeze technical system parameters (*e.g.*, bandwidth, gain, power output, spurious signal levels) and focus attention on "weak sister" component improvement in subsystems.	Development	TRW, Electronic Systems Group; Northrop, Defense Systems Div.; Westinghouse, Defense & Electronic Center
Interactive Ada Workstation The Interactive Ada Workstation seeks to improve Ada programmer productivity by at least one order of magnitude through the use of symbol-processing hardware with large primary and secondary memory space, incremental compilation evaluation of Ada code fragments, multiple graphic representations of Ada source code, a Smart Librarian to help create reusable designs/code, and an intelligent help system.	Development	General Electric
High Power Countermeasures This program is to define, develop, and flight-test an improved standoff jamming capability that permits operation of jammer in sanctuary. The system will provide very high effective radiated power and electronically-steered, fast-switching, narrow-beamwidth, multiple-beam jamming.	Definition	Raytheon Co.; ESD
Flight Dynamics Laboratory (FI)		
Advanced Fighter Technology Integration (AFTI/F-16) The AFTI/F-16 research program objective is to develop, integrate, and flight-validate technologies that will improve the lethality and survivability of future advanced military fighters. Technologies include a digital flight-control system, an automated maneuvering attack system with redundant ground/aerial target-collision avoidance, G-induced loss-of-consciousness recovery system, conformal IR sensor/tracker, digital terrain management and display system with autonavigation function, automatic real-time weapon fuzing, voice interactive avionics, and a helmet sight.	In Flight Test	General Dynamics
X-29 Advanced Technology Demonstrator The X-29 research program objective is to develop, integrate, and flight-validate advanced aerodynamic, structural, and flight-control technologies of a forward-sweptwing aircraft that can provide new design options for future military and commercial aircraft. Technologies include an aeroelastically tailored forward-swept-wing using composite wing box covers, discrete variable camber, relaxed static stability, and digital flight controls with full-authority, close-coupled canards and three-surface pitch control.	In Flight Test	Grumman Aerospace
STOL and Maneuver Technology The program objective is to develop, integrate, and flight-test advanced technologies to provide a short-takeoff-and-landing (STOL) capability for supersonic fighters while enhancing cruise performance and maneuverability. An F-15 fighter will be modified with a two-dimensional thrust vectoring/reversing exhaust nozzle, an integrated flight/propulsion control with STOL displays/controls, and a rough-field landing gear. It will be tested to demonstrate routine and effective operation from a battle-damaged/repaired runway at night and under weather and enhanced maneuverability throughout the flight envelope.	Aircraft Modification	McDonnell Aircraft
AFTI/F-111 Mission Adaptive Wing The AFTI/F-111 research program objective is to develop and flight-test a smooth-skin variable-camber wing system that will increase range, maneuverability, and survivability for tactical and strategic missions by using automatic wing configuration control to maintain peak aerodynamic efficiency. The approach is to modify the TACT F-111 aircraft wing with smooth-skin variable-camber mechanisms that are operated by a newly developed digital computer control system.	In Flight Test	Boeing

NAME AND MISSION	STATUS	CONTRACTOR
ariable Stability In-Flight Simulator Test Aircraft (VISTA/F-16) ıe VISTA program will design, build, and flight-test a new, high-performance, in-flight simulator to replace ıe NT-33. VISTA features will include a variable stability flight-control system, direct force generators in all ıree axes, and fully programmable controls and displays in the evaluation cockpit. The completed VISTA ircraft will be used for (1) pre-first-flight analysis and familiarization; (2) research in flying qualities, displays, nd flight control; and (3) test pilot training.	RFP Preparation	To be determined
daptive Flutter Suppression Flight Demonstration ıe objectives of this program are to develop and flight-demonstrate an adaptive flutter suppression system. ıch a system will eliminate the need to restrict with flutter placards the operational envelopes of fighter rcraft carrying external stores. The adaptive concepts incorporated into the active feedback system will ıtomatically adjust to changes in flight condition, fuel loading, and store configuration and to the structural ynamic differences among aircraft of the same model.	RFP Preparation	To be determined
ıtegrated Control and Avionics for Air Superiority (ICAAS) ıe ICAAS program will develop and demonstrate key control and avionics technologies that will enable ıperating fighter aircraft to engage and defeat multiple airborne threats. The design approach will stress nctional integration of target sensors, fire control, weapons, and interface with the pilot. Significant ıprovements in beyond-visual-range attack and pilot situation awareness are expected compared to current stems. Demonstration will include piloted simulation and flight test.	Final RFP Preparation	To be determined
Materials Laboratory (ML)		
omputer Integrated Manufacturing (CIM) ɔmputer Integrated Manufacturing (CIM) is a major initiative that will demonstrate massive cost and span-ne reductions through improved integration of all manufacturing functions, on and off the factory floor. In ddition to information management technologies programs, three different large-scale fabrication demon-ration programs are in progress: Integrated Sheet Metal Center (ISMC), Advanced Machining System (AMS), ıd Integrated Composites Center (ICC). This initiative is currently being broadened to address aircraft ssembly procedures.	Manufacturing Technology	Boeing Military Airplane Co.; General Dynamics Corp.; McDonnell Douglas Corp.
omposite Materials Research and Development wide variety of important new composite materials systems (fiber-reinforced organic resins) is under evelopment to exploit their unique performance attributes for Air Force aircraft, spacecraft, tactical missiles, uise missiles, and long-range strategic missiles. New composite concepts, such as molecular composites, e being explored. A highly integrated approach is being pursued in these developmental efforts. For each ɔmposite materials system, R&D is being performed on fibers, matrix materials, fiber/matrix interfaces, echanics of fiber/matrix interaction, processing, quality control, and environmental effects.	Research & Exploratory Development	McDonnell Douglas Corp.; Boeing Co.; Lockheed; University of Dayton Research Institute; other numerous universities, small businesses, and aerospace companies
dvanced Powder Metallurgy Structural Alloys apid progress is being made in the laboratory's comprehensive powder aluminum, titanium, and magnesium ructural alloy R&D program. It is structured to maximize the recent advances in rapid solidification chnology that have opened up major new alloying possibilities heretofore impossible. This program couples search, exploratory development, and advanced manufacturing technology contractual efforts with a strong -house research effort in characterization and processing to create and put into production superior uminum alloys having improved strength, corrosion resistance, and use to 900°F.; new low-density, high-rength titanium alloys with use to 1,800°F. operating capability; and corrosion-resistant magnesium base loys.	Research Exploratory Development Manufacturing Technology	Lockheed; Rockwell Science Center; General Electric; University of Virginia Pratt & Whitney; Lockheed-Calac; Boeing Co. Alcoa; Northrop
aAs Research and Manufacturing Technology ɔgressive exploratory development programs are under way to improve the yield and establish the optimum ɔcesses for growing high-quality GaAs crystals for microwave devices for satellite communications, space-ased and airborne active array radars, electronic countermeasures, and missile seekers. The manufacturing chnology program addresses generic manufacturing issues and demonstrates new techniques for low-cost ɔcessing to make higher-performance and more reliable GaAs devices.	Research Exploratory Development Manufacturing Technology Procurement	Cominco; Mass. Institute of Technology; General Telephone and Electronics Texas Instruments; Rockwell International; Stanford University Westinghouse
aser Hardened Materials—Tactical Subsystems Hardening search and advanced development are being conducted to provide technology to systems designers and velopers for laser protection of tactical systems and their optical and electro-optical subsystems. The thodology includes studying the system mission, establishing hardening requirements, developing tech-ology options, and assessing payoffs and penalties through comprehensive testing of actual hardware or mparable brassboards. Efforts are also directed toward new methods for preventing laser radiation damage personnel and optical components.	Advanced Development	Martin Marietta Corp.; Texas Instruments, Inc.; McDonnell Douglas Corp.
anufacturing Technology for Advanced Propulsion Materials new manufacturing technology initiative has been undertaken to provide production capabilities for engine mponents incorporating advanced materials systems that significantly improve engine performance. anufacturing methods are to be established for titanium and superalloy integrally bladed rotor (IBR) signs; superalloy fabricated turbine blade and vane designs; titanium aluminide cases, rings, and vanes; aphite polyimide composite fan airfoils and front frames; and carbon-carbon composite liners and nozzles.	Manufacturing Technology	General Electric; Pratt & Whitney
omposites Supportability ıe Increased application of advanced composites in USAF systems has led to the establishment, within the aterials Laboratory, of an activity responsible for the overall program in composites supportability. A variety programs is now under way to increase the in-house composites engineering expertise in advanced mposite materials technology relating to supportability. In addition, a series of contractual exploratory velopment programs to solve user composites supportability issues is now under way. These contractual &D programs will address the technologies of composite inspection, repair (materials, processes, and uipment), post-failure analyses, paint removal, impact-damage protection, and low-energy curing resins d adhesives. The program includes composite supportability issues at the depot, field, and base levels and	Exploratory Development	Northrop; General Dynamics; Boeing; Southwest Research Institute; Iowa State University; other universities, small businesses, and aerospace companies

NAME AND MISSION	STATUS	CONTRACTOR
the establishment of technology and materials data bases for the required activities at each level. The program will include presently used materials (graphite/epoxies) as well as materials of the future, including structural thermoplastics, BMIs, and polyimides. The objectives of the program are to have the technology in place to support the increasing applications of advanced composite materials before these materials, in the form of primary and secondary structures on weapon systems, find their way into the inventory in large quantities.		
Aircraft Composite Structure Manufacturing Manufacturing technology activities are being pursued to provide primary advanced composite structures for large aircraft to improve operational efficiency and to automate shop-floor production of composite components. The objectives are to establish and validate manufacturing technology for large aircraft composite wing and fuselage structures in order to produce these structures at a reasonable and predictable cost and to decrease cost and increase quality for fighter-type aircraft. For these applications, automated fabrication methods are being emphasized. The established targets (vs. conventional aluminum structures) for reduced part count and lower manufacturing cost and weight will be verified in the planned component demonstrations.	Manufacturing Technology	Rockwell International; Boeing Co.
Failure Analysis Structural and electronic failure analyses of aerospace components and ground support equipment are an integral part of ensuring maximum useful life of military hardware. Laboratory investigations incorporating the use of sophisticated light and electron optics, microelemental analysis, and Auger and ion-scattering spectroscopy are performed to determine failure modes. Research is conducted to develop new failure-analysis techniques and methodologies for such advanced materials and devices as structural composites and integrated circuits. The issuance of recommendations for corrective actions to preclude repetitive failure occurrences provides vital information to the using organizations and is critical to maintaining safety of flight posture and fleet readiness of systems.	Exploratory Development	University of Dayton Research Institute; Technical Services Group; Boeing Co.; Northrop
Aero Propulsion Laboratory (PO)		
High-Performance Turbine Engine Technologies (HPTET) Initiative This initiative focuses resources and generates programs necessary to demonstrate a revolutionary advancement in turbine-engine technology through the 1990s. This is an integrated program between the Aero Propulsion Laboratory and the Materials Laboratory of AFWAL to ensure that individually developed materials and component technologies are compatible with the overall objective of a 100 percent engine technology improvement (*e.g.*, thrust to weight) over the Advanced Tactical Fighter engines' technology level.	Exploratory Development	Allison Gas Turbine Div., GMC; Garrett Turbine Engine Co.; General Electric Co.; Pratt & Whitney; Teledyne CAE; Williams International
Joint Technology Demonstrator Engine (JTDE) A complete technology demonstrator engine sponsored by the Navy and Air Force Aircraft Propulsion Subsystem Integration (APSI) program, these experimental engines consist of advanced high-pressure core components from the Advanced Turbine Engine Gas Generator (ATEGG) program combined with advanced low-pressure and adaptive components.	Advanced Development	Garrett Turbine Engine Co.; General Electric Co.; Pratt & Whitney Aircraft; Teledyne CAE
High-Speed Propulsion This is a group of related technology programs aimed at rapidly developing an Air Force capability for high-speed flight, including turboramjet engines for Mach 5 interceptors, hydrogen-fueled engines for hypersonic cruise vehicles or space boosters, and new engine options for high-speed missiles. One of the approaches being pursued is a supersonic combustion ramjet engine (scramjet). The scramjet can operate to speeds higher than those of any other air-breathing engine.	Exploratory Development	Many
Spacecraft Power This program is to provide evolutionary and revolutionary improvements in spacecraft power systems while achieving significant reductions in weight and volume, accompanied by increased survivability. Advances are made through higher-efficiency solar cells, solar concentrator and planar arrays, high-energy-density rechargeable batteries, nuclear power thermal management systems, dynamic and thermionic energy-conversion devices, power conditioning components, and electrical energy storage concepts.	Research/Exploratory & Advanced Development	Many
Solid-Fuel Ramjet Propulsion This is a technology program to improve performance and demonstrate tactical acceptance of hydrocarbon-fuel engines and to develop and demonstrate boron fuels in a solid-fuel ramjet engine. This involves environmental testing of established engines with both previously tested and advanced hydrocarbon fuels, development of both intermetallic and metallized boron fuels, and demonstration of these fuels in a full-size, flight-type engine. Since the solid-fuel ramjet is extremely rugged and conceptually is the simplest and least costly of all ramjet types, these technologies are directed primarily toward tactical applications. However, as boron fuels become established, solid-fuel ramjet technologies will be candidates for longer-range applications as well.	Exploratory Development	Atlantic Research Corp.; United Technologies Corp., Chemical Systems Div.
Aviation Fuel Technology This program will develop advanced fuels for subsonic, supersonic, and hypersonic aircraft and missiles powered by air-breathing engines. Work will continue to ensure the availability of low-cost fuels from domestic petroleum, heavy oils, oil shale, coal, and tar sands. Programs are being initiated to develop endothermic hydrocarbon fuels for potential high-Mach applications. The fundamentals of fuel atomization, fuel/air mixing, and combustion are also being investigated.	Research/Exploratory & Advanced Development	Many
Expendable Turbine Engine Concept (ETEC) Demonstrator This advanced technology demonstrator engine, sponsored by the Aircraft Propulsion Subsystem Integration (APSI) program, is to address future propulsion technology requirements for small, unmanned, limited-life applications. Emphasis is on providing a technology base for a broad range of missile requirements, including subsonic and supersonic tactical and strategic systems.	Advanced Development	Allison Gas Turbine Div., GMC; Garrett Turbine Engine Co.; Teledyne CAE; Williams International
Compressor Research Facility This is a modern component test facility, fully automated and computer-controlled and designed to support both exploratory and advanced development efforts in compressor technology for the improvement of gas turbine engines. First test programs have included steady-state aerodynamic and aeromechanical mapping for both clean and distorted inlet flows. Standard pressure, temperature, and flow instrumentation; laser velocimeters; multipurpose traverses; and high-response pressure transducers have been employed. Data precision has been very high. Transient compressor operation, including post-stall performance, will be investigated.	Operational	In-House

NAME AND MISSION	STATUS	CONTRACTOR
'craft Power s program will advance aircraft electrical and hydraulic power system technology through the develop-nt of a nonflammable hydraulic system, advanced battery systems, highly reliable fault-tolerant electrical ver systems, and associated operation, distribution, actuation, and control components. Program objec-s are to reduce life-cycle costs, increase power-extraction efficiency, decrease weight, and improve ecific fuel consumption.	Research/Exploratory & Advanced Development	Many
riable-Flow Ducted Rocket Demonstration s missile propulsion concept, when combined with advances in aircraft fire control and missile sub-tems, will contribute to air-to-air superiority in the post-1995 time frame. An integral rocket/ramjet, using a l-rich solid propellant gas generator for ramjet fuel, can provide a two- to fourfold improvement in total ge over rocket propulsion for an equivalent size.	Exploratory Development	Many
rospace Lubrication g is a program to assure the availability of optimum lubricants, lubrication techniques, lubrication system nponents (bearings, gear, and seals), and lubrication-system condition monitoring techniques to meet the eds of USAF air-breathing propulsion and power systems. Present emphasis is on high-temperature ricants and lubrication system components to meet Project Forecast II requirements.	Research & Exploratory Development	Many
rcraft Fire Protection s effort will assure the fire safety of aeronautical systems through analytical, experimental and full-scale monstrations. This is accomplished by providing the capability and the timely availability of fire- and losion-prevention design criteria, containment and hardening measures, and detection and suppression uipment for future Air Force needs.	Exploratory & Advanced Development	Several
4950th Test Wing		
lvanced Range Instrumentation Aircraft (ARIA) Scoring Systems s program is to provide state-of-the-art broad ocean area coverage of reentry vehicles for weapon system ting. Functions previously requiring both EC-135 and P-3 aircraft will be combined in the EC-18 ARIA craft. The Sonobuoy Missile Impact Location System (SMILS) will acquire and process missile impact data. pact locations of multiple reentry bodies will be determined precisely by SMILS, using either deep ocean nsponders or Global Positioning Satellites. Associated programs will collect optical data on reentry hicles during the terminal phases of flight and will sample meteorological parameters from the surface to 000 feet.	Development	Applied Physics Laboratory (Johns Hopkins University); E-Systems, Inc.
C-18B Conversion is effort is modernizing the current EC-135 Advanced Range Instrumentation Aircraft (ARIA) fleet by nverting used Boeing 707-303 series commercial aircraft and reconfiguring them as EC-18B ARIAs. The -18B has a larger volume and payload than the EC-135s, allowing it to hold the existing Prime Mission ectronic Equipment plus the new ARIA Scoring System. Modification of the first aircraft was completed in nuary 1985, and a successful flight-test program was completed at Edwards AFB, Calif., in June 1985.	Production	In-house
crowave Landing System (MLS) Tests S is a new type of precision approach, missed approach, departure, and landing guidance system that will place ILS as the standard precision landing system. It provides the capability to fly high-angle approaches, rved approaches, and segmented approaches, thus reducing noise and allowing precision approaches in as of high terrain. Flight tests are scheduled for FY '87 in a C-141 to obtain data needed to develop proach criteria for large aircraft and evaluate operational characteristics of the system.	Development	Lear Siegler; Bendix Corp.
ark XV Identification, Friend or Foe (IFF) e Mark XV IFF program is intended to test the next generation of IFF equipment for the Air Force, Navy, Army, d NATO. It is designed to be a secure, antijam, high-reliability system that can operate in an ECM vironment. The first phase of testing involves one NKC-135 and two C-141 aircraft flying 500 hours from ight-Patterson AFB, Ohio, and Patuxent River NAS, Md. The second phase of testing, also referred to as rvice-Unique Testing," calls for the 4950th Test Wing at Wright-Patterson AFB to support Mark XV IFF ting in specified environments for the three services (Air Force, Navy, and Army). This second phase will e place in FY '90 and FY '91 and will probably have more 4950th flight activity than the first phase. Initial ting will focus heavily on the digital signal processing capability, target resolution, and new IFF interroga-n techniques.	Development	Bendix; Texas Instruments
CCM/Advanced Radar Test Bed (ARTB) support of the ECCM master plan, the ECCM/ARTB is an airborne platform for development test and aluation of advanced radar systems and ECCM techniques, to include multisensor integration. This unique Force resource will support development of the B-1, F-15, F-16, and ATF radar systems and advanced hnology programs into the 1990s. The area of ECCM and system-vulnerability analysis is growing steadily mportance due to tactical considerations. The test-bed represents a major step in the Air Force's ability to aluate sensor systems in a realistic environment and early in system development. The test-bed, currently der design development, is scheduled for employment in FY '89.	Development	None
sting Off-the-Shelf Aircraft is program provides evaluation of civil aircraft against specific military requirements. Areas of evaluation clude ground handling, maintenance, flying qualities, performance, and human factors. Test results are ed extensively in the source-selection process. A wide range of Technical Order Management and velopment services is provided to determine suitability for various maintenance levels and specialties in Air Force. Recent evaluations of off-the-shelf aircraft have resulted in the selection and procurement of the 12, C-18, C-20, C-21, C-22, C-23, and the Air Force One replacement aircraft.	Continuing	Many
rodynamic Evaluations of Modified Aircraft craft utilized for advanced systems test often undergo significant external modifications. Radomes, ennas, special fairings, shaped protrusions, and movable turrets that have at one time or another been ded to the 4950th Test Wing's aircraft to accommodate test requirements in the aircraft's performance, bility, and control and handling qualities are evaluated using approved flight-test techniques prior to the rt of actual system evaluation. Aero-eval results are then incorporated into flight certifications and are cumented for further use.	Continuing	Many
rcraft Systems Testing ariety of aircraft components is evaluated under the management of 4950th Test Wing flight-test directors. onics, control and braking systems, aerial refueling projects, and communications equipment are tested or to Air Force procurement. Engineering support is provided for many tests, including acceptance flight ting for the C-23 and C-5B.	Continuing	Many

The tiltrotor V-22 is built for versatility. Its roles will include special operations, airlift, combat rescue, and more.

The Amazing

The "amazing airplane" that General Cassidy speaks of, the V-22, is the first airplane program to be designed from the ground up for all the services. Deliveries of the first aircraft are planned for the US Marine Corps.

Osprey

BY JEFFREY P. RHODES, DEFENSE EDITOR

IN AN AGE of specialization, the Bell-Boeing V-22 Osprey stands apart. The V-22, which is a joint-service program, will cover the bases for a number of different missions.

"Asking what good is the CV-22 [Air Force designation] is like asking what good is a newborn baby," Gen. Duane H. Cassidy, Commander in Chief of the Military Airlift Command, said recently. "It can do almost anything you can imagine, and I have a big imagination. I see a big role. It will have a major role in SOF [Special Operations Forces], in short airlift, and in combat rescue, and it will have a major role in low-intensity conflicts of all sorts. It will be an amazing airplane."

The feature that most sets the Osprey apart from almost everything else is the fact that it is part helicopter, part conventional airplane. The Marine Corps's AV-8A Harrier was this country's first operational vertical takeoff and landing (VTOL) airplane, but the V-22—originally known as the JVX—will be the first large-scale effort to employ tiltrotor technology for vertical and/or short takeoff and landing (V/STOL).

While on the ground and while hovering, the Osprey's engine nacelles will be perpendicular and the large-diameter rotors parallel to the wings. After takeoff and for straight-and-level flight, the rotor/nacelle combination will rotate forward ninety degrees, allowing the V-22 to fly like a "normal" airplane at speeds of more than 300 knots. It is precisely this neither-fish-nor-fowl configuration that will make the Osprey such a versatile performer.

New Concepts in Design and Construction

The V-22 is the first airplane program to be designed from the ground up to meet the needs of all four services. Consequently, the needs of one service would frequently be the driving force behind a certain design feature.

The Air Force has a requirement for the airplane to go 700 nautical miles with twelve troops at 1,000 feet altitude, and that was a deciding factor in sizing the powerplant and drive train in the 6,000-shp-class. And because of the Navy and Marine Corps need for the airplane to operate from *Tarawa*-class assault ships (LHAs), the rotor size was set at thirty-eight feet to clear the ship's superstructure, although a forty-three-foot-diameter rotor would otherwise have been more efficient.

Also because of the need to operate these fairly large airplanes (nearly fifty-eight feet long and almost forty-seven feet wide from rotor hub to rotor hub) from ships, a unique wing/rotor fold system was developed to save space and to ensure ease of movement. This system involves the rotor blades folding inward, the nacelles being rotated down, and the entire wing being turned ninety degrees clockwise when looked at from above the airplane.

Once stowed, the port nacelle will hang in front of the cockpit, while the starboard nacelle will rest in front of the horizontal stabilizer and twin rudders. The Navy and Marine aircraft will accomplish this wing stow by means of an automatic system, and the entire process will take only ninety seconds. The Air Force version, as currently planned, will include the ninety-inch-diameter stainless steel ring that the wing rotates on, but the stow system will be manually operated.

The V-22 is the first major airplane project to be designed entirely on computer. With computer-aided design (CAD), engineers were freed from having to draw a multitude of blueprints and could easily make changes in the design. Another great advantage to the CAD system is that it allows designers at Boeing Vertol's plant in Philadelphia, Pa., to communicate instantaneously with their brethren in Bell Helicopter Textron's Fort Worth, Tex., facility.

The two companies have split the work on the V-22, with Boeing Vertol being responsible for the fuselage, empennage, overwing fairing, and systems integration. Bell is building the wing, nacelles, transmissions, and rotor and hub assemblies and is handling the integration of the Allison T406-AD-400 engines. These engines are a derivative of the T56 engines that power the Grumman C-2A and E-2C and the Lockheed C-130 and P-3 aircraft.

The Osprey is also the first major military aircraft design whose airframe will be made up almost entirely of composites. Slightly more than 6,000 pounds of the aircraft's almost 13,200-pound structure will be made of a graphite-epoxy laminate. The composite materials are very lightweight (about a quarter of the weight of aluminum), and because of the buoyant fuel sponsons, the V-22 will have good flotation characteristics in the event of a ditching at sea. There will only be about 1,000 pounds of metal in the airframe, and most of that comes in the form of perforated copper that will be laminated to the outer skin panels for lightning protection.

Hatching the Osprey

Bell and Boeing entered full-scale development (FSD) on the V-22 program in earnest in May 1986 after the Naval Air Systems Command (NAVAIR) awarded the two companies a $1.714 billion, seven-year, fixed-price-

incentive contract. When engine development is included, the total contract value comes close to $2.5 billion.

One part of the V-22 contract that is a first for a military procurement is that Boeing and Bell will each pay roughly $300 million of the tooling costs. The Navy will pay the other one-third of the costs. The tools and jigs themselves are unique in that they are made of composites also, although they were not made by the same process as the V-22's components.

The two companies, though, began limited FSD with their own funds in June of 1985 in order to keep up with the Navy's development schedule. In addition, Boeing Vertol alone has invested some $200 million in upgraded and expanded facilities over the last few years in preparation for work on the V-22. The limited FSD work came after the completion of two predesign stages that began in April 1983 and May 1984, respectively.

The first predesign stage demonstrated to the government that the V-22 was a low-risk program. The longest wind-tunnel test program in history—6,600 hours—was also undertaken during this time. The second predesign stage included testing of components and the designing of long-lead-time items. During the second stage, the Allison engine was chosen as the winner of a competition that also included Pratt & Whitney (which was recently chosen as the second-source engine contractor) and General Electric.

As part of the FSD effort, Class III (or full-scale) mockups have also been made to check the fit and function of the various subsystems. The mockups are being built in the Marine Corps's MV-22A version, since the Corps will be the largest customer and the first service to receive the Osprey.

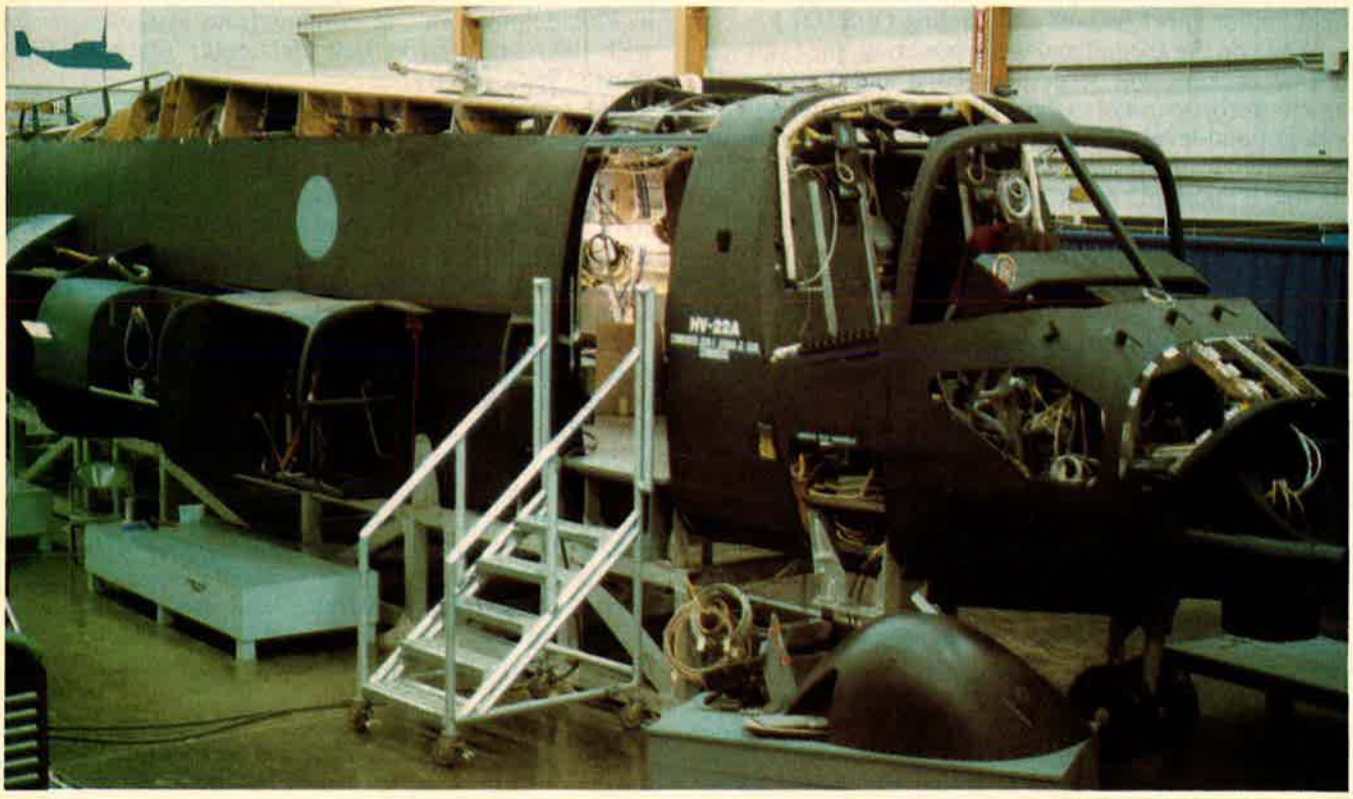
The mockups (there are five at Boeing Vertol and three more at Bell) include most of the features that will be found on the real article. As an example, there will be access doors in the bottom of the V-22's fuselage that will allow in-flight inspection of the tandem external cargo hooks, which will hold up to 10,000 pounds each or 15,000 pounds together. Another design innovation included on the mockup is the downward-hinged access panels on the engine nacelles that will be strong enough for mechanics to use as work platforms.

Other features in the V-22 include a sensor track handle in the middle of the console to let either crew member operate the forward-looking infrared radar (FLIR) system. This control was added to the console instead of located on the stick to prevent the flight crew from "fighting" with each other while one was flying the plane and the other was operating the sensor. A 2,000-pound-capacity fold-down winch, standard in the Navy's combat search and rescue HV-22A variant, will be available as a kit for the other versions.

The winch is unique in that it will be operated from a pistol grip stick just inside the starboard crew door. The grip serves as a stationary grab handle, but can be removed and connected by a fifteen-foot umbilical cord so that the loadmaster can also operate the rear loading ramp or the external hooks from outside the plane or while in the cabin. This grip will also give the loadmaster limited longitudinal and lateral control in hover.

The Air Force's Version

While work is progressing toward construction of the actual prototypes (more than 10,000 composite parts have already been manufactured), cockpit design work continues on the Air Force's CV-22 version. The Air



Full-scale mockups have been built to check the fit and function of the various subsystems. The weight growth that creeps into any new aircraft is being carefully watched and kept in check through the wide use of composite materials in the Osprey.

Prominent features in the CV-22's cardboard cockpit mockup include two color MFDs that show engine or flight instrumentation and, on the left, the sensor track handle for crew FLIR control.

Force intends to use the CV-22 for special operations, and, as a result, almost 3,000 pounds of avionics alone must be incorporated into the design.

The CV-22 will have no dedicated gauges, but instead will have four six-inch-by-six-inch color multifunction displays that will show engine or flight instruments when called up by the crew members. The avionics package also includes an AYK-14 redundant mission computer that operates in a prime and "hot shadow" configuration and that provides emergency backup. There will also be a triple-redundant fly-by-wire control system.

The avionics package works on the 1553B data bus, and this package includes such equipment as a helmet-mounted display (HMD) for the night-vision system (NVS) and/or the FLIR system. There will also be a medium-accuracy ring-laser gyroscope (RLG) for extended self-contained navigation flight, along with a whole host of other equipment.

A digital moving map system is in the works for the CV-22, and further along, a chaff/flare dispenser, a radar detection system, and a missile warning system could be included.

The weight growth that creeps into any new airplane, and especially in the CV-22, is being carefully watched by the two companies. There are signs posted everywhere in the design areas that bear such slogans as "Nobody Likes a Fat Osprey" and "I Think I'll Have a Light . . . Airplane." In fact, Boeing rewarded the employee who came up with the best weight-saving suggestion last year with a company-paid vacation to Hawaii.

Because the CV-22 will be heavier than the other V-22 versions, the 700-nautical-mile range cannot be reached as the aircraft is currently configured. The company can guarantee a 520-nm radius for the CV-22 now, and if the weight can be kept down, the range should stretch to 641 nm in the near future.

Allison anticipates that power upgrades to the T406 engines can be realized during the course of development. If this should come to pass, then meeting the 700-nm requirement would be feasible. Even with the range limitation, the CV-22 will still be able to get to more target areas than the MH-53 Pave Low III helicopters it will replace.

Onward and Upward

The FSD contract calls for the production of three Ospreys for ground, static, and fatigue testing as well as six flying prototypes. As a result of extensive testing of models and components, there will be no need for a drop-test article. After an exchange of components, Bell will assemble three of the prototypes, and Boeing Vertol will complete the other three examples. The first three flying aircraft will be fitted with Martin-Baker ejection seats, while production aircraft will have bulkhead-mounted armored seats.

First flight is expected to be made by a Bell-assembled aircraft in June of 1988, and a Boeing Vertol V-22 will be flown in August of that same summer. A pilot lot of twelve aircraft is expected to be delivered in 1991 and 1992. Each of the companies will completely build one of the last two aircraft in this lot to demonstrate that the companies can compete against each other.

After production of this initial batch, Bell and Boeing Vertol will compete against each other. The low bidder will build a majority of the aircraft in each lot, while the higher bidder will produce the remaining percentage of airplanes.

The twelve aircraft of the initial run will be MV-22As, and the first of the additional 540 aircraft in the Marines' order will be delivered in early 1992. The first of fifty HV-22As ordered by the Navy will arrive in mid-1992, and the Air Force will get the first of its eighty CV-22As at the end of that year. The Army, which will use MV-22As for utility and medevac missions, will get the first of its 231 aircraft in early 1993.

While the total buy of 913 aircraft (at approximately $16 million each flyaway cost) will keep the two firms busy until the mid-1990s, there is considerable discussion of an additional Navy order for 300 Ospreys to replace the Lockheed S-3 Viking in the antisubmarine warfare role. There is also the possibility that the Air Force could order more of the aircraft for either the SOF mission or for combat rescue, given the cancellation of the HH-60 Night Hawk program. One further role under discussion for the Osprey is as a replacement for *Marine One,* the President's VH-3 helicopter.

The V-22 Osprey might appear to some to be a novelty, but the technology is mature, and the support is there from all quarters. It does indeed appear that there is no limit as to what the Osprey can be made to do. ■

ALL ABOUT WING

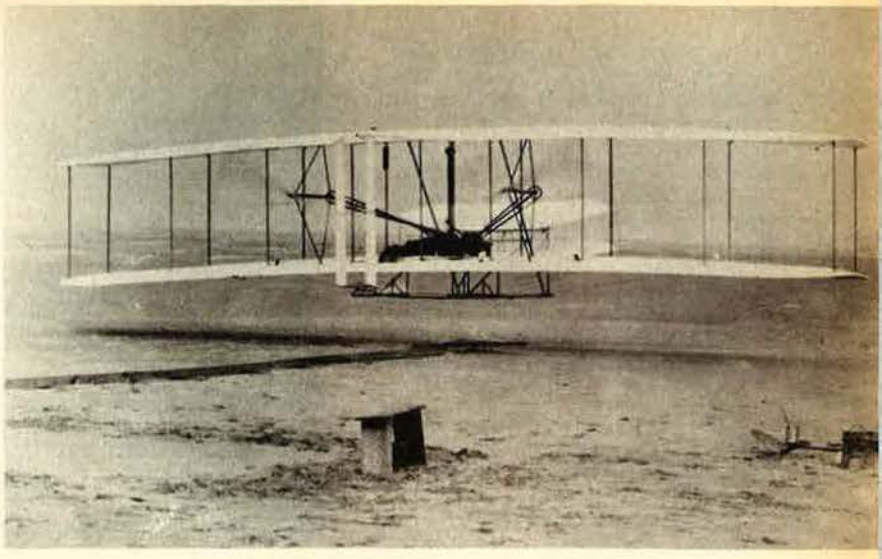
A STAFF REPORT

SR-71

In the elegant and imposing sweep of its lifting surfaces, the SR-71 Blackbird is an eye-catching reminder that wings are the essence of flight. Now in its twenty-first year of reconnaissance service with Strategic Air Command, the Blackbird, originally designed as an interceptor, is still the highest-flying, swiftest operational aircraft in the world and the holder of flight records galore. It looks the part. Dominating the aircraft's afterbody, its delta wings blend gracefully with the sleek engine housings that protrude from them and with the low-drag fuselage, itself an integral part of the lifting surface. In all this, the SR-71 is an aerodynamic tour de force—the classically configured, triple-sonic forerunner of aircraft that will fly even higher and faster in years to come. ▶

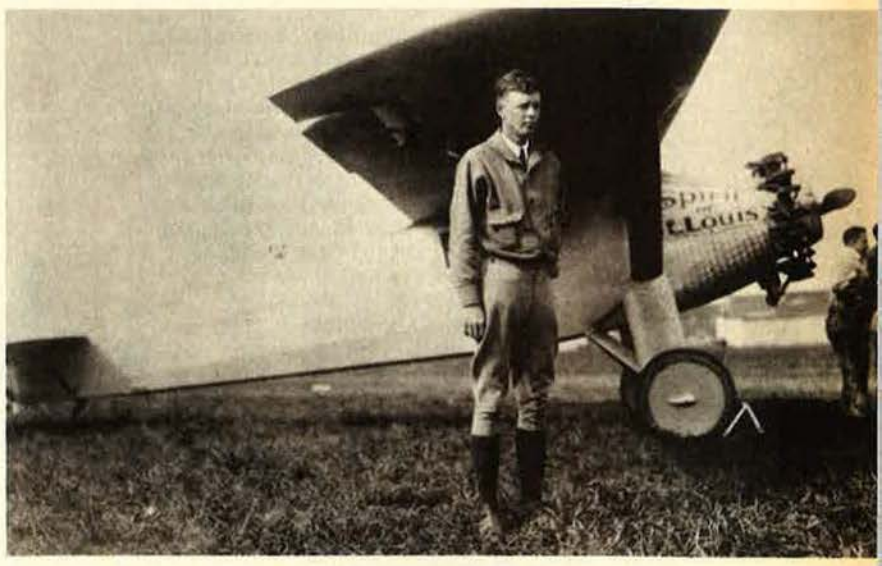
1903 Wright Flyer

There is an aeronautical world of difference between the SR-71 and the pioneering Wright Flyer of 1903, yet their basic principles are the same. All aircraft get their lift from the differences in air pressure on the bottom and on the top of their wings, which are rounded on top to speed the passage of air and, consequently, to lower its pressure there. The flight of an aircraft is controlled in part by changing the shape—the camber—of its airfoils. The Wright brothers built curved ribs into the Flyer's wings to give them camber and achieved "wing warping" by means of control cables that the pilot pulled to twist the outboard wing sections for lateral stability.



Spirit of St. Louis

By the 1920s, flight had come a long way, and all the essentials of modern airplanes were in place. The* Spirit of St. Louis, *maybe the most famous aircraft ever, took Charles Lindbergh nonstop from New York to Paris. It exemplified the advances of the time. Biplanes, burdened with wires and bracing cables, gave way to cleanly configured monoplanes. Metal replaced cloth, greatly enhancing durability. The trailing edges of wings now featured flaps and ailerons, giving aircraft greater lift and enabling them to turn more tightly while maintaining stability.



The Rotary Wing

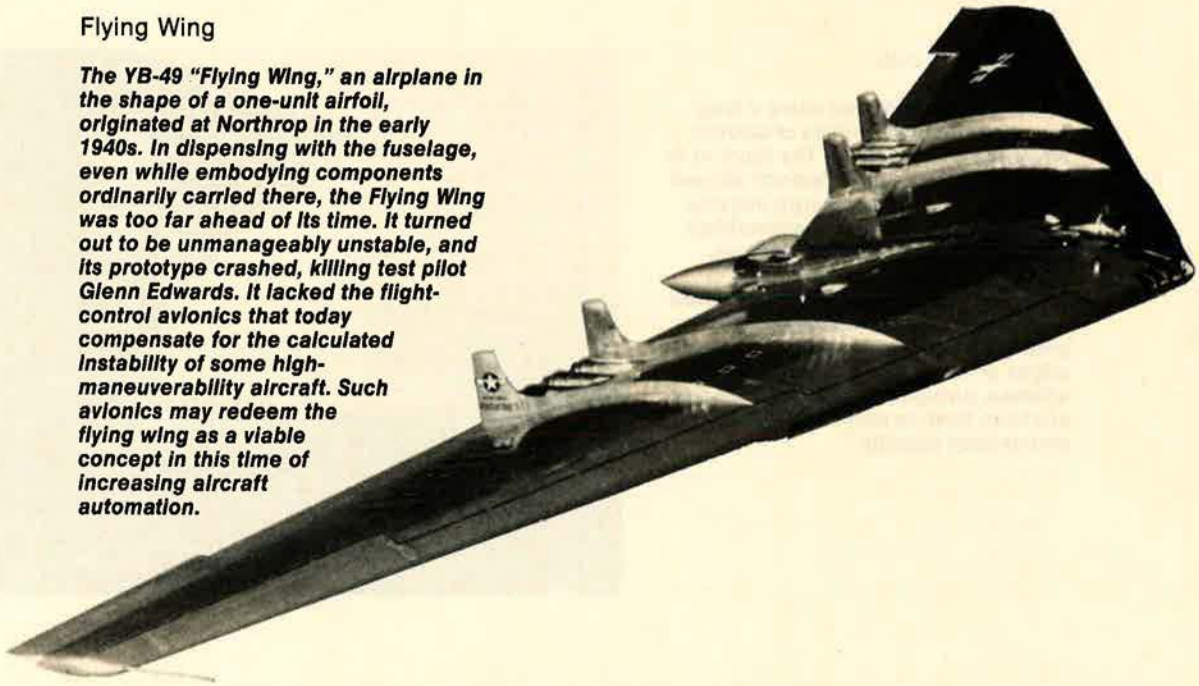
As fixed-wing aircraft were being refined, the rotary wing came on the scene in the form of this Sikorsky helicopter. Propellers had long since provided forward thrust by acting as wings, courtesy of their sustained rotation, in the vertical plane. In the making of helicopters, this thrust-making capability was applied upward in the horizontal plane. The blades of the rotors acted as airfoils, enabling this new, "wingless" type of aircraft to take off and land vertically and to hover in flight.

B-17

During World War II, wings gained in strength and utility and were put to work as gas tanks and as weapons carriers. Self-sealing tanks in wing cavities contained the fuel that took the B-17, for example, to faraway targets and back. This also freed space in the fuselage for bigger bomb loads. New construction techniques and design innovations generated wings that were sufficiently strong and streamlined to carry external stores without unduly sacrificing lift. Such advances set the stage for the wings of the jet age shortly to come. ▶

Flying Wing

The YB-49 "Flying Wing," an airplane in the shape of a one-unit airfoil, originated at Northrop in the early 1940s. In dispensing with the fuselage, even while embodying components ordinarily carried there, the Flying Wing was too far ahead of its time. It turned out to be unmanageably unstable, and its prototype crashed, killing test pilot Glenn Edwards. It lacked the flight-control avionics that today compensate for the calculated instability of some high-maneuverability aircraft. Such avionics may redeem the flying wing as a viable concept in this time of increasing aircraft automation.



F-86

Maneuverability was the hallmark of the F-86 Sabre, master of the air war over Korea in the early 1950s. The Sabre showed what swept wings could do in diminishing airfoil drag, a phenomenon that hurt the performance of previous straight-wing jet fighters. The leading edges of their wings hit the air head-on, creating great friction and boundary-layer drag that built up into aircraft-buffeting shock waves. But the V-shaped wings of the F-86 attacked the air at a much sharper angle. Thus, it passed over them with much less friction, giving the fighter great play in flight. ▶

F-104

Sweeping the wings is but one way to reduce their drag. Making them smaller and thinner does it, too, as witness the supersonic F-104 Starfighter, sometimes called "the missile with a man in it." The unprecedentedly short, skinny wings of the Starfighter were designed to induce so little drag that their lift at high speeds would be relatively enormous. This configuration made the F-104 a hot and rugged—but sometimes temperamental—fighter. Its special-purpose airfoils had their antithesis in the long ones of the U-2 reconnaissance aircraft, which was designed to loiter on high and to be sparing in the rate of its fuel consumption.

F-4

The beefy wings of the F-4 Phantom—the new biservice fighter of the 1960s—were designed to accommodate burly landing gear required for carrier landings, to withstand the pounding of such landings, and to carry, at their hardpoints, loads of ordnance that weigh twice as much as the loads carried by World War II B-17s. The hardpoints serve an important ancillary purpose; they absorb wing-loading stress that becomes especially heavy during low-level, maneuvering approaches to surface targets. The Phantom proved its muscularity in Vietnam, but sacrificed something in maneuverability, given wings that were designed with load-bearing demands in mind.

F-16

Thanks to automation, wings and other aircraft control surfaces can now be made to act and to react with almost unbelievable speed and precision. The fly-by-wire technology that came into its own in the 1970s makes this possible and is being advanced, in accordance with advances in sensors and microprocessors, by leaps and bounds. The F-16—the "Electric Jet"—was the first production fighter to incorporate it and, thus, to dispense with the mechanical controls that, in their comparative sluggishness, constrain the capabilities of aircraft. Unlike the F-15 that preceded it into the operational Air Force, the F-16 was designed as an unstable, supremely maneuverable platform whose pilot could rely on its electronic controls to help him keep it in hand.

C-141

The brute-force flying of today's heavily laden airlifters requires wings of maximum lift and minimum drag that are strong enough to hold up under enormous stress. This is why those wings are swept and huge, as on the C-141. They are also of the "high" variety. Positioned thusly, they leave the aircraft cargo area uncluttered and easily accessible, give the flight crew an unrestricted view, and make it possible for loading and offloading vehicles to be driven freely all around, and up close to, the aircraft.

Shuttle

The Space Shuttle's wings do nothing for it in airless space. However, they do provide a measure of lift and control for the Shuttle Orbiter as it glides back down to earth, acting as giant speed brakes to give it the lift necessary for its approach, flareout, and landing. The Shuttle is a far cry from the hypersonic National Aerospace Plane now being designed to operate in air and space. The NASP will have fully functional wings, but they will not be known as such. They and all other elements of the aerospace plane will be completely integrated into one whole aerodynamic system, and this, designers say, will preclude identifying each in isolation from all others. ▶

F-111

Variable-geometry, or "swing," wings such as those first introduced into operational service on the F-111s of the 1960s endow aircraft with exceptional versatility. Tucked back almost against the fuselage, the wings perform as consummately clean airfoils, inducing little or no drag and enabling the aircraft to engender high speeds. Extended straight out from the fuselage, or nearly so, the wings work against high speeds, but provide maximum lift for long-range cruising and for takeoffs and landings. On a test-bed F-111, the Air Force is experimenting with the Mission Adaptive Wing (MAW), which combines the positive attributes of variable-geometry and variable-camber airfoils.

X-29

Today's aerodynamics research arenas are alive with projects presaging the bright future of flight. For example, totally automated flight controls now make it practical to sweep wings forward and to take advantage of the superb maneuverability characteristics that they, teamed with canards, provide. The highly unstable X-29, which would be far too skittish to fly without such controls, is proving the point in flight tests. The trailing edges of its forward-swept wings autonomously change shape for maximum lift over drag. In other experimental projects, such innovations as winglets—wingtips turned upward to save fuel and increase performance—are also doing well. ▶

Automatic test equipment is a conglomeration of 425 varieties. USAF says this freestyle design costs too much and limits effectiveness. From here on, stricter rules will apply.

Making Test Sets March in Step

The 23d Tactical Fighter Wing based at England AFB, La., shown here on deployment in Italy, is the first unit to receive automatic test equipment for the A-10 INS that was manufactured to USAF's new MATE specifications.

BY JOHN T. CORRELL
EDITOR IN CHIEF

OVER the past several months, the Air Force has been taking delivery of new electronic test sets to diagnose the inertial navigational system (INS) of A-10 attack aircraft.

That, in itself, may sound uneventful. Automatic test sets long ago became everyday tools on the modern flight line. Without them, avionics maintenance squadrons would be out of business.

The test sets for the A-10 INS, however, are different. They are the first to be manufactured to USAF's new Modular Automatic Test Equipment (MATE) specifications—compatible in form, fit, and function with all future Air Force test sets.

This next generation of test equipment will feature common software and standard interfaces. R&D work for one set will be applicable to the others. It will be possible to swap parts back and forth. Test sets can be updated by simple replacement of a module instead of procurement of a brand-new test set.

This process, in the Air Force's estimation, will not only save substantial amounts of money but also will improve the general quality of test equipment in years to come.

On November 1, 1986, the Air Force opened a MATE Operations Center at Kelly AFB, Tex. With few exceptions, no contractor will be able to sell the Air Force a new piece of automatic test equipment until the Center has certified that it meets MATE standards.

The MATE program is a logical extension of a broader Air Force transition to modular electronics. It began with on-board aircraft systems in the 1970s, when a multiplex bus standard was established, requiring that new avionics thereafter be designed to plug into the bus. That initiative has worked well, and USAF hopes for similar benefits with its modular approach to test equipment.

The World of Test Sets

The only sign of trouble in the electronic innards of a modern airplane may be a cockpit sensor that lights up in flight. Unless some aircraft system fails, there may be no other indication. In fact, there may not be any trouble. Warning sensors are notorious for giving false alarms.

Later, when the aircraft is on the ground, the avionics troops will try to find the problem. They will not be able to tell much from what they can see and hear directly. Ailing electronic components seldom announce themselves with such telltale clues as smoke, unusual noise, vibration, or heat. Instead, the malfunction in the avionics suite will have to be isolated with an automatic test set.

If the flight-line crew can confirm the trouble and narrow it down to a single Line Replaceable Unit—an LRU, or "black box"—they will pull the bad module and replace it. Further work on the box is up to the base avionics shop or the depot, where more elaborate automatic test equipment is available.

Today, the Air Force has thousands of racks of automatic test equipment, a conglomeration of 425 different types, representing an investment of $10 billion. It also has several kinds of concerns about this proliferating inventory.

Unfortunately, the test sets are not always reliable. They are very specialized, so it's necessary to keep large numbers of them on hand, along with spare parts. On the average, they become obsolete, or at least partially obsolete, in five to ten years. Under these circumstances, development of new test equipment is ferociously expensive.

The Air Force has gone to considerable technical effort to improve its ability to detect and isolate problems in electronic components. Accuracy is better than it used to be, but avionics people are still hampered by the problem of CND/RTOK ("Could Not Duplicate/Retest OK")—meaning that the aircraft avionics suite and the various test sets disagree about what, if anything, is wrong with a particular black box.

Even after the Air Force recognized its growing reliance on automatic test sets, it continued to treat them as incidental support equipment that came as part of the package in a major system acquisition. Until recently, it made no strong effort to regulate their design. That has changed with the promulgation of the MATE standard, which USAF is now implementing with full muscle.

Benefits of Modularity

A leading advocate of MATE is Lloyd K. Mosemann II, Deputy Assistant Secretary of the Air Force for Logistics and Communications, who foresees both financial and quality benefits ahead.

"Today, when an automatic test station gets old—and therefore becomes less reliable and more difficult to support—you're faced, virtually, with replacing the whole thing, and that's a multimillion dollar operation," Mr. Mosemann says. "Different components obsolesce at different rates. With MATE, we will be able to pull an existing module out and plug a new one in and keep quality up that way."

Still more quality improvement will come from increased operator reliability, he says. With common modules and fewer kinds of test sets, the maintenance people should be able to master them faster and then use them with greater skill.

And if MATE can cut into the CND/RTOK problem, that could mean an enormous leap in quality.

"We'll be using some of the same test modules at base level that we use at the depot," Mr. Mosemann says. "We won't have a situation where one test station is more or less reliable than the others, which is what happens today. We have a tremendous return rate, where the item is tested as defective in the intermediate [base level] shop, but forty to sixty percent of the time, the depot, [which currently has the most accurate equipment,] finds nothing wrong with it."

The basic driver behind MATE, however, is the potential for cost savings. So long as each piece of test equipment is unique, there's a separate R&D bill for each one. Unique software, especially, has been a budget eater. With modularity, numerous products can be based on the same development work—and fielded sooner, since there's no longer a need to start from scratch.

When the products reach the field, various kinds of black boxes can be tested on the same MATE-standard equipment, which will be reconfigurable. This, in turn, reduces the bulk of equipment required, the number of spares, and the number of power sources needed to drive the test sets.

"With MATE, we can cannibalize, if we have to, one piece of equipment to support another," Mr. Mosemann says. "Today, we can't do that because of the proliferation of test sets, which are all different."

The MATE Architecture

There isn't much way for designers and developers to get around MATE. A joint Systems Command-Logistics Command regulation establishes it as the basis for procurement of new test sets and the modification of old ones. Only a handful of waivers to this directive has been granted so far, and those were mostly in instances where extremely minor modification was needed.

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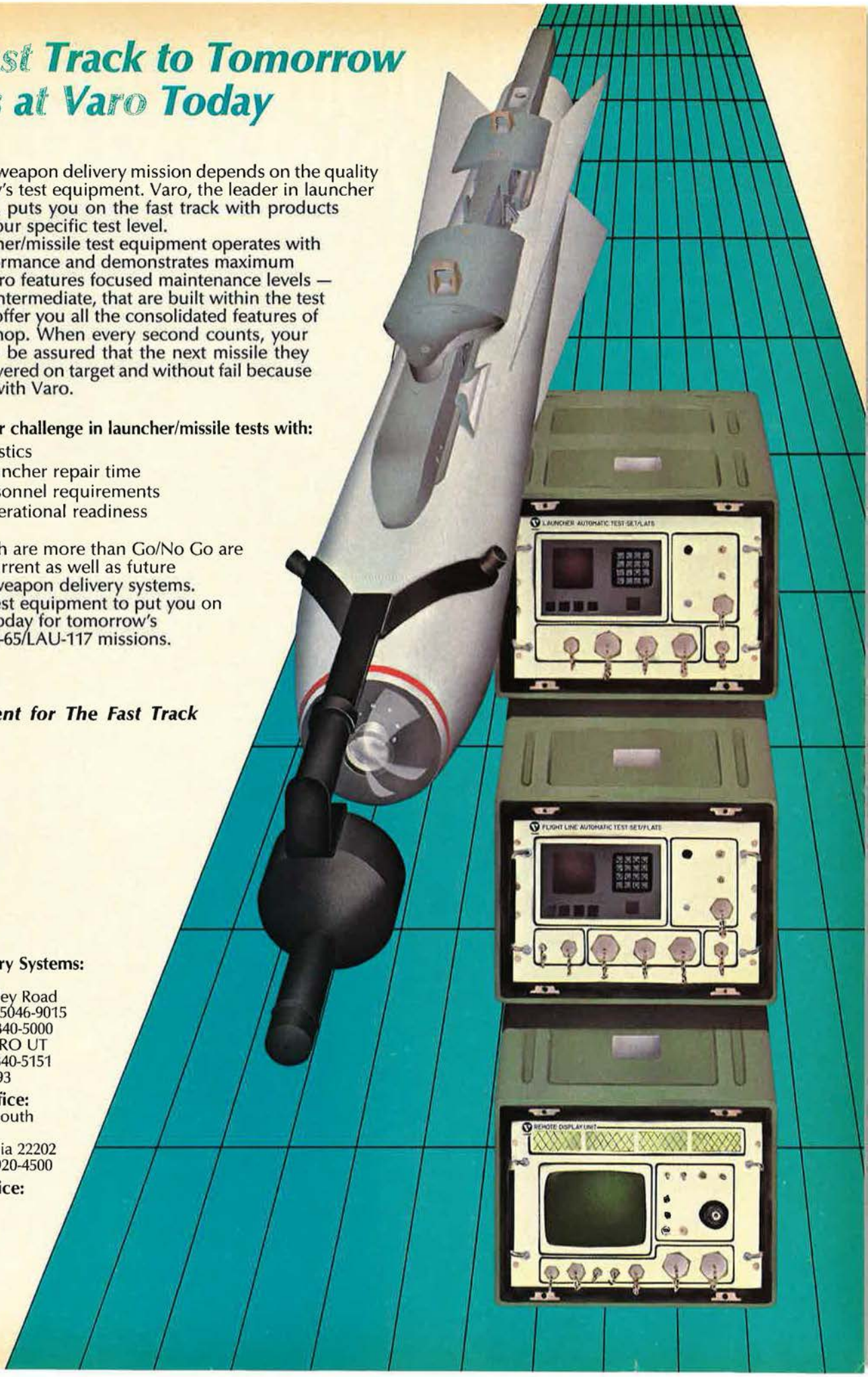

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USAF goes to some pains to explain that it—unlike the Navy in a parallel program—is specifying a form, fit, and function architecture for MATE, not standardized equipment. "Instead of requiring that all the boxes look exactly alike, we are requiring that a box meet specific conditions," Mr. Mosemann says.

The MATE architecture prescribes a number of standard interfaces and protocols and specifies a rack size so that new modules will fit the basic equipment. Instruments must plug into a standard electronic bus for input and output. The standard test language is Atlas, and the equipment must be able to handle black boxes programmed with the Jovial language. One of the benefits of such a modular architecture is that it provides for orderly growth as situations and requirements change. Accordingly, MATE test sets will be adjusted when the time comes to analyze avionics that incorporate Very-High-Speed Integrated Circuitry (VHSIC) and DoD's superlanguage, Ada.

Industry's wariness of MATE has lessened since the opening of the new center at San Antonio. Prior to that, the verification work was done for the Air Force on contract by Sperry. Some manufacturers had been reluctant to submit their proprietary designs for scrutiny by another manufacturer with whom they might later be in competition.

MATE is meeting with a less than unanimous welcome by the system program managers—mainly because the money to get it rolling will come out of their budgets. There is central funding of $20 million, but that is for MATE technology, not specific applications. The first program manager with a requirement for a particular automatic testing capability will pay the R&D freight, and the systems coming along afterward will get a cheaper ride. For the first program manager in line, though, the standardization and interoperability features of MATE-capable equipment may cost more than a unique test set for his individual program.

"We believe that the cost is more than justified, because of the benefit to three or four other programs," Mr. Mosemann says. "But somebody's got to pay that up-front cost, and it's the first program that comes along with a requirement for the box."

To date, twenty-nine programs have been baselined for MATE. When the LANTIRN navigation and targeting system is deployed, each squadron will get six racks of modular automatic test equipment along with the mission pods and other paraphernalia. The B-1, the F-15, the Advanced Tactical Fighter, the Small ICBM, and the C-17 are all on the list for MATE by FY '90.

The Air Force has registered a logotype trademark, which equipment manufacturers are eligible to use once their products pass muster with the MATE Operations Center. From here on, it will be very difficult for a new test set to find its way to an operational flight line without this trademark on its side. ■

Maintenance technicians SrA. Floyd R. Studt (left) and SSgt. John R. Tushner of England AFB's 23d Tactical Fighter Wing use some of the first delivered Modular Automatic Test Equipment (MATE) to test the INS for the A-10.

Commenting on the ATF, Secretary Aldridge said that its lethality and survivability are to be achieved through "a proper balance of speed, maneuverability, reduced observables, integrated offensive and defensive avionics, and an emphasis on reliability and maintainability." Shown here is an artist's concept of the Lockheed ATF aircraft proposal designated YF-22A.

The Secretary and the Chief describe new aircraft for the tactical role—and new concerns about preparing USAF for its strategic role.

shaping the force

BY EDGAR ULSAMER, SENIOR EDITOR (POLICY & TECHNOLOGY)

AFA's national symposium entitled "The Air Force—Today and Tomorrow," held in Los Angeles, Calif., on October 30–31, served as the backdrop for program decisions that will affect US airpower for decades to come. In his capacity as the source-selection authority, Air Force Secretary Edward C. Aldridge, Jr., announced at the conclusion of the AFA symposium the winners of the Advanced Tactical Fighter (ATF) and the Air Defense Fighter (ADF) competitions.

In the case of the ATF competition, Secretary Aldridge chose Lockheed-California Co. and Northrop Corp. each to build two flyable prototype aircraft along with an associated static avionics prototype over the program's fifty-month demonstration/validation (dem/val) phase. At the end of dem/val, which starts immediately, the Air Force plans to select one prime contractor to initiate full-scale engineering and, eventually, to build at least 750 ATFs. While the Air Force, at present, does not plan on a dual-source, "leader-follower" production arrangement for ATF, Secretary Aldridge acknowledged that such a procedure was "definitely possible."

Lockheed and Northrop will each receive a fixed-price contract of $691 million—likely to be complemented by investments out of their own pockets—to carry out the program's dem/val phase. First flight of the prototypes, designated YF-22A in the case of the Lockheed airplanes and YF-23A for the Northrop entries, is expected late in 1989. Dem/val is to be followed by FSD (full-scale development) that will last about five years and culminate in the aircraft's initial operational capability (IOC) in the mid-1990s. ATF's IOC will come twenty years after the aircraft that it is meant to replace, the F-15, passed the same milestone, Secretary Aldridge pointed out.

Twin Goals for ATF

Unit flyaway cost of the ATF, he stressed, is not expected to exceed $35 million, expressed in FY '85 dollars, in line with the Air Force's twin goals for ATF: "Not only must we build [this aircraft] with the capability to cope with the ever-evolving threat, [but] we must also do so at a cost that allows us to buy the number of ATFs we will ultimately need."

The Air Force, Secretary Aldridge pointed out, plans to walk a fine line between affordability and performance in the design of the ATF. Juxtaposed with the not-to-exceed price tag of $35 million are such stiff requirements as twice the combat radius of the F-15, Mach 1.5 cruise without afterburner, and maximized "stealth" characteristics. Compared to the F-15, R&M (reliability and maintainability) and airlift support requirements are to be cut in half, while the ATF's sortie generation rate is to be doubled over that of the F-15.

In addition, the aircraft is to incorporate voice-control features, must be able to take off and land in less than 2,000 feet of wet runway, have three times the engine durability of the engines used by the F-15 and F-16, and carry a complement of existing and planned air-to-air weapons. These will include an internal gun, medium-range missiles (AMRAAM and AIM-7 Sparrow), as well as the ASRAAM and AIM-9 Sidewinder short-range missiles. ATF will be powered by production versions of either Pratt & Whitney's YF119 or General Electric's YF120 prototype engines. Both the Lockheed and the Northrop designs will be tested with all ATF prototype engines.

The Soviets are fielding such new all-weather fighters as the MiG-29 Fulcrum with look-down/shoot-down fire-control systems. Secretary Aldridge has said that "by the turn of the century, the majority of Soviet air-to-air fighters will have those systems in the cockpit." He added that "to counter the threat, we must get going on an advanced aircraft of our own."

The operational imperative driving the need for and the design of ATF was summed up by USAF's Chief of Staff, Gen. Larry D. Welch, in his symposium address: "We have in the past relied on low-altitude tactics, coupled with ECM, as our primary means of avoiding ground-based threats and dealing with Soviet air-superiority fighters. We have no choice in the future but to deal with a compelling air-to-air threat, [since] SUAWACS provides the command and control to support the growing force of Soviet fighters with look-down/shoot-down capability. Unless we have the means to deal with those fighters, we will be denied the low-altitude tactics essential to air-to-ground operations. Hence, the Advanced Tactical Fighter is the essential leverage to maintain the effectiveness of all our support to the AirLand battle."

Secretary Aldridge pointed out in similar fashion that "if we are to maintain the competitive edge we currently hold over a numerically superior adversary, we must move out aggressively on the ATF program. The Soviets are fielding new fighters with F-15 and F-16 capabilities in the MiG-29 Fulcrum and Su-27 Flanker." Stressing that these Soviet aircraft are twin-engine, supersonic, all-weather fighters with look-down/shoot-down fire-control systems, Secretary Aldridge predicted that they would undergo evolutionary product improvement as well as be backed by two new fighters slated to enter the Soviet inventory in the late 1990s. "By the turn of the century," he said, "the majority of Soviet air-to-air fighters will [consist of] these advanced systems. If we are to counter this threat, we must get going on an advanced aircraft of our own." He added that ATF's lethality and survivability are to be achieved "through a proper balance of speed, maneuverability, reduced observables, integrated offensive and defensive avionics, and an emphasis on reliability and maintainability."

The Air Defense Fighter Selection

The Air Force, Secretary Aldridge announced, will convert General Dynamics F-16As to perform the ADF role. For that reason, General Dynamics was awarded a $633 million modification contract that calls for the conversion of 270 F-16As currently in the inventory to the ADF role by FY '90.

Last year, Congress directed the Air Force to conduct a full and open competition to choose a fighter aircraft for the air defense mission. Three proposals were submitted: General Dynamics proposed to modify F-16As, in one bid, and bid on the basis of specially configured new production F-16Cs; in another, Northrop offered to produce 270 F-20s.

Secretary Aldridge explained that "while all three proposals met the technical requirements and mission performance needs . . . both versions of the F-16 were superior to the F-20 in terms of cost and capability." He added that "our commitment to modernizing the tactical fighter force is best served by placing all new F-16Cs and F-15Es in the tactical air forces and upgrading the air defense force with 270 modified F-16As." One of the pluses militating in favor of the F-16A is that this approach lowers up-front costs at a time of severe funding constraints. By using aircraft currently in the inventory, all eleven Air National Guard squadrons now flying F-4s and F-106s "will be completely modernized for a relatively modest $633 million," according to Secretary Aldridge.

Although the 270 modified F-16As will be dedicated to the single role of air defense, the aircraft, of course, retain their intrinsic air-to-ground capability. The aircraft that the F-16As replace—F-4s with an average age of more than twenty years and F-106s with an average age of more than twenty-five years—are to be retired. The remaining useful life of the modified F-16As, the Air Force believes, will be about twenty years. Compared to the F-4s and F-106s, the reconfigured F-16As will offer significant increases in range, radar capability, and armament. The modified air defense fighter will be equipped initially with a 20-mm cannon as well as AIM-7 and AIM-9 missiles. Eventually, the new, high-performance AMRAAM will flesh out its armament.

Potential Arms-Reduction Impacts

The shape of tomorrow's Air Force, Secretary Aldridge and General Welch stressed at the AFA symposium, could be affected dramatically by arms-reduction accords germinated at the recent Reykjavik "presummit" meeting. This would be doubly true if such future accords entail "a shift in national strategy from strategic deterrence through balanced offensive forces to deterrence through assured defense."

General Welch explained that the Joint Chiefs of Staff in principle favor "progressing toward zero ballistic missiles," one of the most attention-getting long-term goals explored by President Reagan and Soviet leader Mikhail Gorbachev at the Iceland conference. But the Air Force Chief of Staff cautioned that the agreements that "were almost negotiated at Reykjavik" need to be looked at in their totality, meaning phased arrangements to make "deep cuts" in ballistic missiles over the next five years and subsequent schemes that will move the superpowers toward the elimination of all ballistic missiles, including air-launched cruise missiles. Deep cuts in the two countries' ballistic missile inventories, General Welch suggested, "would be good for mankind and good for the US. And that's where we ought to start to negotiate."

The second round of negotiations—meaning movement toward the elimination of all ballistic missiles—might prove more difficult, he cautioned: "A world without ballistic missiles clearly is a world that's different [from] the one we live in and [one] that we haven't given too much thought to." The Pentagon, General Welch emphasized, will have to answer some tough questions before the US can move toward a "zero-ballistic-missile" posture.

The pivotal issues that need to be settled before the complete elimination of all ballistic missiles can be prudently contemplated revolve around the associated costs and schedule: "And believe you me . . . we haven't answered these questions, and we owe these answers." Explaining that the elimination of all ballistic missiles equates to a cost increase, not "a savings"—because of the need to provide military capabilities by other means—General Welch said the costs and schedule connected with bringing into being substitute forces have yet to be calculated. A related, crucial question, he suggested, is "what we need to do to persuade Congress to bear that cost."

A strong, stable deterrent force, General Welch asseverated, is "essential to every strategic arms-control proposal put forth by the US, including the proposal to work eventually to zero ballistic missiles on both sides." In light of imminent national decisions involving the future of the US ICBM and SLBM forces, the Air Force Chief of Staff took on myths that tend to becloud the complex issue of stable deterrence and what leads to stable deterrence. There is concern, he said, "that silo-based ICBMs could be vulnerable to a Soviet first strike and, therefore, might invite attack, which would, of course, be destabilizing."

But this concern overlooks the fact that "deterrence springs from US systems capable of prompt and effective retaliation and the Soviet perception of the certainty of such retaliation. One thousand Peacekeeper warheads on 100 missiles serve that purpose regardless of deployment mode and will provide the foundation of affordable strategic deterrence for years to come. We can then build on that foundation with the mobile Small ICBM and sea-based Trident D-5 systems." He underscored the fact that the "Peacekeeper missile is here now, it works, it deters, and it's clearly affordable."

The Air Force, General Welch told the AFA meeting, will not get drawn into canonical arguments over whether the new Small ICBM (SICBM) should be a single-warhead design or MIRVed. "We are after the most capability for the least money. We have completed our analyses and are prepared to present [them] to the Secretary of Defense and Congress. [Our findings] will show the trade-offs between single-RV and MIRVed SICBM [designs]. I have the simple faith that our numbers will speak for themselves." General Welch acknowledged, however, that "there will be some political problems" whatever the decision because there is "one faction that maintains that a single-RV missile is totally unacceptable and that it has to be MIRVed, and there is

General Dynamics F-16As have been selected to replace the aging F-4s and F-106s in the role of air defense. The F-16s will be equipped initially with a 20-mm cannon as well as AIM-7 and AIM-9 missiles. Eventually, the high-performance AMRAAM will be added to the Fighting Falcon's armament.

another faction that says a MIRVed SICBM is totally unacceptable."

Two specific basing modes involving hard-mobile launchers for the SICBM are receiving the Pentagon's "most serious consideration," he added. One approach is predicated on locating the missiles and their launchers on existing Minuteman ICBM sites and "flushing them on tactical warning; the other [concept calls for] random movement" of the SICBM launchers on government lands in the southwestern parts of the country. Other approaches "are still in the hopper," according to General Welch.

Secretary Aldridge added that he holds no categoric personal opinions on whether the SICBM should be MIRVed or a single-RV design. He stressed, however, that there is a link between the design of the SICBM and the deployment of the second fifty Peacekeeper ICBMs. Deploying the fifty Peacekeepers in a garrisoned, rail-mobile fashion "looks attractive, but is not the only option." *(See also "ICBM Basing Mode Questions" on p. 29 of the November 1986 issue of* AIR FORCE *Magazine.)*

Balanced Conventional Forces

A stable US deterrence posture in the strategic nuclear arena—whatever its specific nature—does not "relieve us of the need for conventional forces balance," General Welch told the AFA meeting. The advent of nuclear parity, he added, "greatly elevates the importance of conventional capability. Now more than ever—particularly as we see promising progress toward reducing strategic nuclear weapon systems—adequate conventional forces are the key to deterring the Warsaw Pact challenge in Europe and the Soviet challenge in the Pacific." Maintaining and improving the conventional deterrent demands "robust and flexible systems to meet the full range of conventional forces missions," meaning continued deployment and upgrades of such current systems as the F-15 and F-16 and expeditious development of such new systems as the Advanced Tactical Fighter. All other tactical air warfare systems will be for naught "unless we can deal with a new family of highly capable Soviet air-superiority aircraft," he said in underscoring the pervasive importance of ATF.

In stressing the importance and urgency of improving the Air Force's interdiction capabilities, General Welch questioned the notion that "tactical ballistic missiles [TBMs] might provide a lower-cost, lower-risk approach to deep interdiction." While acknowledging the complementary value of TBMs, he dismissed the "forlorn hope that we might do without manned penetrating interdiction aircraft." Interdiction, he pointed out, "is a grinding day-to-day process. The need is not satisfied by lightning, onetime surgical strikes against preidentified chokepoints. The resilience of the enemy's infrastructure, the ability to adapt under attack, and the inevitable miscalculations in the fog of war all demand the capability for an adaptive, fluid, interdiction campaign."

There is, he suggested, a "motivational gap" in terms of defining realistic battlefield requirements between "analysts behind mahogany desks" and people being shot at. General Welch added that there are "very few massive efforts that can be handled by a few silver bullets. We need robust and flexible systems, such as the F-15E with the LANTIRN system, to perform this mission."

The Air Force's reservations about sole reliance on TBMs for interdiction missions do not diminish the service's determination to exploit advanced technologies for appropriate combat functions, according to General Welch. For instance, the combination of stealthy platforms and smart or autonomous standoff weapons shows great promise for reducing the need to expose manned penetrator aircraft to some high-risk missions,

he said, adding that the Air Force "is totally committed" to the exploration of "robust" high-tech solutions in this area. Secretary Aldridge, in similar fashion, stressed the importance of revolutionary technologies to the Air Force of the future, especially as a means for easing "the coming manpower crisis." Such a crunch, he said, appears unavoidable in the wake of tight numerical caps, on the one hand, and new missions being added, on the other. He cited specifically the potential of unmanned reconnaissance vehicles as well as of artificial intelligence, both of which "may show a way to operate systems with fewer people or less technically proficient support."

Military Role in Drug Interdiction

One of the new manpower-intensive missions the Air Force is gearing up for involves interdiction of drug smugglers. General Welch rejected the notion that it is inappropriate to use military forces for such a task. The military's purpose is "to defend the country from all enemies, foreign and domestic. Drug runners are enemies, foreign and domestic."

Terming it an "overreaction" to treat involvement in the drug war as incompatible with the military's fundamental mission, the Air Force Chief of Staff suggested that the real issue revolves around the question of how deeply entwined in drug interdiction the armed forces should become and how effective they can be in such operations. The Defense Department, "understandably," was firmly opposed to an earlier bill that required the armed forces to "virtually seal all US borders to drug traffic within forty-five days. This is patently impossible." He added, "We weren't particularly excited about raising such an expectation when we knew that failure was inevitable." The current involvement in drug interdiction by the military is probably at the right level and does not encroach on "our primary mission," General Welch told the AFA meeting. The Air Force's role in the drug war is mainly in the surveillance area, while the Navy uses US Coast Guard personnel aboard some of its ships in support of drug interdiction missions, he explained.

The military, he pointed out, is not opposed to greater involvement in the drug war, but "we don't have the right tools, equipment, training, and mission to [perform this task] very well." Except for the assistance that the military is furnishing now, waging the war on drugs should be left to "those who are constituted, trained, and equipped to do that mission—and that's not us."

Pentagon Reorganization Questioned

The reorganization of the Pentagon as implemented by recent legislation leaves a lot of turbulence in its wake, the civilian and military heads of the Air Force agreed. Secretary Aldridge wondered whether strengthening the role of the service Secretaries by congressional fiat was "a good idea," adding that "I certainly don't support" the resultant "downgrading" of the service chiefs. In the case of the Air Force, he emphasized that "we will work it out [in team fashion. Our decisions] are made unanimously by both the civilian and military leaders, and I plan to keep it that way."

Secretary Aldridge, on the other hand, favors the reorganization's provision that expands the role of the Defense Advanced Research Projects Agency (DARPA) in the field of high-risk technology. The services, he explained, are reluctant to invest their limited R&D funds in high-risk projects even if there is the potential for high payoffs. DARPA's new mandate to pioneer new, high-risk technologies in the form of prototype hardware, he said, is "something we have been trying to get DARPA to do for quite some time."

General Welch termed "simply not executable" the so-called joint specialty provision of the Pentagon reorganization legislation. "We can't figure out any way to get officers through all the wickets they have to pass through to become joint specialty officers in time to be of any use. . . . Fortunately, Congress recognized . . . that the specificity of the language associated with [this provision] would be troublesome and invited us [the Joint Chiefs of Staff] back to explain why it won't work. We will certainly do that."

The reduction in the number of officers proposed by the reorganization plan is "very troublesome," according to the Chief of Staff. The order to cut the strength of the officer corps, he explained, is based on the spurious notion that there is "a magic ratio between officers and the enlisted force and that we have exceeded that historic ratio." There are, General Welch explained, many valid reasons why the enlisted/officer ratio has gone down in the Air Force. One of them is the fact that, over the past few years, severe manpower constraints were imposed without allowances for new weapon systems that entered the Air Force's inventory. As a result, "we have had to take fairly draconian measures to live within the blue-suit manpower constraints while taking on board all these new capabilities."

The fact that these capabilities were urgently needed did not ease the Air Force's difficulty of absorbing the additional duties without additional manpower. In order to cope with this problem, the Air Force had to increase its reliance on outside contractors as well as to "civilianize" some of its manpower slots. But these arrangements eased the problem only in terms of the labor force and not for the "management force," meaning the requirement for officers, General Welch explained. He added that in the case of the Air Force, the officer/enlisted ratio is affected by the fact that "most of our fighting forces are made up of officers." Congress, in this instance, too, belatedly recognized the infeasibility of its own mandates and "invited us back to restate our case in 1988—which is a curious way of writing legislation."

Another vexing by-product of the current rush to reorganize the Defense Department centers on the role of the Special Operations Forces. On the basis of widespread misconceptions, the "yardstick for measuring the success [of the SOFs] is a 'Mission Impossible' TV program-style unfolding of a string of miracles to neatly resolve very messy, complex situations. That's the stuff myths are made of," he asserted. The SOFs, he emphasized, "are necessarily trained and equipped to fight at all levels of conflict, and the systems we buy have to be robust and affordable and capable across a wide conflict spectrum." ■

(The concluding report on "The Air Force—Today and Tomorrow" symposium will appear in the February 1987 issue of AIR FORCE *Magazine.)*

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The Airman Who Shook The World

Curtis E. LeMay never did anything halfway.

BY MAJ. GEN. DALE O. SMITH, USAF (RET.)

A typical Curtis LeMay pose—stern visage and ever-present cigar. This photo was taken during the Berlin Airlift.

IT WAS no problem for Flying Cadet Curtis E. LeMay to solo in that yellow-winged biplane at March Field, Calif., in 1929. He had been given seven hours of dual instruction by taciturn Lt. "Peewee" Wheeler, who had already washed out seven students. Given the chance, Curt knew he could fly that PT-3. And he was happily relieved when Peewee finally let him take it around alone. The crisis came a few weeks later.

Peewee sent Curt for a check ride with the flight commander, usually the step before you were washed out. Just after takeoff, the flight commander in the front seat cut the throttle and ordered Curt to land. Seeing an open field to his right, Curt began a turn. The flight commander shook the stick angrily, taking control and gunning the engine. Curt's heart sank. He had apparently done something terribly wrong. But what?

The procedure when the engine cut out on takeoff was to land straight ahead regardless of any obstructions. That way there was a better chance of survival than if you tried to turn at low speed, risking a fatal stall. But Peewee Wheeler had never explained this to Curt.

After his check ride, Curt dreaded the bad news. "I don't know whether to wash you out or not," pondered the lieutenant, leaning on a wing. "You could have killed us trying to turn with a dead stick on takeoff. But I guess I'll give you another chance."

That was how close America came to losing one of its foremost airmen. His inquisitive and inventive mind found ways to bail our country out of one dire emergency after another. What might the world be like now if Flying Cadet Curtis E. LeMay had been sent home to Columbus, Ohio, as a civilian?

The Years of Growth

His dream of becoming a flyer started when Curt was nine as he watched Lincoln Beachey do stunts over San Francisco Bay at the 1915 Panama-Pacific Exposition. Curt was the first of seven children. His parents came from Ohio farming families, but his father preferred mechanical work and became a jack-of-all-trades in Columbus, where Curt was born. But they didn't stay there long, as the elder LeMay moved about from one job to another, from California to Pennsylvania, and then back to Columbus.

Seldom without a job in his growing years, Curt was a real help to his mother and siblings during hard times, a self-imposed obligation he carried all his life. Like many boys, he delivered newspapers, but unlike others, he started his own business and became a distributor to other carriers. He also delivered telegrams and ran a delivery service. Two summers he worked at structural ironwork and made enough to splurge on a $5 airplane ride with a barnstorming pilot in an old Waco.

While attending Ohio State, he worked at a steel casting company, putting in hours from 5:00 p.m. to 3:00 a.m. He made good money, but snoozed through so many classes that he lacked fifteen hours for graduation at the end of four years. An Honor Graduate commission from ROTC led to Curt's selection as a Flying Cadet, and he didn't return to Ohio State. Years later, while in the Air Corps, he managed to make up those fifteen hours and earn his diploma.

Today General LeMay is quietly enjoying retirement in Newport Beach, Calif. He celebrated his eightieth birthday on November 15, 1986. When I called at his house for an interview, I was greeted warmly by him and his loquacious and charming wife Helen. She is a perfect match for silent Curt, who says, "Every general should have a wife like Helen—but of course that's impossible."

Their tastefully decorated home was redolent with the smell of baking bread. Deeply inhaling the hearty aroma, I was about to make a comment when Helen read my thoughts. "Oh, that's Curt," she laughed. "He's way into bread baking."

The aproned General with the piercing hazel eyes and generous shock of grey hair let me watch the final steps in this ritual, and at dinner I couldn't get enough of those delicious warm slices. Curt LeMay never does anything halfway.

The General's other activities are a five-mile walk each day (his five-foot, eleven-inch frame is still trim enough to let him wear his old uniforms, which he refuses to discard), tinkering in a workroom strewn with electronic gadgets and gun cases (he built a TV and stereo and is solemnly devoted to ham and CB radio), and participating on several boards of directors.

Modest and Resourceful

Curtis LeMay's genius began to manifest itself soon after he received his silver wings. He was assigned to a fighter group at Selfridge Field, Mich., but President Franklin D. Roosevelt had other plans for Army officers. They were ordered to help run the Civilian Conservation Corps (CCC), a Depression-era measure to give unemployed youth a chance to work in the woods. This duty was a hardship to young airmen, because it took them away from their airplanes. But Curt LeMay demonstrated his resourcefulness by having a Curtiss P-12 assigned to him, which he flew out of a farmer's pasture. Deprecating this achievement with his usual modesty, Curt said, "It was no big deal, because my commanding officer wanted us to fly. Biggest problem was building a fence around the plane to keep the cows from eating the doped fabric of the wings."

Not long afterward, Lieutenant LeMay wangled an assignment to an early air navigation school at Langley Field, Va., and transferred from fighters to bombers—an unprecedented move because fighter pilots were considered the elite of the Air Corps. With remarkable prescience, Curt believed that the future of military aviation belonged to the big four-engine B-17s. He later navigated formations of B-17 Flying Fortresses on good-will missions to South America and, in May 1938, to intercept the Italian liner *Rex* 725 miles east of New York City. The weather was marginal, but the bombers found the ship on the first pass. This newsworthy exercise advanced the concept of strategic airpower and did much to enhance the reputation of the studious and conscientious Curtis E. LeMay.

On May 12, 1938, Y1B-17s from the 2d Bombardment Group intercepted the Italian passenger liner* Rex *in marginal weather more than 700 miles from New York City. First Lt. Curtis LeMay was the lead navigator on this historic flight.

During World War II, Lieutenant Colonel LeMay organized and trained the 305th Group of thirty-six B-17 bombers and led it to England. At that time, the yet-to-be-mighty Eighth Air Force was not doing very well. Losses were heavy, and bombs were not hitting the targets. The Flying Fortresses had to run a gauntlet of bursting flak over their targets, and nervous pilots took violent evasive action. Colonel LeMay knew the Norden bombsight was not made for such gyrations. Evasive action on the bomb run would have to go.

Leading the next raid himself, LeMay flew straight and level on the ten-minute bomb run, disregarding the murderous flak. His bombs hit the target squarely, and luckily his unit took no losses. Soon all groups of the Eighth were following his gutsy example.

Then he conceived another way to improve accuracy: the lead crew concept. Organizing his best bombardiers, navigators, and pilots into a few lead crews, he had them do the navigating and bomb aiming for the whole group. Those lead crews thoroughly studied all prospective targets so that they were well prepared when the teletyped orders came in, just a few hours before the mission was scheduled to take off.

But losses in the Eighth continued to mount. Enemy fighters were taking a crippling toll, and Curt LeMay suffered with the loss of each airman. Col. John deRussy told me that when he returned from a raid on Kiel, he had lost so much blood from wounds that he barely retained consciousness. It was Curt LeMay who rushed through the shotup B-17 after it rolled to a stop and helped John from the cockpit.

Birth of the Combat Box

Insightful LeMay thought something could be done to reduce their cruel losses, and he worked out a new formation called the combat box. B-17s were staggered and stacked in such a way that almost every airplane was covered by the eleven .50-caliber guns of every other airplane. When fifty-four B-17s in a wing combat box flew into Germany, it became an indomitable force that was never turned back by enemy action.

This LeMay combat box was flown throughout the rest of the war in Europe. So with this, combined with improved bombing accuracy, Curtis LeMay was more than a little responsible for the great success of the Eighth Air Force. Had strategic bombardment failed, as it had for the Germans in the Battle of Britain, it is doubtful if Gen. Dwight Eisenhower would have made it to shore in Normandy. As it was, the D-Day forces were virtually unopposed by the Luftwaffe.

In mid-1943, Colonel LeMay was given command of the 3d Air Division. His inestimable worth was being recognized, and two stars would soon shine on his shoulders.

He led many missions over enemy territory, but his roughest was the shuttle operation to Regensburg and thence on to African bases. It was August 17, 1943, the first anniversary of the Eighth's puny initial raid with a dozen B-17s. This time a maximum effort of 375 Fortresses was launched to attack a Messerschmitt fighter factory at Regensburg and the ball-bearing plant at Schweinfurt. LeMay's division of 147 B-17s was to be first off.

Regensburg and Schweinfurt

The blanket of fog was so thick over his bases that lanterns and flashlights were needed to let the bombers taxi. One pilot said it was so bad he couldn't even see his copilot. But LeMay had foreseen such weather, had drilled his groups in instrument takeoffs, and managed to get them all into the air. The following 1st Division had not had such practice, and its departure was delayed for more than three hours. So LeMay's wing spearheaded the attack and took the full brunt of the vicious enemy defenses. At that stage of the war, friendly fighters had too little range to penetrate the Continent much beyond the enemy coast and offered only meager protection. "The only escort we saw," LeMay recalled, "had black crosses on their wings."

That Regensburg/Schweinfurt mission was one of the most savage air battles ever fought. For miles the sky was cluttered with burning airplanes and falling debris, smoke, black flak bursts, parachutes, and tumbling bodies. A total of sixty Flying Fortresses was shot down with the loss of some 540 crewmen. Aircraft that survived the onslaught brought home many killed and wounded.

But the redoubtable LeMay didn't turn back. Battling for hours with swarms of enemy fighters, he flew on. His bombers flattened the Messerschmitt factory and pressed on south over the Alps, Italy, and the Mediterranean to primitive bases in Tunisia.

After the airmen licked their wounds, LeMay led his crews back to England, bombing German targets on the way. But of the 147 Flying Forts that had departed the English bases, only eighty-five returned. For superb personal leadership on this first shuttle mission, General LeMay was awarded the Distinguished Service Cross, America's second highest combat decoration.

After D-Day, LeMay was ordered to command the new Twentieth Air Force of huge B-29s scheduled to attack Japan from bases in India, staging through China. This deployment was known from the start to be a marginal effort at best, but if anyone could make it work, it was Curtis LeMay. The task of bombing Japan with untested bombers from bases in central China where the only fuel available had to be flown in over the forbidding Himalayas (it took seven trips for one B-29 to bring in enough fuel for a single bomber sortie) was a challenge for LeMay's great talent. Several successful attacks were run, but logistics were simply impossible. The campaign was abandoned when the Marianas bases of Saipan, Tinian, and Guam became available.

The Firebombing of Japan

Late in 1944, LeMay and his B-29 Superfortresses began operating from the Marianas. The islands were near enough to Japan to put most of that empire under his air attacks.

General LeMay studies the results of a 300-plane B-29 raid on Tokyo during World War II while Brig. Gen. Lauris E. Norstad (left) and Brig. Gen. Thomas S. Power (right) look over his shoulder. These men would all have major roles in the postwar Air Force.

LeMay wasn't wedded to the successful tactics he used in Europe. This was a whole new ball game. The jet stream over Japan almost ruled out accurate bombing from high altitude. Moreover, B-29 engines weren't up to the demands and frequently caught fire. Contrary to all advice and against heated opposition from crews, LeMay directed his B-29s to bomb at night from only 5,000 feet and be stripped of guns and excess crew to save weight. Because cottage industries were supporting Japan's war effort, LeMay (with approval from Washington) began systematically burning up one city after another. He

even dropped leaflets announcing which cities he would hit next and urging the inhabitants to evacuate. "Your leaders cannot protect you," he warned. "Tell them to end the war."

Efforts were being made by Japanese authorities to surrender even before the first atomic bomb was dropped. Few will contest the conclusion that LeMay's forces provided the *coup de grâce* to a thoroughly defeated Japan and obviated a planned invasion by United States surface forces against a well-equipped and tenacious Japanese home army of 2,000,000. Army Chief of Staff Gen. George C. Marshall estimated American casualties alone might have been as high as a million.

When the Chief of the Army Air Forces, Gen. Henry H. Arnold, visited Guam in June 1945, LeMay told him, "The B-29s will surely knock Japan out of the war before November," the month of the planned invasion. The decision to use the two atomic bombs was made by President Harry S. Truman, and General LeMay carried out those orders, although he believed them unnecessary since in his judgment the war was all but won.

A Scowl and a Cigar

An unflinching disciplinarian with a frightening scowl, LeMay was often referred to as "Iron Pants." Those less affected by his tight command policies called him "The Cigar," for he was seldom without one clamped rigidly between his teeth. He demanded dedication to an all-out effort, and he got it.

But he had a compassionate side. Shortly after the Japanese surrender, two of Curt LeMay's pilots came to him with an odd request. They were brothers, Al and Jack Wilson. Their father, an infantry officer, had been captured at Bataan by the invading Japanese. The Wilson brothers had received word that their father was imprisoned somewhere in China. Would the General authorize them to borrow a B-29 and go look for their father? The General would. He had "AL-JACK" painted in large letters on the underside of a B-29 and wished the brothers Godspeed as they flew off on their sentimental journey.

After many days of fruitlessly buzzing one former Japanese prison camp after another, they noticed a commotion and panel signals being put out in one. Locating an airfield nearby, the brothers landed, found their father, put him aboard their B-29, and flew all the way home to California.

"I didn't worry about their not returning that B-29," LeMay said. "I knew most of them would end up in the boneyard anyway. I just put the brothers on R and R leave so they could enjoy a family reunion. Heard it was a lulu."

Shortly thereafter, LeMay himself piloted one of three B-29s that made a record nonstop flight from Japan to Chicago. Then, in 1947, the cold war intensified, and he was ordered to Europe to assume command of our air forces there. LeMay was America's "big stick" to warn off the USSR. This assignment brought Curt LeMay his third star.

The Berlin Airlift

Nor did the Berlin blockade find Curt LeMay wanting. He organized and supervised the airlift that saved West Berlin from Soviet control. Never before had a large city been totally supplied by air. When the Kremlin realized the blockade had failed, it was lifted.

To perform this miracle, LeMay achieved an informal cooperation among allied powers that set the pattern for NATO. By closing ranks and assisting in the airlift, the wartime western allies learned that they could face down the threatening Bear.

Late in 1948, LeMay was ordered home to take command of the new Strategic Air Command, America's atomic delivery force. He was given his fourth star and held that active rank longer than any other American general. The nine years he headed SAC were years when America, with its fate in his capable hands, felt comfortably secure from nuclear attack.

In 1955, I was working on a White House staff and overheard President Eisenhower say, "I'm counting on LeMay to keep us out of war." On a visit to SAC headquarters in Omaha, Neb., I passed this word to General LeMay, who was then wrestling with the Pentagon and Congress for funds and who needed all the help he could get. "I wish he'd tell *me* that," he growled.

When he was driving the Twentieth Air Force in the Marianas to the limit of endurance, he said, "I aim to shorten the war." And he did. As head of SAC he said, "I aim to prevent a nuclear war." And he did. He gave SAC the motto, "Peace Is Our Profession."

Innumerable successful innovations at SAC eventually set standards for the entire United States Air Force. Among them were a command structure that permitted the launching of aircraft in minutes to avoid destruction on the ground as at Pearl Harbor or from a surprise missile attack. His strip alert system of nuclear-loaded bombers inaugurated the concept of strategic deterrence now fundamental to United States defense policy.

Although he expected top performance at all times from his airmen, he was always alert to ways that might reduce their burdens and make life more pleasant. "I tried to get rid of those noisy, drafty, open-bay barracks we inherited from the Army," he told me. "Crews that flew at all hours couldn't get their sleep and had no privacy. The Air Force didn't see it my way, so I asked the good citizens of Omaha for help, and they financed a model dormitory-style barracks with private rooms and comfortable beds. Not long after that, this kind of barracks became standard for the Air Force."

The New Chief of Staff

Air Force Chief of Staff Gen. Thomas D. White moved LeMay back to Washington as his deputy in 1957, and in 1961, on General White's retirement, LeMay was selected to head the Air Force. As Chief of Staff, LeMay launched the United States into the era of the intercontinental ballistic missile (ICBM). Remarkable Soviet progress in this field had brought a shift in the power balance. Through a masterpiece of organization, General LeMay was able to procure and almost complete the emplacement of 1,000 Minuteman ICBMs in record time before his retirement in 1965. Thus was America's deterrence again enhanced through his leadership genius.

Once I accompanied General LeMay to the White House for an

arms-control meeting chaired by President John F. Kennedy. I had broken a hip and was on crutches, awkwardly attempting to carry a briefcase with all the pertinent papers the Chief might need. As we were about to enter his big car, the snap came loose on my briefcase, and the papers tumbled all over the sidewalk. General LeMay realized that I couldn't bend over. Without saying a word, he calmly gathered up all the papers, put them back in the briefcase, and carried it himself while I looked on with acute embarrassment. I wasn't used to having the Chief of Staff of the United States Air Force carry my briefcase.

En route, Curt joked wryly, "You know, sometimes I don't understand what they're talking about when they refer to destabilizing weapons and use other terms I've never heard of. I think somehow my military education must have been inadequate."

General LeMay reached the summit of a brilliant career in 1961 when he was named Chief of Staff of the Air Force. He is shown here talking with his Commander in Chief, Lyndon Johnson, in the President's office.

While commanding SAC, he was the fair-haired boy of both Congress and the press. America recognized him as a fighting general, a tactician and strategist without parallel and a leader in the mold of Ulysses S. Grant. His blunt but truthful remarks were refreshing. But the arms-control doctrine held that manned bombers were destabilizing and frightening to the Soviets and should be eliminated. A systematic condemnation of bombing and the number-one exponent of that form of warfare, Curtis E. LeMay, began to appear in the media. Before long, the hero had become a villain in some quarters.

Winding Things Up in Vietnam

LeMay said that the war in Vietnam could be quickly won by "bombing them back to the Stone Age." The press regarded this remark as cruel and heartless. In fact, LeMay was only saying that North Vietnam's industrial, fuel, and transportation systems could be completely destroyed by strategic bombing, leaving the enemy no wherewithal to wage war. This was the means by which he had contributed so much to our smashing victories on two fronts in World War II.

In frustration over the stalled Vietnam War truce talks, President Richard Nixon ordered B-52s against strategic targets in North Vietnam in December 1972. Thirteen days of bombing quickly brought Hanoi's negotiators back to the truce table and helped end the war. "They should have kept on until the North Vietnamese surrendered unconditionally," LeMay declared. Nevertheless, his faith in strategic bombing had been vindicated.

After retiring from the Air Force, General LeMay joined the third-party candidate for President, George Wallace, as running mate. They had no hope of winning the election in that 1968 campaign, but they thought they could win enough electoral votes to exact some concessions from the winner should a deadlock have to be resolved in the House of Representatives. LeMay felt that only a radical change in US policy could make possible a Vietnam victory, and Wallace provided hope for that change. Their game plan almost worked. Wallace and LeMay took five states, and Nixon defeated Hubert Humphrey, the Democratic candidate, by less than one percent of the vote.

Today, although active in numerous Air Force educational activities, Curt LeMay keeps a low profile, rarely giving interviews. "I never did like making speeches," he told me, "and now I don't have to." Unassuming, even somewhat shy, he rarely engages in small talk and takes refuge behind an ever-present pipe. Anything but aloof, he has a legion of loyal friends whom he regards with deep affection. When there's something important to talk about, he has no trouble expressing himself, and when there's a job to be done, he's a giant of purposeful activity.

This is the airman whose tactical ingenuity permitted the American Eighth Air Force to contribute so much to pounding Nazi Germany into impotence, who brought Japan to her knees with B-29 attacks, who conducted the Berlin Airlift, who built and commanded the Strategic Air Command that kept the peace for more than a decade with unquestioned nuclear superiority, and who organized the deployment of a thousand Minuteman intercontinental missiles that have since provided America with an unprecedented deterrent to war.

Yes, he is an airman who shook the world. ■

Maj. Gen. Dale O. Smith, USAF (Ret.), is a frequent contributor to this magazine. His by-line last appeared here in the October '86 issue with the humorous reminiscence "Philpott Has the Last Word." Earlier contributions have included "But for the Captains" (March '85) and "The Target Was Marienburg" (September '82). A 1934 graduate of West Point, he commanded the 384th Bomb Group, based in England, during World War II. During his USAF career, he commanded two air divisions and served in high-level assignments at the Pentagon. He retired in 1964 and began a second career as a writer. He has produced a number of books on defense-related matters.

VIEWPOINT

McNamara on Missiles

By Gen. T. R. Milton, USAF (Ret.), CONTRIBUTING EDITOR

Robert McNamara expands his assault on nuclear strategy. He is not alone in his dislike for nuclear weapons, but some worry that his solutions would mainly make the world safe for conventional war.

The 1960s were heady times for Robert S. McNamara, Secretary of Defense and, for all practical matters, the Commander in Chief. Scarcely a detail in the escalating Vietnam War escaped his notice. I recall, for instance, answering the telephone in PACOM's Command Center early one morning. The voice on the other end of the line was no flunky's, but that of Secretary McNamara himself, wanting confirmation on precisely how many oil tanks had been demolished by an air strike a few hours before.

As we all know, that enthusiasm gave way to disillusionment, and Mr. McNamara went off to the World Bank. Thirteen years later, he has once again interested himself in defense matters—this time, in the subject of nuclear weapons. In 1982, Mr. McNamara, along with Messrs. McGeorge Bundy, Gerard Smith, and George Kennan, produced an article for *Foreign Affairs* that called for NATO's renunciation of any first use of nukes. The authors, quickly labeled the Gang of Four by European statesmen, were roundly denounced in NATO circles as having done severe damage to the Alliance.

Robert McNamara's new book, *Blundering Into Disaster* (New York, Pantheon Books), is a further assault on the concept of nuclear weaponry. He states, in fact, that nuclear explosives serve no legitimate military purpose other than to deter the other side from using them. It follows then, according to that thesis, that we need only enough invulnerable missiles to assure the ability to inflict unacceptable damage on whoever launches a nuclear strike—in short, the strategy of Mutual Assured Destruction, so despised by advocates of SDI. Mr. McNamara, not surprisingly, is no fan of SDI and devotes a considerable portion of this small book to a critique of the concept.

The Strategic Defense Initiative, in McNamara's terms, is defined as Star Wars I and Star Wars II. Star Wars I is the President's original proposal for a perfect shield, a dream unattainable in our lifetime. Star Wars II is a missile defense, and there, in McNamara's opinion, lies the real danger. He believes missile defense, and thus a coupling of defensive and offensive systems, may give the appearance of a US first-strike strategy.

In all fairness, judging from their adamant opposition to SDI, the Soviets appear to share his concern. Reassuring statements by US leaders that the United States doesn't do that sort of thing will not suffice, in Mr. McNamara's opinion. Given the cynical nature of the Soviet system, he is probably right, but so what? We had an overwhelming first-strike capability years ago, and it was not destabilizing.

By and large, it is difficult to argue with the McNamara contention that nukes are not useful weapons, once employed. Their selective and precise use in a NATO context, for example, is an interesting theoretical strategy, but how to prevent an immediate escalation to an all-out nuclear war has not yet been satisfactorily explained. Beyond that, there is Europe's reluctance to be used as a nuclear battleground. And so, to a large extent, NATO's nuclear doctrine is a doctrine to be employed only *in extremis*. It sounds irrational, perhaps, but that is the logic behind it, and it has been convincing thus far.

Mr. McNamara has an abiding and fierce dislike of nuclear explosives, which is understandable. Most of us prefer not to contemplate nuclear war and what might remain afterward. The trouble is that nuclear weapons exist in vast numbers and are increasingly found in the hands of other than superpower countries. It might be useful to reduce the number of warheads, although even that is debatable given the havoc only a few could cause.

The main trouble I have with McNamara's crusade against the nuclear arsenal, however, is his pie-in-the-sky alternative. For a man who has such contempt for the SDI concept, solving the nuclear weapons dilemma by bolstering NATO's conventional forces is a bit unrealistic. It is particularly unrealistic to urge nuclear forbearance before there has been the slightest indication that NATO, or the United States, would be willing to undertake a massive buildup of conventional forces. From all the evidence of the years since NATO adopted a strategy of flexible response, at McNamara's urging and with fingers crossed, it will be lucky if it can hold on to what it has. Only the threat of the use of nuclear weapons, if and when needed, has made the Alliance credible.

When he was Secretary of Defense, Robert McNamara had an unconcealed lack of respect for military advice. The Tuesday White House sessions during which bomb loads, targets, and even tactics were decided took place for years with no military man present. The Secretary of Defense was expert enough.

In *Blundering Into Disaster,* Mr. McNamara, uncharacteristically, does shore up his case by dropping a few military names, albeit predictable ones. He could have dropped a few more so long as he sought opposition to an unbridled nuclear strategy. But to deny that nuclear weapons might be used to avoid a capitulation of the West is something else again.

In essence, as someone has remarked, Robert McNamara is just trying to make the world safe for conventional war. And that, given Soviet force preponderance and the monolithic and uncomplicated Soviet decision-making apparatus, is a world where the odds would be heavily against our side. ■

AIRMAN'S BOOKSHELF

"Greatest Air Commander"

Iron Eagle: The Turbulent Life of General Curtis LeMay, by Thomas M. Coffey. Crown Publishers, Inc., New York, N. Y., 1986. 474 pages with photos. $18.95.

Any thorough discussion of the uses of strategic air forces in warfare will surely bring forth the name of Gen. Curtis E. LeMay.

His achievements as probably the greatest air commander the US has ever produced are generally unknown or forgotten today. Few know of the devastating aerial bombing attacks he led against Nazi Germany and a militarily aggressive Japan in World War II, how he organized the Berlin Airlift in 1948 that saved West Berlin from the Soviet blockade, how he built the powerful Strategic Air Command, which has done so much since the 1940s to help deter another world war, and, later, how he served as Chief of Staff of the US Air Force under Presidents Kennedy and Johnson.

General LeMay is more widely remembered—mistakenly, says Thomas Coffey—as the bomber general whose professed solution to all grave national military threats was aerial bombardment, preferably with nuclear weapons.

In LeMay's own book, *Mission With LeMay,* published eight months after his retirement as Air Force Chief of Staff, is this statement about bringing an end to the Vietnam War: "My solution to the problem would be to tell them frankly that they've got to draw in their horns and stop their aggression, or we're going to bomb them back into the Stone Age." He followed this with a list of suggested targets for air operations. "These would not necessarily require the introduction of nuclear weapons," he wrote. "This could be done with conventional weapons."

LeMay's book was presented as his autobiography, but had actually been written by MacKinlay Kantor, a popular novelist and friend of LeMay.

Unfortunately for General LeMay, "Stone Age" is a term that nowadays conjures up chilling thoughts of devastation in the aftermath of nuclear war.

Coffey writes, "These words, which he never uttered, but which he failed to catch in reading the manuscript, have helped make him one of the most controversial military men of our time."

He adds, "That one quotation alone didn't do the job, of course. LeMay himself helped. He was, throughout his career, so blunt, uncompromising, and unpolitical, his closest friends called him, with irony, 'The Diplomat.' "

This masterfully crafted biography is a hefty volume, but it is so deftly organized and so thoroughly researched that it makes for fascinating reading throughout. Anyone who served the US in World War II is likely to feel bittersweet twinges of nostalgia while reading the book. And every reader will find revelations of heretofore secret negotiations among policymakers in the Pentagon.

Most rewarding, though, is the author's success in penetrating the shield that the "Iron Eagle" fashioned for himself from his earliest days in Ohio. Coffey breaks through the LeMay mystique and shows us a man of many exemplary, even heroic, qualities, along with shortcomings unique in a person of his unparalleled accomplishments.

Work was the secret of his extraordinary success. He always "did his homework." As a first lieutenant, he was the navigator on several of the most important pioneering navigational flights in history.

Training, never-ending training—sometimes even immediately after a mission—was almost an obsession with LeMay as he strove always for better performance. In England during World War II, he sometimes stayed awake at night working on tactics, making mathematical calculations and sketches of flight formations. As group and then division commander, he contributed, more than any of his colleagues, to the tactics that finally enabled the daylight bombing strategy to work against Nazi Germany.

As the commander of Twentieth Bomber Command in the Pacific, LeMay inaugurated the B-29 incendiary tactics that left Japan nearly prostrate even before the introduction of the atomic bomb in August 1945.

When he retired in 1965, General LeMay was fifty-nine and had been in the military for thirty-seven years. He'd been a general officer for twenty-two years. In 1944, at thirty-seven, he had become the youngest major general in the US Army (of which the Air Force was then a part). He is the only person other than Ulysses S. Grant to have become a four-star general by the age of forty-five.

Thomas Coffey's engrossing biography of Curtis LeMay goes a long way toward revealing the whole truth about this extraordinary man.

—Reviewed by Frank W. Jennings, former Editor, Air Force Policy Letter for Commanders. For more on General LeMay, see "The Airman Who Shook the World" on page 100 of this issue.

Aviation's Advances

The Leading Edge, by Walter J. Boyne. Stewart, Tabori & Chang, Inc., New York, N. Y., 1986. 231 pages with photos and index. $29.95.

Walt Boyne, who is more than simply a well-known author in a literary profession that remains as competitive as the equipment about which it writes, has created one of those rare professional references that is a must for every respectable aviation library. *The Leading Edge,* as Mr. Boyne's latest is entitled, is an aesthetic tour de force of aviation advances, describing a subject that is more than worthy of such effort. It is the kind of aviation book many of us in the aviation writing business have envisioned for many years. Until now, none of us has had the guts or the gumption intellectually or physically to commit it to paper.

The Leading Edge is, simply stated,

a stunningly beautiful book and, as such, an exercise in technical aesthetics that will not easily be overshadowed in the foreseeable future. The publishers, Stewart, Tabori & Chang, Inc., have taken this project seriously and, accordingly, have opted to create a product that has been designed and produced to an extraordinarily high standard. From design and layout to paper quality and color photo reproduction, *The Leading Edge* is exquisite.

The book was, in fact, printed in Japan by the Dai Nippon Printing Co.—the same printers who put together such noteworthy periodicals as *Koku Fan*. Dai Nippon's color work approaches the ultimate possible in the printing business, and with *The Leading Edge*, they have underscored, yet again, their dominance in this highly competitive field.

Mr. Boyne, whose insightful text is quite commendable and whose complementary photo selection is superb, has put together a broad overview that does an outstanding job of presenting what the publisher refers to as "a fascinating retrospective of the leading edges in aviation technology." In truth, this book amounts to much more, for not only do the text and photographs cover the hardware, personalities, and events that represent the essence of the "leading edge," they also subtly project and make tangible the mystique that surrounds this massive technological triumph and that is at the core of every flying machine since the days of Daedalus.

Flying machines and the innumerable parts thereof, by the hundreds, are photographically explored in this book. And as per Mr. Boyne's well-known penchant for eclecticism, there is no bias among props and jets, biplanes or monoplanes, American aircraft or foreign. From the immortal "Jenny" to the seemingly inimitable SR-71, the breadth and height of the world of flight and flying are gently but adequately heralded.

In conclusion, if you enjoy spectacular aircraft photography and pithy text, all reproduced between two covers to the highest quality standards, *The Leading Edge* is a must. I find it difficult to recommend a book more highly.

—Reviewed by Jay N. Miller. Mr. Miller is Publisher for Aerofax, Inc.

New Books in Brief

The Automated Battlefield, by Frank Barnaby. In this work, nuclear physicist Barnaby looks into the future of warfare and posits the development of high-tech military forces that function autonomously in battle. Such advances as phased-array radars and other sophisticated surveillance systems, microprocessor-based target-acquisition systems, advanced guidance systems, and highly lethal, "smart" conventional munitions will make possible the largely "remote" prosecution of war by human beings—a vision of war "fought with machines and computerized missiles with no direct human intervention." The author concludes that automation should lead to a NATO strategy of "conventional nonprovocative defensive deterrence" that eschews first use of tactical nuclear weapons. His judgments on the ultimate impact of battlefield automation promise to provoke spirited debate. With photos and index. The Free Press, New York, N. Y., 1986. 185 pages. $18.95.

An Illustrated Guide to Aircraft Markings, by Barry C. Wheeler. Author Wheeler, who is Editor of the *Joint Services Recognition Journal*, here details the color and camouflage schemes for the military aircraft of more than 100 of the world's air forces. In addition to a nation-by-nation register of national insignia, this book explores aircraft markings for air superiority, ground attack, penetration, naval applications, and such special categories as aggressor training and aerobatic aircraft. Also examined are high-tech concealment techniques now being developed and applied by various air forces. This profusely illustrated work will be valued by professional and hobbyist alike. An Arco Aviation Book published by Prentice Hall Press, New York, N. Y., 1986. 156 pages. $9.95.

Images of Flight: The Aviation Photography of Rudy Arnold, by E. T. Wooldridge. The airplane inaugurated a revolution in photojournalism, enabling a degree of aspect and access that had not been possible before the advent of flight. Photographer Rudy Arnold understood that possibility and exploited it to the fullest, becoming the nation's premier aerial photographer from the 1920s to the 1940s. His work appeared in most of the major newspapers and magazines of the day, covering air races, natural disasters, industrial accidents, and a world at war. Author Wooldridge has gathered here some of the best examples of Arnold's work and has framed the pictures with a sound text that details his thirty-year career. Smithsonian Institution Press, Washington, D. C., 1986. 160 pages. $16.95.

The Military Balance 1986–1987, compiled by the International Institute for Strategic Studies. Longtime readers of this magazine should be well acquainted with the IISS's annual catalog of the world's military forces, which for many years had been reprinted in condensed form in the December issue of AIR FORCE Magazine until the IISS's withdrawal of reprint rights last year. This year's edition follows true to form in its comprehensive, detailed accounting of the military hardware of the nations of the world. In its analyses, the Institute characterizes superpower strategic forces as being in rough balance and points out that both sides continue significant investment in strategic defense research, with Soviet efforts "thought to be on the scale of American efforts." The International Institute for Strategic Studies, London, UK, 1986. 238 pages. $24.95.

Modern Fighting Aircraft: B-1B, by Mike Spick. This eleventh entry in the Arco series on military aircraft makes a timely appearance with the delivery of the first operational B-1Bs to Dyess AFB, Tex. Author Spick's large-format work sketches the history of the development of SAC's newest manned bomber and provides basic information on the aerodynamics, engines, avionics, and armament of the swingwing penetrator. The cutaway drawings and color photography are special highlights. An Arco Aviation Book published by Prentice Hall Press, New York, N. Y., 1986. 64 pages. $12.95.

USN: Naval Operations in the '80s, by Michael Skinner. The United States is indisputably a maritime power—history and geography conspire to ensure that fact. Those realizing this truism for the first time can acquaint themselves with the nuts and bolts of that power by enjoying this lively overview of the United States Navy. Author Skinner takes the reader on a tour de force of naval operations, covering the surface community, the submarine fleet, and naval air. A series of appendices rounds out the picture with basic information on such topics as organization, ranks, hardware, markings, and the Soviet adversary. This book is a crack introduction to the ways and workings of the American fleet. With photos and glossary. Presidio Press, Novato, Calif., 1986. 142 pages. $12.95.

—Reviewed by Hugh Winkler, Assistant Managing Editor.

A Man for His Time

The pilot for whom Luke AFB was named is a unique figure in the history of air warfare.

BY JOHN L. FRISBEE
CONTRIBUTING EDITOR

FRANK Luke ranks second to Eddie Rickenbacker among American aces who flew with the Army Air Service in World War I. He was the first airman to be awarded the Medal of Honor, but in several respects, Luke is least typical of the fifty-eight Air Force men who have earned that distinction in four wars.

Luke earned his wings at Rockwell Field, Calif., in January 1918. When he showed only mediocre ability during operational training in France, he was assigned the unglamorous task of ferrying planes to the Front. For a young man motivated by a lust for personal glory earned in combat, that was a bitter blow. He compensated by constant bragging about his skill as a pursuit pilot and by flouting regulations.

The final German offensive kicked off on July 15, with American pursuit squadrons suffering heavy losses. On July 26, Lieutenant Luke was sent as a replacement to the 27th Aero Squadron of the 1st Pursuit Group. He immediately alienated the old hands by bragging about his untested ability.

On August 1, during his first patrol, led by squadron commander Maj. Harold Hartney, soon to become group commander, Luke left the formation to go off on his own. Turning a deaf ear to Hartney's lecture on air discipline, Luke repeated that performance in his next two missions, once claiming an unconfirmed victory.

None of the squadron's flights wanted the unreliable Luke. He was an outcast with no friend other than Lt. Joseph Wehner, a quiet young man who was intrigued by Luke's unorthodox behavior. Luke asked Major Hartney to let him fly solo patrols, and Hartney, apparently seeing some potential in the unruly pariah, agreed.

By September 11, Frank Luke's search for glory remained unrewarded. That evening, he heard some of the pilots talking about the most dangerous of targets—tethered enemy observation balloons. Each balloon site was surrounded by a ring of antiaircraft guns and a second ring of heavy machine guns and protected by pursuit planes stationed at nearby strips. The pilots agreed that they would attack a balloon only if ordered to do so. Immediately Luke knew he had found his path to fame.

He persuaded Joe Wehner to fly cover for him the next day when he intended to—and did—explode his first balloon. Heading for home base to post his victory claim, Luke left Wehner without cover as the latter attacked another balloon, a pattern that was to continue so long as the two flew together.

Luke and Wehner soon concluded that the best time to attack balloons was at dusk, when the big bags were being hauled down. On September 18, Frank Luke had his best day, shooting down two balloons, two Fokkers that attacked Wehner and him, and one German observation plane to become the leading Air Service ace. Wehner, with eight victories—second only to Luke—was shot down that day and died in a German hospital.

Balloon-busting World War I pilot Frank Luke flouted regulations, but scored eighteen victories in as many days.

Luke's arrogance mounted with his victories. Several times he landed at French fields to spend the night. On September 29, after still another AWOL episode, his new squadron commander, Capt. Al Grant, grounded his fifteen-victory pilot. Luke's response was to fly to an advance field where he planned to refuel and attack three balloons reported near Murvaux.

Grant phoned the field commander, ordering that Luke be placed under arrest. By coincidence, Group Commander Major Hartney landed moments after Luke and, not knowing the circumstances, approved Luke's request to hit the balloons.

While Hartney watched, there were three explosions in the gathering dusk, just as Luke had predicted. Grant is reported to have said that when Luke returned, he would court-martial him, then recommend him for the Medal of Honor.

Luke never returned.

The details of Luke's death were not known until after the war. His Spad had been damaged on one pass at a balloon, and perhaps Luke had been wounded. He may have shot down two of the Fokkers that pursued him in the twilight. Certainly he machined-gunned German troops near Murvaux, then landed in a field and was surrounded by enemy soldiers. Luke drew his pistol and killed three Germans before he was fatally shot in the chest.

Eddie Rickenbacker called Frank Luke "the greatest fighter who ever went into the air." He was a fighter to the end. Arrogant, self-centered, and undisciplined, Luke probably would have been a failure in later wars, but in the freewheeling days of the baptism of air combat, he earned a niche for himself in the history of military aviation with eighteen confirmed victories in as many days.

He was, indeed, a man for his time. ■

AFA INTERCOM

By Robin Whittle, AFA DIRECTOR OF COMMUNICATIONS

New York Hosts Italian AFA

It started with a simple *buón giorno* o AFA headquarters in Arlington, Va., ınd wound up becoming an interna- ional happening of unusual dimen- ions.

The Italian Air Force Association, ed by its President, Gen. Catullo Nar- li, decided to contact AFA when the roup arranged to visit America in October. The group would be accom- panied by the Italian Air Force Band, which was scheduled to give a concert it Lincoln Center in New York City.

New York AFA President Maxine Donnelly accepted the task of hosting he Italian AFA delegation during their stay in New York. But, in fact, the en- ire Northeast Region got involved, as did AFA Board Chairman Marty Harris and National Directors Jack Kruse, Gerry Hasler, and Bill Rapp, among many other Northeast Region AFAers.

As details of the Italian AFA trip un- folded, Maxine Donnelly decided to go to Italy in August to smooth the way for the two Associations to get ogether. The result of that planning rip made for an interesting several days, according to all who joined in he festivities.

Arriving in New York on Friday, Oc- tober 10, the Italians began a whirl- wind three-day tour of the Big Apple hat included Mass at St. Patrick's Ca- hedral, a New York AFA-hosted re- eption at the Southgate Hotel with many prominent aerospace leaders present, participation with New York AFA in New York's famed Columbus Day Parade, a tour of Long Island's Cradle of Aviation Museum, a wreath- laying ceremony at Pinelawn National Cemetery, and a thrilling night at the races, during which the sixth race was dedicated to the Italian and New York Air Force Associations.

The evening included a joint dinner at the Roosevelt Raceway Clubhouse. The New York leg of the trip was capped by the Italian Air Force Band concert at Lincoln Center on October 13. AFA Board Chairman Marty Harris and Italian AFA President General Nardi exchanged greetings and warm remarks on stage during the concert.

In October, New York AFAers and the Italian Air Force Association enjoyed many exciting events together, including a night at Roosevelt Raceway. Pictured from the left are AFA National Director Bill Rapp, Italian AFA President Gen. Catullo Nardi, harness racer Mark Lancaster and "No Compromise," Italian Defense and Air Attaché General Lenzo, and New York AFAer Bill Kaiser.

Then it was on to the nation's capital for an awards luncheon and special tour of the Smithsonian Institution's National Air and Space Museum, which included an exhibit on Gianni Caproni, the pioneer Italian aircraft designer.

"We've been invited to visit our new Italian AFA friends in Italy in the future, and, in fact, I'm planning a trip for January," Maxine Donnelly said. She also intends to gather as much information as she can on today's Italian Air Force."The Italian AFAers are organized in this country as well. In fact, they are now in New York, Washington, D. C., and Texas. It could be that our AFA chapters in these locations might want to consider joint programs in the future. They are a wonderful bunch of people," she added.

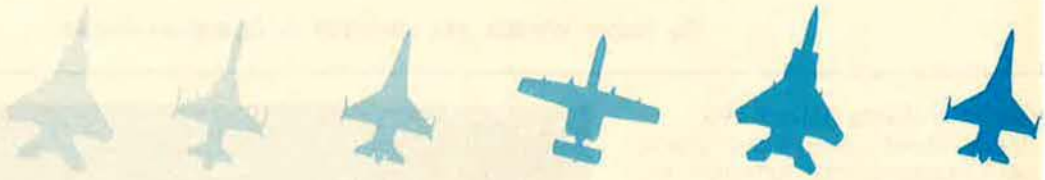
Spitfire Anniversary Celebrated

On National POW/MIA Day last September 19, AFA's Golden Gate Chapter joined the Royal Air Force Association and the Western Aerospace Museum for a dinner celebration of the fiftieth anniversary of the Spitfire. The Spitfire first flew on March 5, 1936, out of Eastleigh Airport in England.

Held at the Presidio Officers' Club in San Francisco, the event attracted some 130 guests. Featured guests included Ronald T. Reuther, President of the Western Aerospace Museum; Kenneth Culverson, a retired US Navy officer, who spoke on"National POW/ MIA Day"; Robert Reynolds, Secretary of the Royal Air Force Association, who discussed the Battle of Britain; and former Spitfire pilots James Gray, George Solak, and George Sperry, who reminisced about the

An Air Force Association National Symposium

"Tactical Air Warfare — Status and Prospects"



In conjunction with the Tactical Air Command, we are sponsoring our third annual Symposium to provide in-depth assessments of tactical air requirements and related topics from research and development and hardware to doctrine and the growing Soviet threat. Such topics as the AirLand Battle, theater air defense, defense suppression, tactical command and control, electronic warfare, and close air support will all be explored extensively.

January 29—30, 1987

The Buena Vista Palace Hotel
Lake Buena Vista, Fla.

The tentative lineup of distinguished speakers includes:

Hon. Richard P. Godwin, Under Secretary of Defense for Acquisition
Hon. Donald C. Latham, Assistant Secretary of Defense for C³I
Gen. Charles L. Donnelly, Jr., Commander in Chief, USAFE
Gen. Robert D. Russ, Commander, TAC (Keynoter)
Gen. George B. Crist, USMC, Commander in Chief, Central Command
Gen. Carl E. Vuono, USA, Commanding General, Training and Doctrine Command
Lt. Gen. Jack I. Gregory, Commander in Chief (designate), PACAF
Lt. Gen. Melvin F. Chubb, Commander, Electronic Systems Division, AFSC
Lt. Gen. Harry A. Goodall, Acting Commander in Chief, Readiness Command
Maj. Gen. Gordon E. Fornell, Commander, Armament Division, AFSC

We know you will want to take advantage of this topical, important Symposium as well as the many attractions in the Orlando area. Space is expected to be limited, so sign up now. Registration for all Symposium events is $225 ($250 for non-AFA members).

For information and registration, call Jim McDonnell or Dottie Flanagan at (703) 247-5800.

Special Note: AFA's Central Florida Chapter is sponsoring a Golf Tournament on Wednesday, January 28, and a black-tie gala on Friday evening, January 30. Inquiries about these local events should be addressed to the local contacts—Mr. Ty Arnold at (305) 867-4714 or Ms. Nancy Blue at (305) 356-8408.

REGISTRATION FORM
A 1987 Air Force Association National Symposium

"Tactical Air Warfare— Status and Prospects"

NAME (Print) _____

TITLE _____

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ADDRESS _____

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TELEPHONE: (Code) _____ *(No.)* _____

My check covering the Symposium fee for AFA individual or Associate member of $225, payable to the Air Force Association, is enclosed. The fee includes one (1) Reception/Dinner ticket. (Note: Fee for non-member is $250.)

_____ *Mark here if an additional guest Reception/Dinner ticket is desired. Enclose $85 for the additional ticket.*

Registration closes Monday, January 19, 1987. No refunds can be made for cancellations after that date.

Mail this form to:
Air Force Association
Attn: Miss Flanagan
1501 Lee Highway
Arlington, Va. 22209-1198

amed fighter. The evening also featured a benediction and airman's prayer by Chaplain Ruxton Fox and the screening of a film on the Spitfire.

Community Partners Visit Tinker AFB

In October, AFA's Central Oklahoma (Gerrity) Chapter invited a group of its Community Partner members and patrons to Tinker AFB for a briefing. At an appreciation breakfast in honor of the Community Partners, Maj. Gen. William P. Bowden, Commander of the Oklahoma City Air Logistics Center, recounted his pride in the Gerrity Chapter, which he had joined a decade ago during his first assignment at Tinker AFB. He also praised AFA's Community Partner program, which has strengthened AFA in meaningful ways and has bolstered its leadership and effectiveness.

Following the breakfast, the group was escorted by Col. James R. Sterk, Commander of the 552d Airborne Warning and Control Wing, on a tour of the 552d alert facility. Gerrity Chapter President Michael O'Hara, a civilian personnel officer at Tinker AFB, briefed the group on base-personnel matters and logistics operations. Next on the tour was a visit to the AWACS flight line, followed by a briefing by the maintenance director, Col. Albert Schmidt. The Community Partners were shown depot-level overhaul, breakdown, and rebuilding of the TF30, J57, TF33, TF41, F110, and F101 jet engines and the depot-level repair of A-7 fighter aircraft.

Colonel Schmidt's briefing concluded the Tinker AFB tour. Gerrity's Community Partners came away better informed about operations at Tinker AFB and its support of the Air Force's global mission, Gerrity officials reported.

On the Scene

Lately, several AFA leaders have been making their views known in the local press in support of AFA objectives. Louisiana AFA President **Paul Johnston,** an Air Force veteran now retired and in private business in Alexandria, La., was interviewed by reporter **Danny Heitman** of the Baton Rouge *State Times* on President Reagan's refusal to trade away the Strategic Defense Initiative at the US-Soviet summit in Iceland. Mr. Johnston seized the opportunity to quote from the AFA policy paper adopted by AFA convention delegates last September. Mr. Johnston noted that SDI was "one of the most important technological programs the nation has ever undertaken. However, it is not a deployment program, nor is it a substitute for the modernization of our strategic nuclear, nonstrategic nuclear, and conventional forces."

Mr. Johnston told the reporter that he supported arms control, where practical. "I think it would be to everybody's advantage to build down," he said. But a frequent snag in the arms-control process, he pointed out, has been the unreliability of the Soviets. "We have found that out over the years. When President Reagan backed off from Reykjavik, I think he did the right thing," the AFA leader said.

Former AFA National Director **Tom Bigger,** an active leader in Tullahoma, Tenn., wrote a letter to the editor in support of President Reagan's position in Iceland. The letter appeared in the October 21 Tullahoma *News & Guardian*. "It borders on irresponsibility for news analysts and politicians to immediately begin criticizing President Reagan's decision based on their opinions and theories. These actions appear to be attempts to gain attention and to promote personal ambition and/or partisan politics and are not in the best interests of our country," Mr. Bigger concluded. The letter also appeared in the Chattanooga *News/Free Press* on the same day.

Former AFA National Treasurer and current Aerospace Education Foundation Treasurer **Jack B. Gross** wrote a letter to the editor that appeared in the October 19 New York *Times*. Mr. Gross wrote in reference to the resignation of State Department spokesman **Bernard Kalb** over the alleged disinformation program. "Yet, one wonders whether in rare instances some deception might be justified for the common world interest. If we regard terrorism as despicable and something to be crushed, certainly every ploy and stratagem to use against it should be examined for practicality rather than whether it conforms to normal diplomatic mores.

"We and our allies frequently used deception in World Wars I and II with no hesitation. The ultimate goal of victory was overriding. To have thought otherwise would have been naïve and defeating. And the horror of terrorism, whether induced by a Libya or Syria or whoever, must be attacked with the use of any wartime expedient," Mr. Gross wrote, adding that his letter was not meant to suggest any criticism of Mr. Kalb's action.

Longtime Alabama AFA leader **Cecil Brendle** earned the accolades of **Col. Ed White** and **Maj. Tim Krull** of the Air Command and Staff College at Maxwell AFB, Ala., for helping to make a reality of the dream for an F-4 display at Tuskegee University's new Gen. Daniel "Chappie" James, Jr., Center for Aerospace and Science.

Tuskegee University President **Dr. Benjamin Payton** had asked the Air Force for an F-4 to display near the main entrance of the new building, which is slated to be dedicated in May.

INTERCOM

Director of Maintenance at the Oklahoma City Air Logistics Center Col. Albert Schmidt explains the workings of the complex to AFA Community Partners from the First National Bank of Midwest City, Steve Spencer (center) and Noal Shuffield (right).

INTERCOM

General James flew the F-4 with the 8th Tactical Fighter Wing at Ubon AB, Thailand, during the Vietnam War. Then-Air University Commander **Lt. Gen. Thomas C. Richards** tapped Colonel White and Major Krull to head the project. After a great deal of research and the assistance of Air National Guard Headquarters and the Alabama National Guard, led by Colonel Brendle, the two located an F-4C, tail number 64-0851, that General James had actually flown in combat in Southeast Asia. It had been scheduled for destruction by the US Army Ballistic Research Laboratory.

After being flown to Maxwell AFB, Ala., the F-4 will be prepared for static display and moved by crane helicopter to its final resting place early in 1987 by members of the Alabama National Guard. The James Center at Tuskegee will house the school's AFROTC offices, the Gen. Daniel "Chappie" James Museum, and the aerospace engineering department. General James was a 1942 graduate of Tuskegee and a member of the Tuskegee Airmen.

"Winning nine out of a possible eleven trophies available to a collocated B-52/KC-135 wing is a feat unmatched in the history of BOMB COMP," CINCSAC **Gen. Jack Chain** said in announcing the amazing win by the 92d Bombardment Wing of Fairchild AFB, Wash., in SAC's Bombing and Navigation Competition. AFA's Inland Empire Chapter in nearby Spokane presented special jackets and caps to the BOMB COMP crews, as it had for members involved in a Weapons Loading Competition held in July. "We were certainly proud to have the 92d wearing our jackets and caps after securing such an impressive win," said Washington AFA President and former Inland Empire Chapter President **Charles Burdulis.** The Chapter's expenses for the two competitions exceeded $5,000, "but were well worth it."

The competition pits aircraft crew from SAC's sixteen bombardmen wings against one another to tes their proficiency in bombing and nav igation. The teams are rated on preci sion navigation, high- and low-leve bombing, and defensive capabilitie over a six-month period.

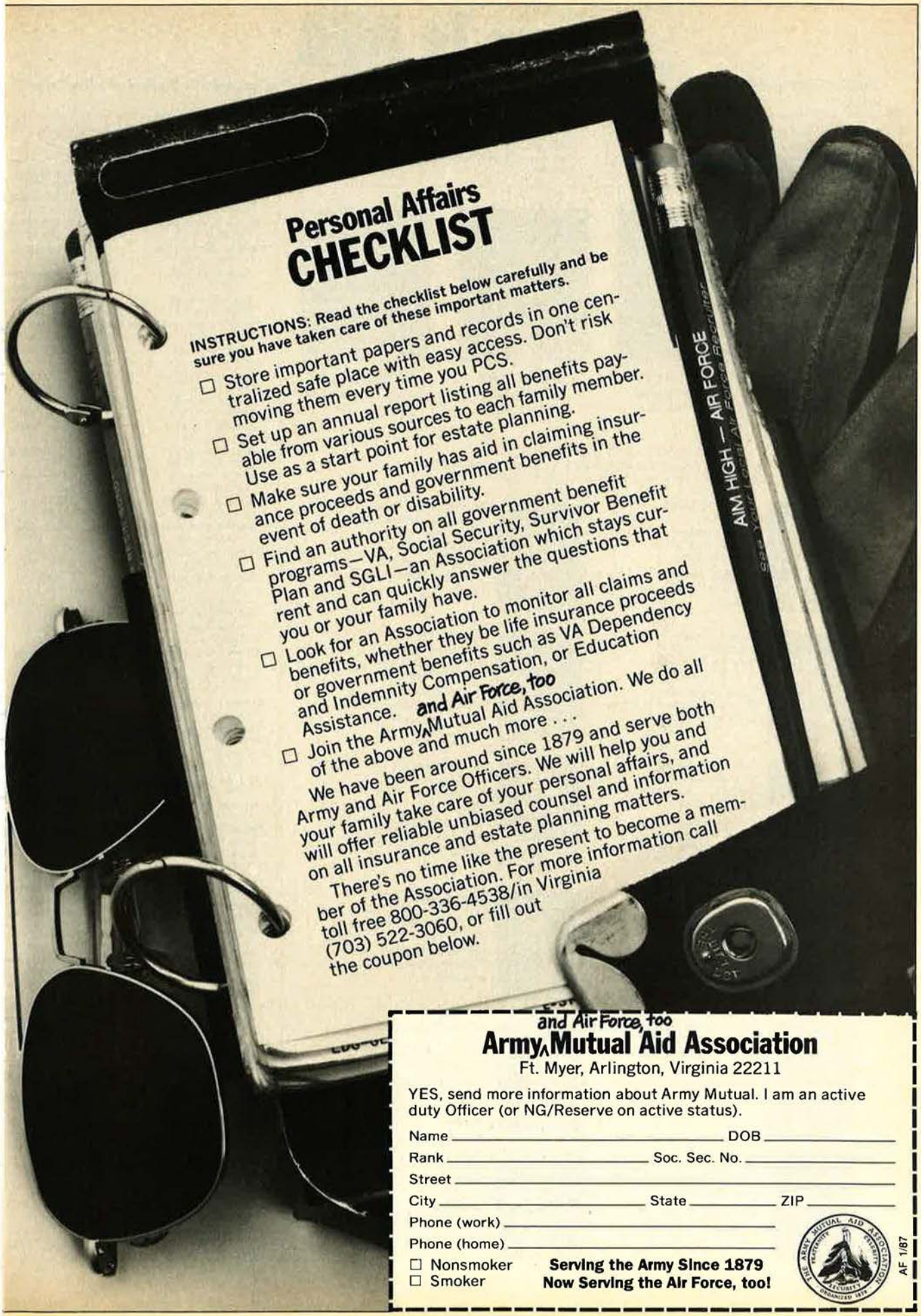
During a recent joint meeting of th Front Range, Silver and Gold, an Blue Baron Chapters at Lowry AFB Colo., Aerospace Education Founda tion Chairman **George D. Hardy,** a for mer AFA national president, boar chairman, and director, discusse problems in American education an the role AFA might play in remedyin

The 92d Bomb Wing of Fairchild AFB, Wash., won nine out of a possible eleven trophies in SAC's Bombing and Navigation Competition. Here, team members sport jackets furnished by AFA's Inland Empire Chapter of Spokane, Wash.

AEF Chairman George D. Hardy (left) meets with (from left) Brig. Gen. Edwin Wittbrodt, USAF (Ret.), recipient of a Doolittle Fellowship; outgoing Colorado AFA President Tom Ratterree; and Jim Clark, recipient of AFA's Exceptional Service Award.

them. During the event, Mr. Hardy presented a General Jimmy Doolittle Fellowship to retired **Brig. Gen. Edwin Wittbrodt.** Also honored were outgoing Colorado AFA President **Tom Ratterree** with a congratulatory plaque from current Colorado AFA President **Jack Powell** and Front Range Chapter Past President **Jim Clark** with AFA's Exceptional Service Award for significant contributions during four terms as Chapter president.

Following a recent luncheon at New York's "21" Club, Iron Gate Chapter members **Bob Kane** and World War II fighter ace **Francis "Gabby" Gabreski** discussed aerial combat maneuvers. Mr. Kane, a New York public relations consultant who had served in 3d Fighter Command, Tampa, Fla., as a sergeant during World War II, had a good time showing 8th Fighter Command pilot Gabreski, who compiled a total of 34½ victories during World War II and Korea and



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OBJECTIVES: The Association provides an organization through which we as a free people may unite to address the defense responsibilities of our nation imposed by the dramatic advance of aerospace technology; to educate the members and the public at large in what that technology can contribute to the security of free people and the betterment of mankind; and to advocate military preparedness of the United States and its allies adequate to maintain the security of the United States and the free world.

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INTERCOM

vho is America's top living ace, how hey did it down south. Both now live on Long Island, where Mr. Gabreski vorks for the Grumman Corp.

John Paul Riddle of Coral Gables, Fla., was recently honored at the wentieth annual Pikeville Old Timers' Dinner held in Pikeville, Ky. A Pikeville native, Mr. Riddle is an aviation pioneer and a contemporary of many Air Force leaders of the past generation. He joined the Army Air Service in September 1920 and attended an air service mechanics school. Following a short barnstorming career, Mr. Riddle bought two Waco biplanes and started a flying service. Soon after, he formed a partnership with **T. Higbee Embry** of Cincinnati, Ohio, and the two started the Embry-Riddle Flying School in 1926 as part of the Embry-Riddle Co.

Subsequently, the school moved to Florida and trained thousands of US and Allied pilots, mechanics, and technicians prior to and during World War II. Today, Embry-Riddle Aeronautical University is the world's only completely aviation-oriented university. During its sixty-year history, more than 50,000 students have studied at more than eighty campuses around the world. Mr. Riddle is still active on the board. He also formed Riddle Airlines and has been instrumental in the training of pilots in Europe and South America. John Paul Riddle is "an old, bold pilot" in the Rickenbacker tradition, said **Walt McNeil,** Pikeville AFA leader. "Riddle flew a JN-4D 'Jenny' under the bridge leading into Pikeville on July 4, 1923."

AFA's Albuquerque Chapter presented scholarships worth $250 to **Jon D'Andrea,** Cadet Drill Team Commander, and **Brian Eckerson,** Arnold Air Society Commander from the University of New Mexico, at a quarterly meeting recently, reports AFA Chapter President **Roscoe L. Bell** . . . AFAers in Mobile, Ala., turned out in November to support the Mobile Bay Area Veterans Day Commission, Inc., in a tribute to the 8,100 veterans residing in the Mobile Bay area . . . "The average American thinks we spend twice as much on defense as we actually do. . . . In the past five years, the public consensus, which was once seventy-one percent for increased defense spending, has dwindled to just fourteen percent," said **Lt. Gen. Bernard P. Randolph,** Deputy Chief of Staff for Research, Development and Acquisition, at a Virginia AFA meeting at the Sheraton National Hotel in Arlington, Va., in September.

AFA National Director and former AFA national president and board chairman **Dave Blankenship** was among the more than 1,000 USAFE members and distinguished guests at the Air Force anniversary ball held at Ramstein AB, Germany, to celebrate the Air Force's thirty-ninth birthday. The Ramstein NCO Club staff transformed a base aircraft hangar into a large ballroom to accommodate the crowd, which, officials said, was the largest ever to gather at a military in-

AFA's Albuquerque Chapter recently awarded scholarships to AFROTC cadets from the University of New Mexico. From left are Cadet Carol Janni, AFA Chapter President Roscoe L. Bell, AFROTC scholarship recipients Jon D'Andrea and Brian Eckerson, AFAer 1st Lt. John Steele, and UNM Professor Lt. Col. Robert Erickson.

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stallation for an Air Force anniversary ball. The event was dedicated to the memory of Gen. H. H. "Hap" Arnold, Commanding General of the Army Air Forces in World War II and AFA founder.

Elsewhere in Germany, AFA's Maj. Gen. Robert White Chapter in Heidelberg helped sponsor a reception for some 400 federal and state officials of the German government. **Dr. Wilhelm Hahn,** a member of the European Parliament; **Maj. Gen. Charles J. Fiala,** Chief of Staff, USAREUR; **Lt. Gen. Walter Schmidtz,** Commander, Fourth Allied Tactical Air Force; and local Heidelberg officials and political party representatives joined Air Force personnel from

INTERCOM

air bases in the Central Region for the event.

White Chapter officials worked hard in assisting **Maj. Gen. and Mrs. William M. Charles, Jr.,** Chief of Staff of the 4th ATAF, with the event. Several Chapter committees handled the decorations, food, and beverage selection and other key elements that made the event memorable. "It was a spectacular evening with splashes of color everywhere, from the great variety of uniforms and evening gowns to the contrasting US state flags and Air Force artwork.

"The American flag covered one end of the ballroom, and a gigantic Air Force seal covered the other," said **MSgt. Spence W. Gruber.** ▪

Conference for Educators

AFA's Aerospace Education Foundation, in cooperation with the US Air Force Academy and the Rocky Mountain Region of the Civil Air Patrol, will host a conference for educators on January 15–16, 1987, at the Air Force Academy, Colo. For information, call Noel Bullock at (303) 370-3075.

Reunion Notices

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.

UNIT REUNIONS

Blackbirds
A reunion for all personnel associated with the SR-71, U-2/TR-1, and KC-135Q programs will be held on May 7–10, 1987, at the Nugget Hotel in Reno, Nev. **Contact:** Blackbird Reunion Committee, Box 3777, Beale AFB, Calif. 95903-5000.

NEACP
Personnel of the National Emergency Airborne Command Post (NEACP) and 1st Airborne Command Control Squadron (1st ACCS), also known as "Nightwatch" and "Silver Dollar," are planning to hold a twenty-fifth-year anniversary celebration on June 4–6, 1987. **Contact:** Col. Stephen H. Evans, USAF, OJCS/NEACP, Offutt AFB, Neb. 68113-5000. Phone: (402) 294-6291.

Mailing Lists

AFA occasionally makes its list of member names and addresses available to carefully screened companies and organizations whose products, activities, or services might be of interest to you. If you prefer **not** to receive such mailings, please copy your mailing label **exactly** and send it to:

Air Force Association
Mail Preference Service
1501 Lee Highway
Arlington, Va. 22209-1198

Stalag Luft III
Former Stalag Luft III POWs will hold a reunion on May 21–24, 1987, in Seattle, Wash. **Contact:** Robert L. Weinberg, 2229 Rock Creek Dr., Kerrville, Tex. 78028. Phone: (512) 257-4643.

Valiant Air Command
The Valiant Air Command will hold its annual air show on March 13–15, 1987, at the Space Contor Executive Airport in Titusville, Fla. **Contact:** Kevin L. Quinlan, Valiant Air Command, 6600 Tico Rd., Titusville, Fla. 32780. Phone: (305) 268-1941.

Yuma AAF
Former officers and cadet graduates of Yuma Army Air Field will hold a reunion on April 2–4, 1987, at the Chilton Inn in Yuma, Ariz. **Contact:** Lloyd D. Collins, 325 Myrtle St., Laguna Beach, Calif. 92651. Phone: (714) 494-4695.

2d Bomb Group/Wing
Members of the 2d Bomb Group and Wing will hold a reunion on September 10–13, 1987, at the Downtown Holiday Inn in Norfolk, Va. **Contact:** Charles P. Huntington, 721 Cascade Dr., San Jose, Calif. 95129.

11th Service Squadron
The 11th Service Squadron, the 482d Service Squadron, the Headquarters Squadron, and the 8th Service Group from World War II will hold a reunion on April 24–26, 1987, in Lancaster, Pa. **Contact:** John J. "Jack" Heckler, 76 E. Harbor Dr., Teaticket, Mass. 02536.

14th Fighter Squadron
Members of the 14th Fighter Squadron, 53d Fighter Group, will hold a reunion on April 24–25, 1987, in Nashville, Tenn. **Contact:** Robert W. Johnson, 6031 Hollywood Blvd., Sarasota, Fla. 33581. Phone: (813) 924-6726.

Class 41-B
South Eastern Flying Training Class 41-B will hold a reunion on April 27–29, 1987, in San Antonio, Tex. **Contact:** Col. Dane W. Harlan, USAF (Ret.), 16403 Ledge Point, San Antonio, Tex. 78232.

73d Bomb Wing Ass'n
The 73d Bomb Wing and all assigned and attached units of the 73d that served on Saipan during World War II will hold a reunion on May 14–17, 1987, at the Nugget Hotel in Reno, Nev. **Contact:** Glenn E. McClure, 73d Bomb Wing Association, 105 Circle Dr., Universal City, Tex. 78148.

99th Bomb Group
Members of the 99th Bomb Group will hold a reunion in April 1987 in Dallas, Tex. **Contact:** Wilbur Dixon, 7831 Fallmeadow Lane, Dallas, Tex. 75248. Phone: (214) 744-1005.

347th Fighter Squadron
The 347th Fighter Squadron will hold a reunion on May 7–10, 1987, in Hot Springs, Ark. **Contact:** Ben Buehler, Rte. 5, Box 72-A, Hot Springs, Ark. 71901. Emery Toups, P. O. Box 91, Abbeville, La. 70510.

438th Troop Carrier Group
The 438th Troop Carrier Group will hold a reunion on May 22–24, 1987, in Louisville, Ky. **Contact:** Ronald H. Worrell, 419 S. 4th St., DeKalb, Ill. 60115. Phone: (815) 756-6582.

462d Fighter Squadron
Members of the 462d Fighter Squadron, 506th Fighter Group, will hold a reunion on May 21–24, 1987, in Colorado Springs, Colo. Members of the 457th and 458th Fighter Squadrons are also invited to attend. **Contact:** Edward F. Bahlhorn, 7485 Center Parkway, Sacramento, Calif. 95823.

4080th Strategic Wing
The 4080th Strategic Wing will host its thirtieth-year anniversary reunion on May 21–24, 1987, in Del Rio, Tex. **Contact:** Timothy Deason, 1001 Ogden St., Del Rio, Tex. 78840. Phone: (512) 775-1341 or 775-5383.

6910th Security Wing
Personnel assigned to Detachment 2 of the 6910th Security Wing who were based at Wiesbaden, Germany, will hold a reunion on June 26–28, 1987, in Greensboro, N. C. **Contact:** Capt. Donald B. Cork, USAF (Ret.), 10889 Hillcrest Dr., Laurel, Md. 20707-1020. Phone: (301) 498-9073. Chuck Bennett, 505 Gretchen Ct., Greensboro, N. C. 27410. Phone: (919) 294-4324.

8th Combat Cargo Squadron
The 8th Combat Cargo Squadron, 2d Combat Cargo Group, is trying to locate enlistees and officers who served with the squadron for a reunion to be held in October 1987.
Please contact the address below.
DuBose "Doc" Egleston
Box 124
Rockbridge Baths, Va. 24473

Class 43-C
I would like to hear from members of Class 43-C (Eagle Pass, Goodfellow, and Stamford) for the purpose of planning a reunion.
Please contact the address below.
Thomas J. Shotwell
15123 Concord Dr.
Dale City, Va. 22193
Phone: (703) 670-8992

Class 54-E
I would like to hear from members of Class 54-E who would be interested in having a reunion.
Please contact the address below.
Maj. Gen. Neil L. Eddins, USAF (Ret.)
2500 Chandler Ave.
Suite 3
Las Vegas, Nev. 89120
Phone: (702) 739-7719

81st Tactical Fighter Squadron
I am trying to organize a reunion that would be held this summer for former members of the 81st Tactical Fighter Squadron who served at Hahn AB, Germany. I would like particularly to hear from pilots of the 1963–65 era.
Please contact the address below.
Rollo Elam
6 Spooks Branch Rd.
Asheville, N. C. 28804
Phone: (704) 253-6136

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Inpatient civilian hospital care	CHAMPUS pays 75% of allowable charges.	CHAMPLUS® pays the 25% of allowable charges not covered by CHAMPUS.
Inpatient military hospital care	The only charge normally made is a $7.30 per day subsistence fee, not covered by CHAMPUS.	CHAMPLUS® pays the $7.30 per day subsistence fee.
Outpatient care	CHAMPUS COVERS 75% of outpatient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 25% of allowable charges not covered by CHAMPUS after the deductible has been satisfied.
	For Dependents of Active-Duty Military Personnel	
Inpatient civilian hospital care	CHAMPUS pays all covered services and supplies furnished by a hospital, less $25 or $7.30 per day, whichever is greater.	CHAMPLUS® pays the greater of $7.30 per day or $25 of the reasonable hospital charges not covered by CHAMPUS.
Inpatient military hospital care	The only charge normally made is a $7.30 per day subsistence fee, not covered by CHAMPUS.	CHAMPLUS® pays the $7.30 per day subsistence fee.
Outpatient care	CHAMPUS covers 80% of outpatient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 20% of allowable charges not covered by CHAMPUS after the deductible has been satisfied.

NOTE: Outpatient benefits cover emergency room treatment, doctor bills, pharmaceutica and other professional services.

There are some reasonable limitations and exclusions for both inpatient and outpatien coverage. Please note these elsewhere in the plan description.

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AFA's CHAMPLUS®

EPTIONS & LIMITATIONS

rage will not be provided for condi- for which treatment has been re- d during the 12-month period prior effective date of insurance until xpiration of 12 consecutive months surance coverage without further nent. *After coverage has been in for 24 consecutive months, pre- ng* conditions will be covered re- ess of prior treatment. Children over 1 (age 23 if in college) will continue eligible if they have been declared acitated and if they were insured r CHAMPLUS® on the date so de- d. Coverage for these older age en will be provided at slightly higher upon notification to AFA.

LUSIONS

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- juries or sickness resulting from red or undeclared war or any act of
- ıries or sickness due to acts of inten- l self-destruction or attempted sui- while sane or insane
- atment for prevention or cure of al- lism or drug addiction
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- sthetic devices (other than artificial and artificial eyes), hearing aids, pedic footwear, eyeglasses and con- enses
- enses for which benefits are or may ayable under Public Law 89-614 MPUS)

PREMIUM SCHEDULE

Plan 1—For military retirees and dependents (Quarterly Premiums)

Inpatient Benefits

Member's Attained Age	Member	Spouse	Each Child
Under 50	$21.88	$27.35	$14.85
50–54	$32.70	$40.88	$14.85
55–59	$39.78	$49.73	$14.85
60–64	$45.80	$57.25	$14.85

Inpatient and Outpatient Benefits

Under 50	$30.82	$36.98	$37.13
50–54	$42.35	$50.82	$37.13
55–59	$56.01	$67.21	$37.13
60–64	$64.48	$77.38	$37.13

Plan 2—For dependents of active-duty personnel (Annual Premiums)

Inpatient Only	None	$ 9.68	$ 5.94
Inpatient and Outpatient	None	$38.72	$29.70

APPLICATION FOR AFA CHAMPLUS®

Group Policy GMG-FC70
Mutual of Omaha Insurance Company
Home Office: Omaha, Nebraska

Full name of Member _____
Rank Last First Middle

Address _____
Number and Street City State ZIP Code

Date of Birth _____ Current Age _____ Height _____ Weight _____ Soc. Sec. No. _____
Month/Day/Year

This insurance coverage may only be issued to AFA members. Please check the appropriate box below:

☐ I am currently an AFA Member.

☐ I enclose $18 for annual AFA membership dues (includes subscription ($14) to AIR FORCE Magazine).

PLAN & TYPE OF COVERAGE REQUESTED

Plan Requested (Check One)
☐ AFA CHAMPLUS® PLAN I (for military retirees & dependents)
☐ AFA CHAMPLUS® PLAN II (for dependents of active-duty personnel)

Coverage Requested (Check One)
☐ Inpatient Benefits Only
☐ Inpatient and Outpatient Benefits

Person(s) to be insured (Check One)
☐ Member Only
☐ Spouse Only
☐ Member & Spouse
☐ Member & Children
☐ Spouse & Children
☐ Member, Spouse & Children

PREMIUM CALCULATION

All premiums are based on the attained age of the AFA member applying for this coverage. Plan I premium payments are normally paid on a quarterly basis but, if desired, they may be made on either a semi-annual (multiply by 2), or annual (multiply by 4) basis.

Quarterly (annual) premium for member (age ____) $_____

Quarterly (annual) premium for spouse (based on member's age) $_____

Quarterly (annual) premium for ____ children @ $ $_____

Total premium enclosed $_____

If this application requests coverage for your spouse and/or eligible children, please complete the following information for each person for whom you are requesting coverage.

Names of Dependents to be Insured	Relationship to Member	Date of Birth (Month/Day/Year)

(To list additional dependents, please use a separate sheet.)

In applying for this coverage, I understand and agree that (a) coverage shall become effective on the last day of the calendar month during which my application together with the proper amount is mailed to AFA, (b) only hospital confinements (both inpatient and outpatient) or other CHAMPUS-approved services commencing after the effective date of insurance are covered and (c) any conditions for which I or my eligible dependents received medical treatment or advice or have taken prescribed drugs or medicine within 12 months prior to the effective date of this insurance coverage will not be covered until the expiration of 12 consecutive months of insurance coverage without medical treatment or advice or having taken prescribed drugs or medicine for such conditions. I also understand and agree that all such pre-existing conditions will be covered after this insurance has been in effect for 24 consecutive months.

Date _____, 19 ____ _____
Member's Signature

Form 6173GH App.

Application must be accompanied by a check or money order. Send remittance to: Air Force Association, Insurance Division, 1501 Lee Highway, Arlington, VA 22209-1198

1-87

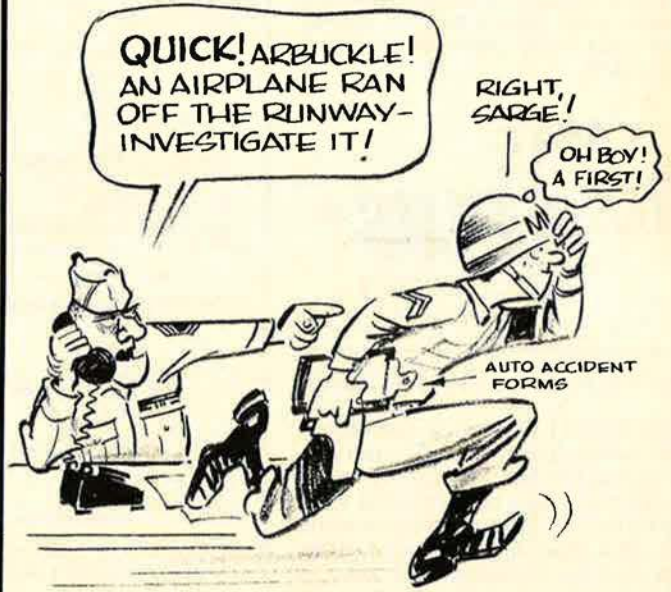
Bob Stevens'

"There I was..."

LIKE MOST "THERE I WAS as", THIS STORY IS TRUE. A C-141 HAS FOLLOWED A THUNDERSTORM IN-TO AN OVERSEAS BASE WITH A BARELY ADEQUATE RUNWAY. MIX A BEHEMOTH AIRCRAFT WITH MINIMAL RUNWAY LENGTH, ADD WATER and...

AS THE STARLIFTER HITS THE H_2O IT STARTS "HYDROPLANING"-

A FEW MOMENTS LATER, THE LOCAL M.P. DETACHMENT (YES, THEY WERE ARMY) GETS A CALL-



The multimode Collins ARC-182 replaces four separate radios to provide a single tri-service communications terminal. ■ Widely used in Navy aircraft, the ARC-182 delivers multiband coverage of VHF-FM/AM and UHF-FM/AM frequencies. Available options enable multi-channel scanning and/or voice Satcom. It has 11,960 channels in the 30 to 400 MHz AM/FM frequency range. ■ The compact Collins ARC-182 completely integrates communications with close air support, air traffic control, military and NATO forces and maritime operations. ■ The unit offers built-in or remote control operation. Optional configurations can be controlled from a MIL-STD-1553 multiplex data bus. It features built-in test to the module level for quick, easy maintenance. Dual installations provide redundant, full-band coverage. ■ For information contact: Collins Defense Communications, Rockwell International, 350 Collins Road N.E., MS 120-131, Cedar Rapids, Iowa 52498, U.S.A. (319) 395-1600, Telex 464-435. **Collins ACCD: The Electronic Combat Specialists.**

COLLINS ARC-182. JOINING FORCES.

Rockwell International

...where science gets down to business

Aerospace / Electronics / Automotive
General Industries / A-B Industrial Automation

THE F-15: KEY PLAYER ON THE USAF TEAM.

THE MISSION: FLY FAR BEHIND THE BATTLE AREA TO DENY AN ENEMY THE MEANS AND WILL TO CONTINUE AN ATTACK.

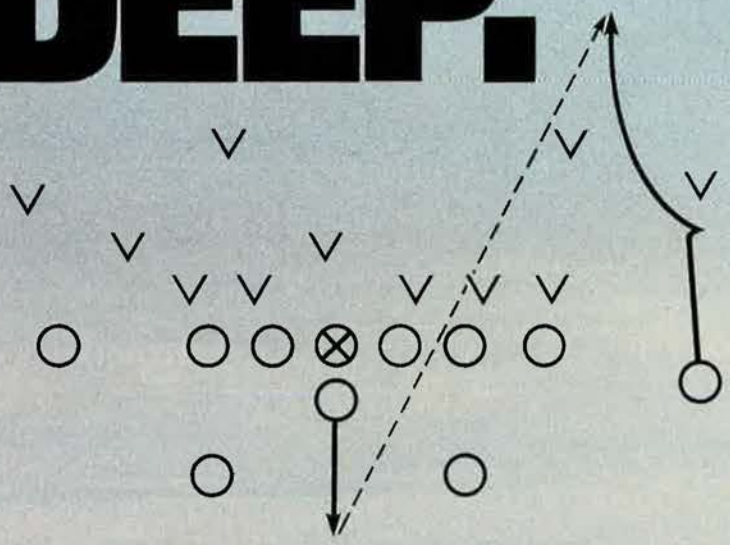
Deep interdiction is a crucial U.S. Air Force mission. Why? Because hostile forces are brought closer to defeat when denied the resources to continue.

A strong defense for America means that the Air Force must be able to go deep when necessary. The mission requires a plane that can fight its way to and from the target through hostile skies, in any weather, day or night, then deliver its payload with precision on high-value, rear-echelon targets.

The Air Force chose the F-15E for this deep interdiction mission. The Eagle's range gets it deep. Its sensors guide it over enemy terrain in any weather, day or night, with a payload large enough to do the job. Its speed, maneuverability, countermeasures and air-to-air weapons get it back safely.

For a strong defense, America counts on the Air Force. And the Air Force counts on the F-15 Eagle.

GOING DEEP.



McDONNELL DOUGLAS