JANUARY 1985/$2

AIR FORCE MAGAZINE

PUBLISHED BY THE AIR FORCE ASSOCIATION

Aeronautics: Coming On and Coming Up

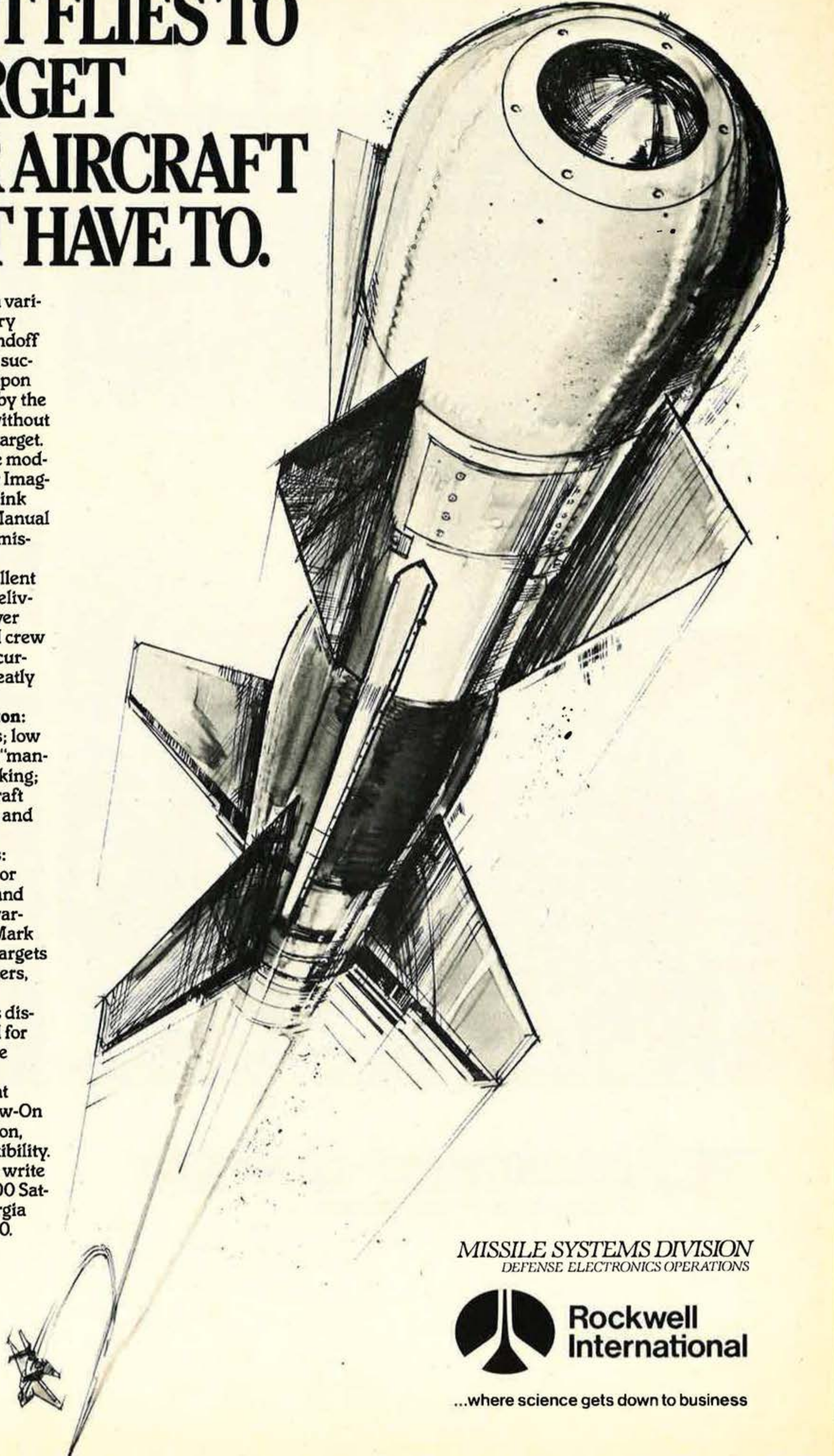
The New Era in Propulsion Testing

Jane's Aerospace Survey

How Doolittle Won in the Turns

Jimmy Doolittle

GBU-15. IT FLIES TO THE TARGET SO YOUR AIRCRAFT DOESN'T HAVE TO.



In deep strikes against a variety of targets, pinpoint delivery of payload from adequate standoff ranges is essential to mission success. The GBU-15 Guided Weapon System, now being deployed by the U.S. Air Force, does just that without aircraft and crew flying to the target.

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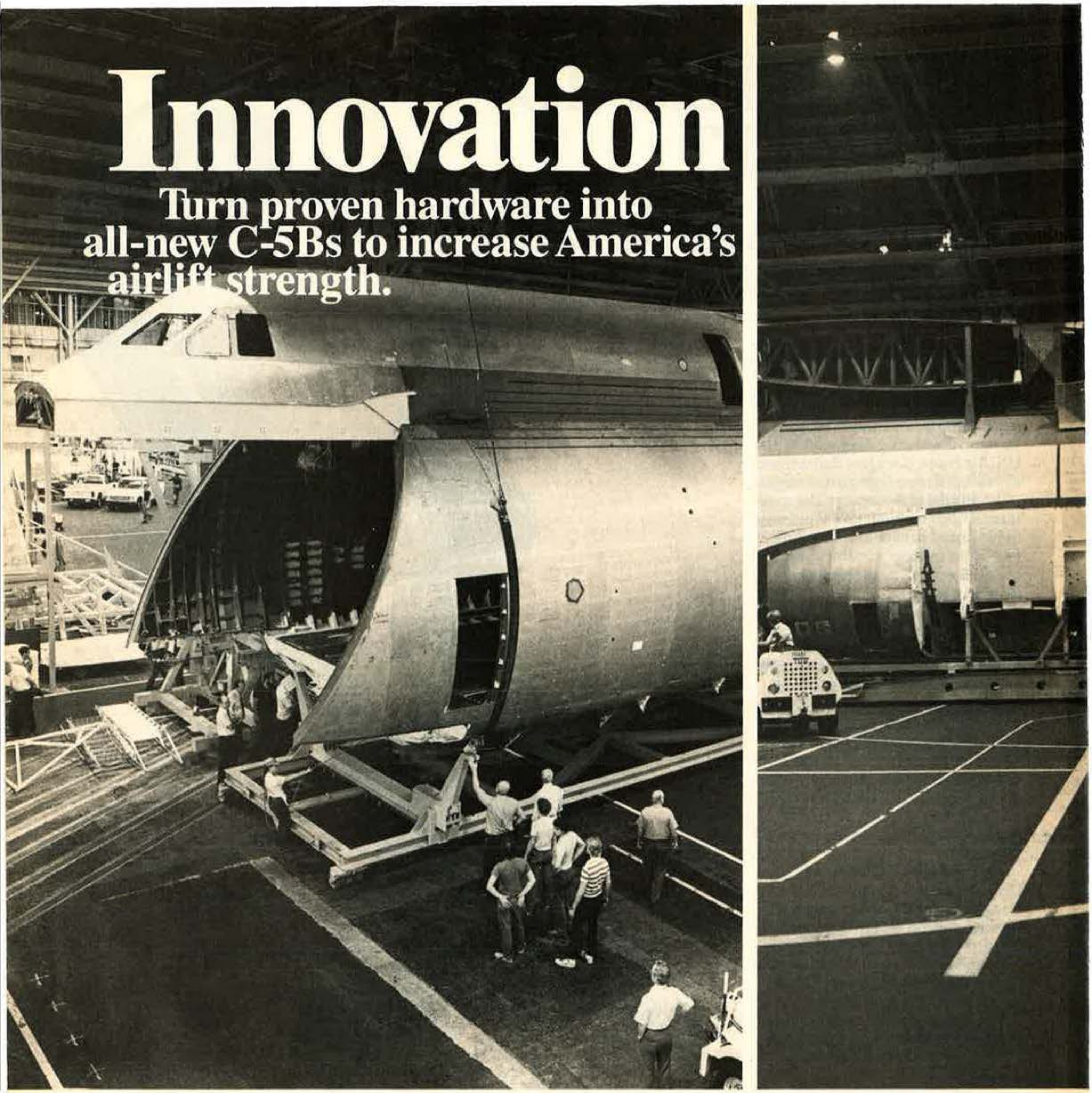
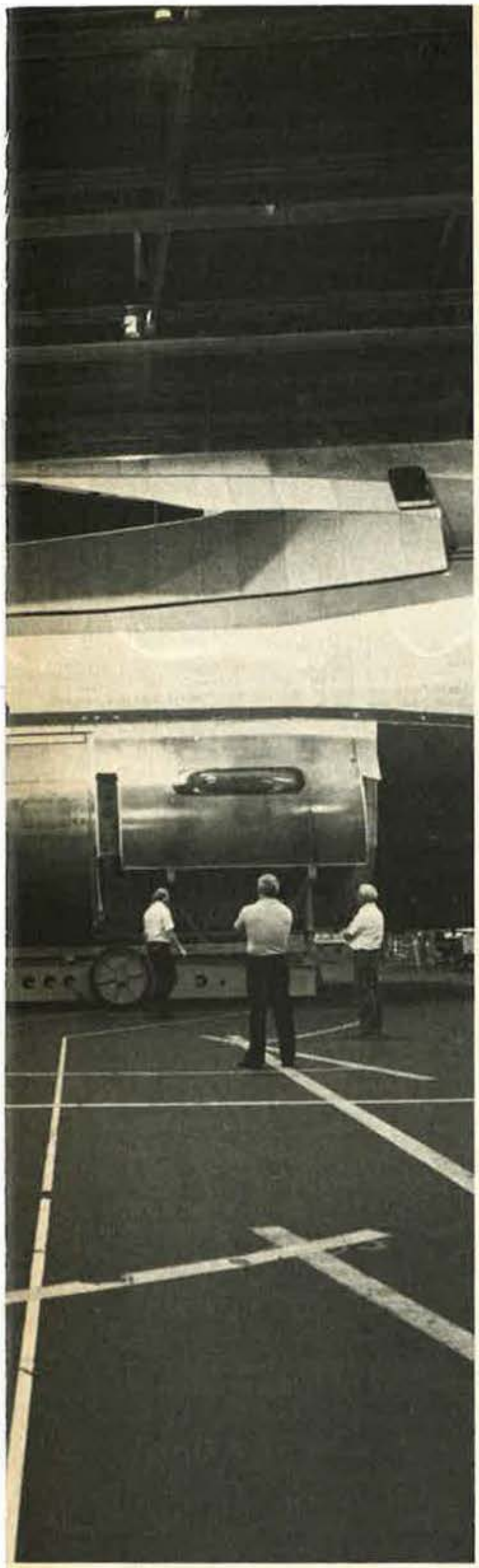
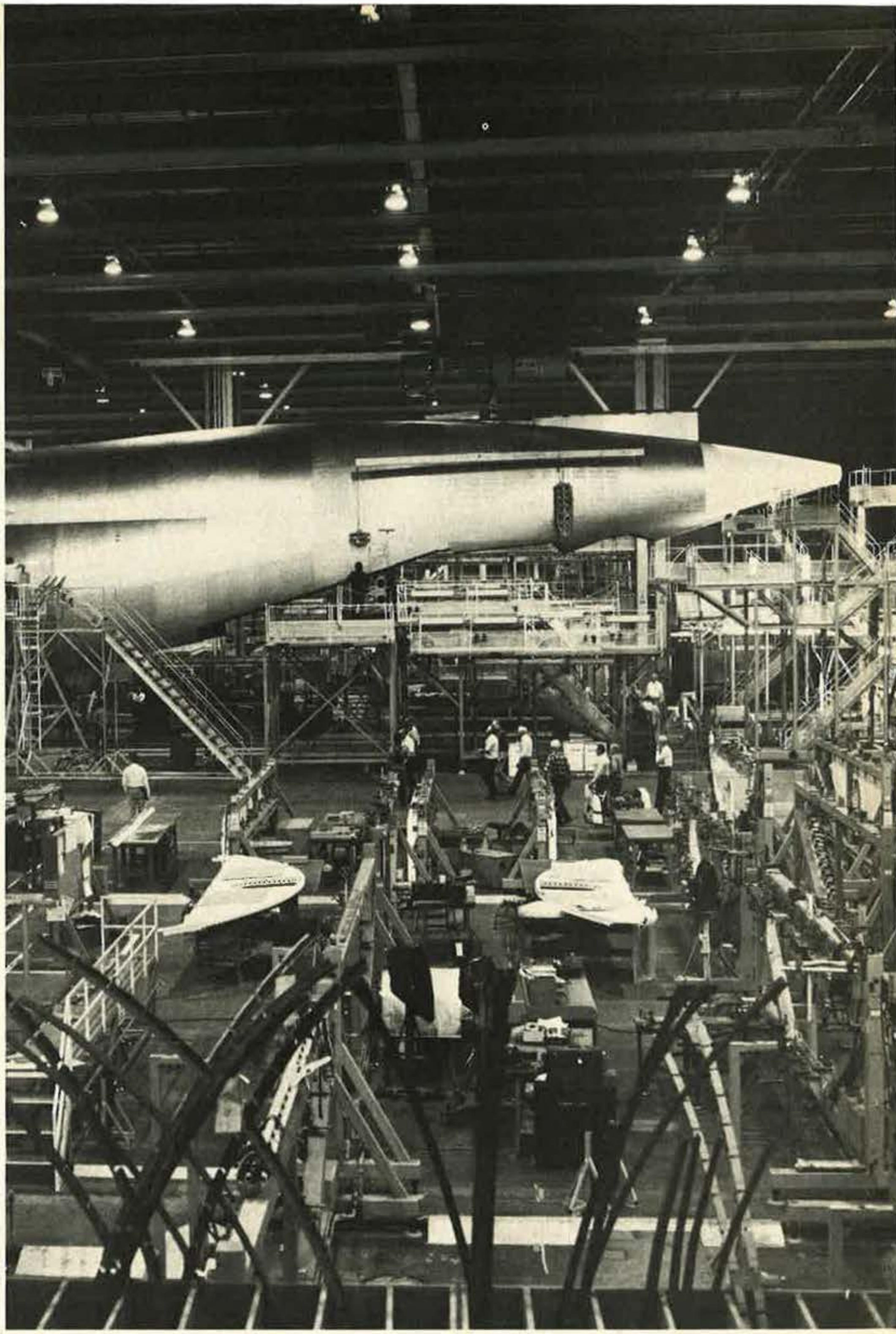


Lockheed-Georgia
Giving shape to imagination.





Marietta, Georgia—January 1985

Major assembly is continuing rapidly on the first of the new USAF C-5Bs. After its first flight this fall, it will join the 77 C-5As already in service with the Military Airlift Command.

The fixed-price program calls for Lockheed-Georgia to produce 50 C-5Bs, making America's outsize cargo capacity 65% greater and dramatically expanding airlift—the backbone of deterrence.

This will increase the nation's ability to airlift fully assembled helicopters, infantry fighting vehicles, self-propelled artillery, M-1 tanks, and all other needed equipment to any part of the world with the speed necessary for effective deployment.

Moreover, the new C-5Bs will significantly enhance operations through such improvements as a simplified automatic flight control system; color weather radar that is lighter and more reliable; a digital air data computer; and a highly advanced navigation/communications system.

The C-5B also will have improved engines with increased reliability. And much of the aircraft will employ new alloys that are stronger and more corrosion-resistant. Other advances enhance its maintainability.

As assembly continues at Marietta, Georgia, the C-5B is meeting or exceeding all program quality requirements—one result of our new, modern machines and production methods.

It is also a testimonial to the skill and energy of the people at Lockheed-Georgia, as well as workers at Lockheed's suppliers in 47 states.

With the C-5B, they are not only building the free world's biggest airlifter, they are building it better.

ASTRO-INERTIAL

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MAGAZINE

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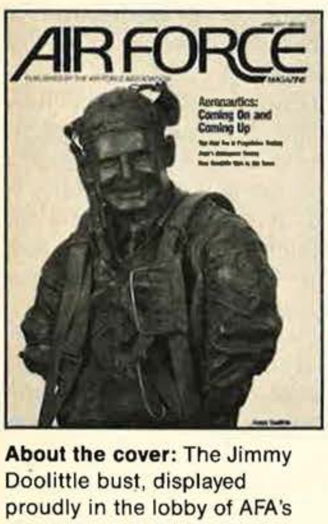

About the cover: The Jimmy Doolittle bust, displayed proudly in the lobby of AFA's new National Headquarters building, symbolizes the spirit of airpower and aeronautics. The bust was sculpted by John Lajba. (Photo by Eddie McCrossan)

Special Section: Aeronautics

Features

Departments

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AN EDITORIAL

The Next Round on Retirement

By John T. Correll, EDITOR IN CHIEF

THIS year, the strongest attack on the military retirement system in a decade is coming. That system has been under steady assault for a long time, but in 1985 the federal deficit will escalate it to a priority for the new Congress. Bugle noise for the attack will be provided by J. Peter Grace, who headed up the President's Private Sector Survey and presented its flawed findings and who has since held a press conference to complain that his report is being ignored.

There are two schools of thought about how to respond to this. One advocates what might be called preemptive concession. It holds that change is probable, perhaps inevitable. Either the defense establishment can show a degree of cooperation and help shape the coming change or else the change will be shaped by Congress and imposed on the military. Others, however, do not believe that the victim should become a willing participant to the mugging.

It is the view of the Air Force Association that a strong defense of the existing twenty-year retirement system can be and should be mounted. The program has already been cut enough. Changes since 1980 alone will reduce the lifetime value of the package for future retirees by twenty percent. And for all of the talk about excessive benefits, the average retiree today gets $9,372 a year.

The Grace Commission, which proposed cuts that would reduce the value of military retirement by about eighty percent, gave no consideration at all to the impact such action would have. It is difficult to explain to outsiders how much visceral emotion is packed into the maxim, "It all counts for twenty." Those five words can get you through a lot of tough spots over the years and guide your thinking about such things as frequent moves, family separations, unpaid overtime, remote duty, the up-or-out promotion system, the limitations on personal freedom and post-military employment, and maybe even a bullet fired in anger.

Senior Enlisted Advisors report that change to retirement is the number-one concern of airmen in the field. Surveys show that retirement leads all other benefits as an incentive for a military career. If Mr. Grace and like thinkers want to stir up a hornet's nest, they have surely found the right stick.

This is not to say that change to the military retirement system is not coming. The budget deficit is real, and military people, being notorious nonvoters, have less political clout than other groups who will be guarding their own interests with a vengeance. But that is all the more reason to make the case as strongly as it can be made.

Unlike the private industry programs it is often compared with, military retirement is not an old-age pension. It is designed to attract and keep a force of proper size and nature to meet the nation's defense needs. Among other things, it provides a skilled mobilization base of veterans. It is sometimes forgotten that military retirees are required to keep uniforms in their closets in case of involuntary recall, to which they are subject. The system also seeks to avoid the historic problem of an aging force with a stagnant grade structure, which did harmful things to military readiness as recently as the beginning of World War II.

The *Wall Street Journal* says it's a "gravy train." Rep. Les Aspin calls it "a boondoggle." If so, then why aren't more people demanding immediate admission? Why, even in periods of unemployment, do the services have to work hard at recruiting and retention? Why all the concern about the not-too-distant future when the services will have to compete even more for manpower as the pool of military age young people declines?

In the winter of 1972–73, American GIs around the world were herded into base theaters to hear the rites read over the military retirement system as they had known it. The nation could not afford to continue so lavish a benefit, they were told. And now that the All-Volunteer Force was bringing pay comparability with the civilian world, this overly generous retirement program was no longer justified as deferred compensation. Everybody got worksheets to calculate how they would fare individually under the new order.

As for older retirees, they were advised to pipe down about "recomputation"—the updating of retired pay when active forces got a raise. Recomp had died in 1958, and, like it or lump it, retirees would instead have their pay adjusted by the Consumer Price Index (CPI).

Fortunately, the briefings turned out to be premature, but some of the ensuing developments are worth remembering. The budget was found to be strong enough to support new social programs, but pay comparability for the military soon vanished. It was not restored until after the "Hemorrhage of Talent"—career people leaving at an alarming rate, high costs to recruit and train replacements, and a loss of experience levels that it took years to regain. Meanwhile, double-digit inflation drove the CPI to heady altitudes. Those who had schemed to save money at the expense of retirees by eliminating recomp had managed to outfox themselves instead. Fifty-five percent of the increased cost of the military retirement program in recent years is attributable to inflation.

It is also instructive to note that pay comparability for the military, supposedly restored, is slipping again. Even after the January 1 pay raise, a comparability gap of better than ten percent will remain.

The nation is still looking for a way to have its All-Volunteer Force for less than all-volunteer prices. ■

AIRMAIL

Banana Smashing . . .

Someone should warn Norman Polmar that a third-rate polemicist is using his name to publish "Airmail" letters *(see "Airmail," p. 13, November '84 issue)*. The *real* Mr. Polmar is a widely recognized authority on submarine survivability, and that is a status he could not have attained without mastering Harris's Law of the Banana—an important body of theory with which the author of the suspect "Polmar Letter" is obviously not familiar.

I leave it to readers to judge whether or not the "Polmar Letter" could have been written by one who understands even these seven basic elements of Harris's Law:

- Finding and destroying a ship on the ocean is equal in difficulty to finding and smashing a banana on a pool table—just a little more expensive.
- Finding a banana and smashing a banana are separate acts in theory only; in practice, "smash" follows "find" by approximately two eye-twinklings.
- Hiding the banana under the felt does not make the problem more challenging.
- Making the banana bigger and quieter does not improve its prospects.
- Moving the banana around under the felt is futile, since a ballistic banana-smasher will remove most of the county in which the banana is located.
- The above laws do not apply when searching for bananas with one's ear—a mystical, semireligious practice still in vogue among a small cult of ancient mariners.
- Sanguinity is an appropriate response to the threat of the ear people.

Barbara B. Harris
Great Falls, Va.

. . . And Survivability

After reading the November '84 "Airmail," I could not contain myself any longer. Letters like Norman Polmar's letter scare the life out of me. . . .

I only hope that our Defense Department planners and systems people are not so short-sighted. We should not forget what General Billy Mitchell tried to tell us when he sank those German battleships—remember, those systems were supposed to be indestructible, too.

I feel, as did General Mitchell, that any system that we develop can somehow be destroyed sooner or later. Anyone who takes the position that a particular system is impregnable is only fooling himself and putting this country in more danger than it already is.

If man made it, man can destroy it. All we can do is to do what Hap Arnold wanted us to do: Look to the future and use all the technical ability we have to make our defense systems as safe as we can for as long as we can. It is imperative to have a replacement system ready long before a particular system becomes unsafe or obsolete.

Lloyd F. Miller
El Paso, Tex.

Just a note on the "Airmail" letter from Norman Polmar, "Survivable Submarines," in the November '84 issue:

While much of the data and conclusions are quite valid, it appears that the author, like many other analysts, assumes the Soviets will play the game in a particular way, refraining from the use of available equipment or tactics.

Concerning the doubtfulness of tracking submerged subs from space with synthetic aperture radar, it appears quite likely to some in the radar community that this is feasible. In any event, nets of fiber-optic cables with laser-light-phase measurement (such as in laser gyros) to determine slight stretching due to submarine or whale passage could easily provide useful sub-tracking data.

And when subs are located and tracked, there are "known methods" for knocking them out. I submit that it is a nearly trivial problem to program intermediate-range nuclear missiles (or even ICBMs) to drop a few warheads near the sub for detonation at depths of perhaps 1,000–2,000 feet. That should be quite effective. The same thing applies to surface ships, in spades. Forget about masking the presence of surface fleets to satellite radars, friend.

Concerning another topic: As for subs being unable to get within 100 miles of a carrier task force without being detected and intercepted, how about that sub that ran into a US carrier recently? And before the hostilities start, a sub could certainly move within torpedo range without being destroyed. When the coordinated hostilities started, the sub could launch its nuclear-tipped torpedoes at surface ships . . . with detonation far below the ships' hulls. The torpedoes could even be programmed to strike vertically upward when they are below the ships. The surface ships might be able to detect the approach of deep-running torpedoes, but just how would one intercept them in time?

There are many other aspects to such problems, but the underlying idea that we can assume that the Soviets won't launch a serious coordinated first strike is just a bit wishful. No, the Soviets aren't ten feet tall, but why assume that they're peaceful pygmies?

It seems to me that the proper approach would be a crash program to deploy off-the-shelf ABM defenses for our ICBMs and SAC bases (cities, too). There should be an accompanying crash program to build orbiting antiballistic missile weapons to inter-

Submissions to "Airmail" should be sent to the attention of the "Airmail" Editor, Air Force Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Letters should not exceed 500 words and should preferably be typewritten. We reserve the right to condense letters as may be needed. Unsigned letters are not acceptable. Because of the volume of letters received, it is not possible to print all submissions, and none can be returned. Photographs cannot be used or returned. Please allow lead time of *at least* two months for time-sensitive announcements.

cept Soviet missiles in the boost phase or in midflight. Similarly, arrays of coastal radars could detect incoming SLBMs, and there should be ABMs to take them out (along with improved antiaircraft defenses, naturally). . . .

A retaliatory force of intercontinental-range ground-launched cruise missiles, perhaps 10,000 to 30,000 of them, would provide an ideal strike force without any threat of first-strike capability. Furthermore, their ability to be launched on first warning and then be recalled for refueling and reuse in case of false alarm makes them far cheaper to base (no need for hardened silos or costly, slow-to-assemble human crews). They could strike at the USSR from all points of the compass simultaneously, making defense virtually impossible, both economically and technically.

Funding? We could eliminate the useless MX (which is as vulnerable as Minuteman), the B-1 and "Stealth" bombers (they would disappear under mushroom clouds five minutes after SLBM launch), the M-1 tank (unless we hear that Canada or Mexico is about to invade), and the present civil defense program, for starters.

Throwing billions at programs intended only as bargaining chips is no way to defend a nation.

Lannon F. Stafford
Phoenix, Ariz.

The Magnificent B-1B

As a member of the Air Force Association, I look forward each month to reading our fine Air Force Magazine. This month, I enjoyed reading the article "The Magnificent B-1B" by James W. Canan *(November '84 issue, p. 58)*.

It made me feel very proud, as an American, of the fine work Eaton Corp.'s AIL Division has done in electronic marvels pertaining to the defensive avionics system. I salute this very fine corporation and all its workers who made this possible.

God bless you all for keeping our country strong.

Anthony Casamento
West Islip, N. Y.

Your article "The Magnificent B-1B" in the November 1984 issue was most informative and reflects highly on those who have steadfastly pushed for B-1 development. It is apparent that considerable design effort has been placed in providing defensive systems that can "sense and beat all manner of threats." That such systems will require considerable operator expertise to exploit their capabilities fully is also apparent from the statement that defensive systems operators will "train for two and a half years" and by the acknowledgment of USAF officials that "much may depend on the training and proficiency of the system's operators."

Those involved in electronic warfare training recognize the great difficulty and cost in providing realistic training against the density and types of threats the B-1B may have to encounter. The continued development of SAC's Strategic Training Range Complex and Strategic Training Center will do much to provide a more realistic and challenging flying arena and a central forum for comprehensive aircrew debriefings, along with constructive tactics/procedures interchanges among bomber aircrews and instructors. Even so, the limited number of deployed ground-threat simulators will be woefully inadequate to emulate the density and diversity needed for realism, and, of equal importance, the mission data (primarily from ground systems) will not allow a reconstruction of mission events and detail for truly effective aircrew performance assessment.

The use of on-board, computer-generated threat simulations complementing the ground emitters and of on-board recordings of operator observations and actions appears to offer the most cost-effective approach to ensure proficient operators. The investment in the B-1B and electronic training ranges warrants the training of the aircrew in a realistic environment and the collection of data to allow maximum learning and retention. It is hoped that the development of the B-1B and the design of the Advanced Technology Bomber will fully capitalize on technological opportunities for ensuring highly proficient aircrews.

No less than their—and probably our—survival is at stake.

Col. Stanley O. Smith,
USAF (Ret.)
Shalimar, Fla.

Re: The article "The Magnificent B-1B" in the November '84 issue.

The B-1B is truly magnificent and long overdue, but I was perplexed by the use of the terms "Offensive Systems Operator" and "Defensive Systems Operator." In those expressions they have managed to divest the aeronautical rating and commission of the Radar Navigator and Electronic Warfare Officer.

Some may say that titles are superficial; I disagree. It is a dignity—a specific distinction given to persons by virtue of rank or privilege. It can create a bond with the past and a current sense of fellowship.

AIR FORCE MAGAZINE
PUBLISHED BY THE AIR FORCE ASSOCIATION

Many young officers worked for a very long time to earn the privilege of wearing navigator wings, not "operator" wings. We are aviators, and we deserve to be called by our aeronautical rating.

The aviators who will crew the B-1B will be as praiseworthy as the bomber. Give them the respect they have earned.

Lt. A. A. Montalvo, USAF
Rome, N. Y.

• *According to officials in the B-1B program office at the Pentagon, the appellations "Offensive Systems Operator" (OSO) and "Defensive Systems Operator" (DSO) were chosen by the navigators in the B-1B program. The OSOs and DSOs are, in effect, "postgraduate navigators," meaning that while they are all graduates of navigator school, they are also trained in several additional specialties. Further, in Strategic Air Command, the only officers called "navigators" are the ones crewing KC-135s. Navigators in the SR-71s, B-52s, and FB-111s have other titles, all indicative of their more eclectic duties. This is true as well for the OSOs and DSOs aboard the B-1B. They are rated navigators, but their titles are meant to denote that their jobs demand more of them than navigating. (SAC is reportedly considering changing the crew member designations to "Offensive Systems Officer" and "Defensive Systems Officer" as more appropriate.)*—THE EDITORS

Utter Nonsense?

Re: "It Takes a Triad," the editorial in the November '84 issue.

The statement that the "credibility of the US deterrent requires that hardened Soviet military assets be held at risk by our strategic force" is utter nonsense and is a poorly disguised argument for the acquisition of MX.

At issue is whether or not the Soviet Union would indeed initiate a nuclear exchange, in which case it is assumed that we would retaliate. Should that horror of all horrors occur, what would be left on either side to "command and control"?

It is high time the military recognizes the fact that a nuclear war cannot be fought or survived by friend or foe. It is the ultimate example of what has been described at basic levels of confrontation (*i.e.,* one-on-one) as a "Mexican standoff."

Weapons that deter nuclear war are still a "must," but that does not include the MX or B-1B.

Col. Peter Boyes,
USAF (Ret.)
Sacramento, Calif.

AIRMAIL

The Big Challenge

Re: Your November 1984 article, "The Big Challenge of the Little Things" *(p. 44).*

While serving as a logistics maintenance analyst on a major Navy ship construction program in the early 1970s, I was involved in developing on-board maintenance repair support for printed circuit boards (PCBs). The Navy and vendor attitude at the time was that PCBs costing below $500 were not worth repairing. We convinced the program managers that the "cheap boards of today will ultimately become expensive and scarce because of production line shutdowns." Our approach was to provide—early in the program—the procedures, logistics support, and technical data to troubleshoot and repair all PCBs, regardless of acquisition cost at that time.

This idea was partially accepted and, as predicted (and illustrated in your article), many of the boards increased in cost and became scarce. Because an organic capability had been planned for and implemented early in the program, the impact of cost increases and the scarcity of new boards were minimized over the years.

The Technological Research of Advanced Concepts (TRAC) team is a good idea, but it is only a reaction to poor planning. The services would do well to establish, early in the design and construction program, a logistics planning effort to identify the spare parts, tools, test and support equipment, technical publications, and training programs necessary to repair all PCBs in new equipment. The planning and eventual implementation may appear costly in the short term but will more than pay back those costs over the life of the weapon system and will, in addition, increase availability as the system ages.

John E. Heim
Ocean Springs, Miss.

• *For more on the concept of "upfront logistics," see "Gaining on the 'Gotchas' " in the October 1984 issue, p. 52.*—THE EDITORS

Just More Red Tape?

I was appalled by the "Airmail" letter by Rep. Mel Levine in the November '84 issue of Air Force Magazine *(p. 22).*

Having spent more than twenty years in the procurement field, half in the military and half with defense contractors, I would say that government interests were protected fairly by use of appropriate articles (warranty or correction of deficiencies) prior to passage of the new law. The suggestion that the new warranty law will cure a lot of DoD ills and will save taxpayers billions of dollars appears to have been made without a full appreciation of the procurement process and the possible ill effects of an indiscriminate use of such a clause. Waiving requirements and creating exemptions will surely create more red tape in an already overburdened procurement system.

Representative Levine suggests that defense contractors should be willing to warrant their military products in the same way that consumer products are warranted. Unfortunately, in general, there is a significant difference between these "two types" of products and the manner in which they are acquired and used.

I am very skeptical of the $2–3 billion estimated savings on the warranted engines that General Electric is making for the F-16. Could it be that the engines could be purchased for $2–3 (or more) billion *less* without the warranty? Regardless of their complexity and cost, jet engines are now similar to commercial products. As a procurement analyst of the Douglas subcontract with GE for DC-10 engines, I would suggest it reflects a "partnership," with GE "calling the shots." Representative Levine might do well to ascertain how the pricing of the engines was effected. . . .

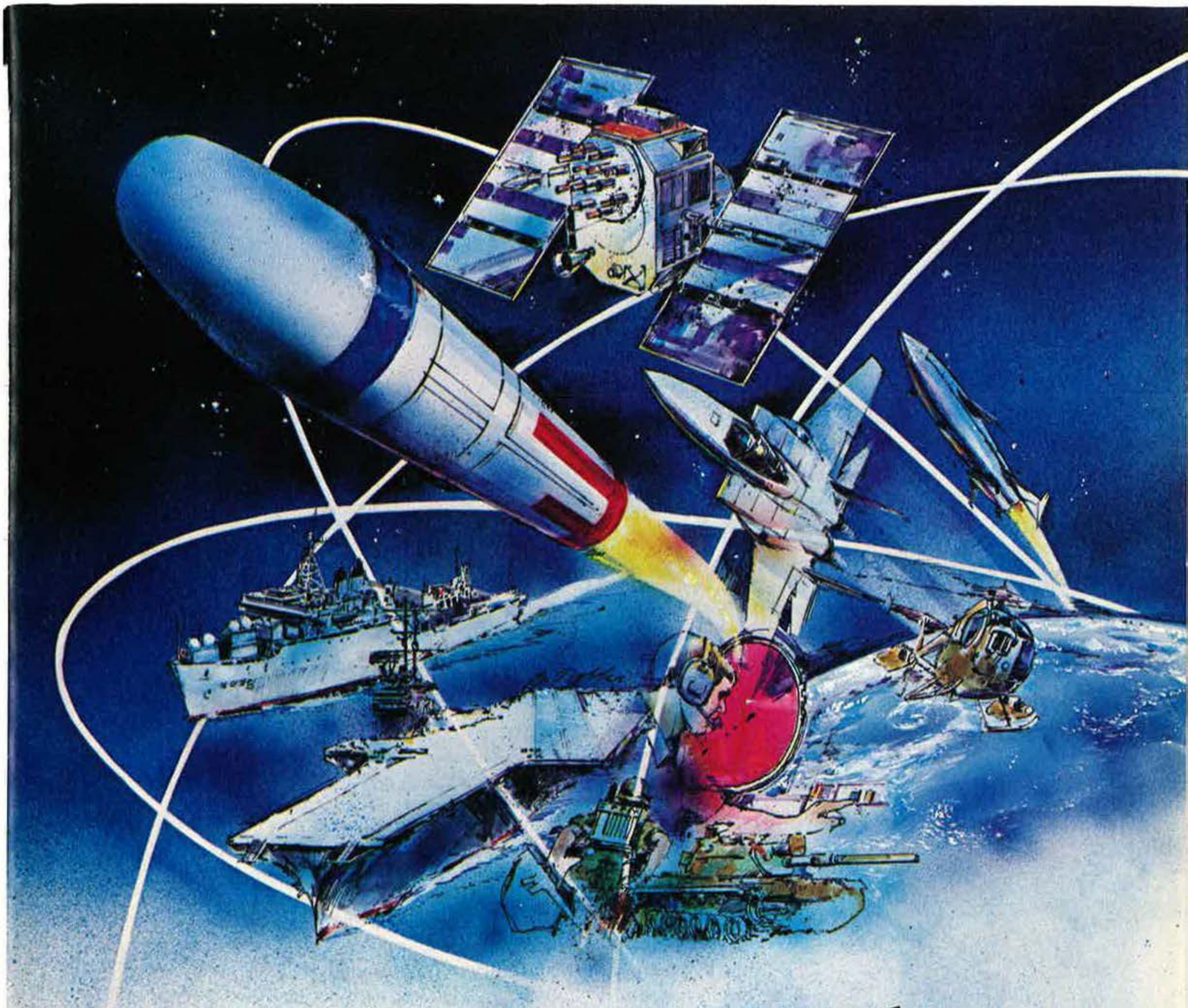
Yes, there is plenty of waste in DoD—so what else is new? There has been, is, and always will be. This is not to suggest that we shouldn't try to eliminate it. In general, perhaps we can all agree, the real problem is people at all levels of an ever-growing, complex business with a highly questionable decision-making process. Unfortunately, the procurement process (governed mostly by technical people) continues to grow in complexity along with the hardware.

Lt. Col. Wendell D. Bundy,
USAF (Ret.)
Orange, Calif.

"The Very Best"

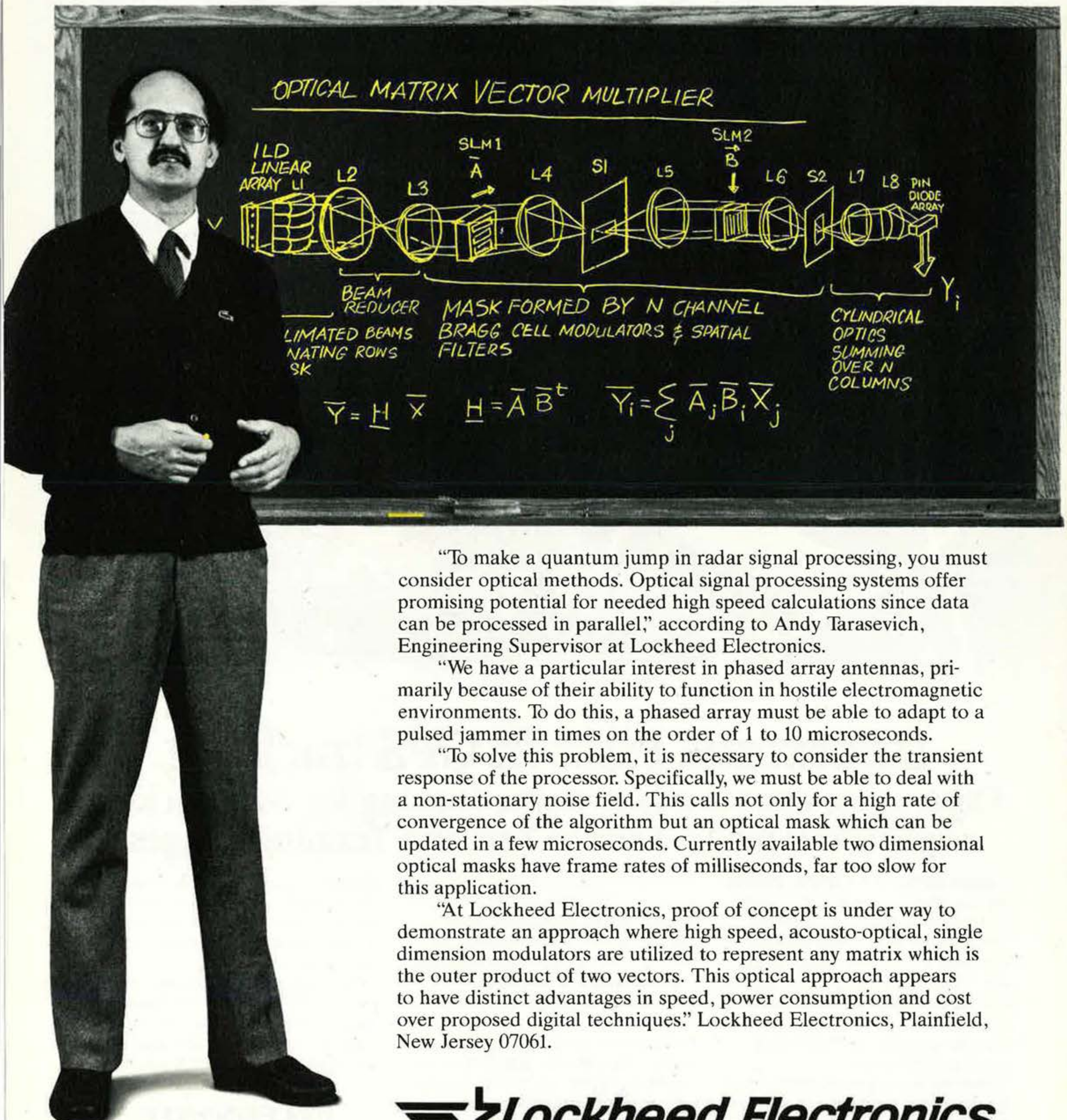
I was pleased to note in your November '84 issue that my longtime friend, Earl D. Clark, Jr., was named 1984 AFA Man of the Year for his many years of service to the United States Air Force and the Air Force Association.

While many of your readers may



Optical Signal Technology on the move.

Andy Tarasevich on high speed processing to cancel sidelobe jamming.



"To make a quantum jump in radar signal processing, you must consider optical methods. Optical signal processing systems offer promising potential for needed high speed calculations since data can be processed in parallel," according to Andy Tarasevich, Engineering Supervisor at Lockheed Electronics.

"We have a particular interest in phased array antennas, primarily because of their ability to function in hostile electromagnetic environments. To do this, a phased array must be able to adapt to a pulsed jammer in times on the order of 1 to 10 microseconds.

"To solve this problem, it is necessary to consider the transient response of the processor. Specifically, we must be able to deal with a non-stationary noise field. This calls not only for a high rate of convergence of the algorithm but an optical mask which can be updated in a few microseconds. Currently available two dimensional optical masks have frame rates of milliseconds, far too slow for this application.

"At Lockheed Electronics, proof of concept is under way to demonstrate an approach where high speed, acousto-optical, single dimension modulators are utilized to represent any matrix which is the outer product of two vectors. This optical approach appears to have distinct advantages in speed, power consumption and cost over proposed digital techniques." Lockheed Electronics, Plainfield, New Jersey 07061.

Engineers interested in contributing to advanced electronic systems are invited to write Employment Manager at LEC, Plainfield, New Jersey 07061.

Lockheed Electronics

Leadership in Technology

know of his longtime efforts on behalf of AFA, I wonder how many know that "Bud" Clark is a distinguished Air Force officer who retired in the grade of colonel a number of years ago following service in World War II and Korea as a member of the Air Force Reserve. As a Reservist and civic leader (he is a former president of the Kansas City Area Chamber of Commerce), he has, over the years, exemplified the very best in the citizen-soldier.

I'm pleased you have honored Colonel Clark with this award.

Brig. Gen. Phillip J. Zeller, Jr.,
USAR
Junction City, Kan.

The Versatile Hercules

Re: The picture of two CH-53Es refueling from a C-130 on p. 42 of the November '84 issue.

Is this meant to be news? We were doing it back in the late 1960s with HH-3s, and later with HH-53s. I remember eleven- to twelve-hour missions requiring four aerial refuelings—the fourth at night and an absolute must to get back to base. That fourth one was not smooth. Refueling on the right side of the C-130 was a rough go!

Also, one at a time on the tanker!

Lt. Col. John H. Morse,
USAF (Ret.)
Springfield, Ohio

• *The picture to which Colonel Morse refers accompanied a report on the thirtieth anniversary of the first flight of the C-130 Hercules. It was meant to illustrate the versatility of the aircraft. Neither the article nor the caption suggested that refueling of helicopters by tanker versions of the Hercules was a "new" procedure.*—THE EDITORS

NATO Force Planning

Thank you for printing my letter *(November '84 "Airmail," p. 14)*, which was somewhat critical of Jonathan Alford's September '84 article, "Which Europe Do You Mean?" Since my criticism was directed at only a small segment of that otherwise excellent article, I do not wish to belabor the point, but I would like to respond to your editorial note and your apparent lack of understanding of the NATO force planning process.

In all fairness to me, to use your words, if you would reread my letter more closely, you would discover that I was, indeed, talking about NATO long-term political and strategic planning—not operational force planning for AFCENT, as you stated.

To begin with, in the NATO force planning process each Major Subordinate Command (MSC) within Allied Command Europe (ACE)—AFNORTH, AFCENT, and AFSOUTH—participates by submitting force proposals, which cover a five-year period, to SHAPE. These proposals—together with those from the other Major NATO Commands (MNCs), Allied Command Atlantic (ACLANT) and Allied Command Channel (ACCHAN)—when approved by NATO, become NATO force goals. These are the very same goals that Mr. Alford felt were not being viewed in light of the threat, yet whose very basis *is* the threat. The failure of nations to adopt current force goals forces the force planner to modify or revalidate the same proposals during the next cycle. It doesn't take long, therefore, for force goals to no longer represent the "current threat."

Furthermore, as I asserted in my original letter, every effort was made—initially by the MSCs, and subsequently by the MNCs—to ensure that the Long-Term Defense Plan's measures, as defined by the force goals, were prioritized and made as affordable as possible. These force goals recommended changes in resource allocation to *all* NATO nations by means of force structure recommendations, thereby addressing long-term strategic and political planning for the Alliance as a whole. Obviously, these recommendations do not, and cannot, go as far as Mr. Alford desires. Nor will they ever as long as NATO remains an alliance of independent, sovereign states.

Finally, as you rightly stated, I am not in serious disagreement with Mr. Alford in general. But even after a second reading, I still believe his statements concerning force goals and the priorities given to the various LTDP measures are misleading.

The difference between us is that while he wrote about the force proposal process, Colonel Nitsch and I, as well as several other allied officers throughout NATO, actually wrote the proposals.

Lt. Col. Sheldon A. Goldberg,
USAF
Air War College
Maxwell AFB, Ala.

22d Bomb Group

Would readers share copies of log sheets, journal pages, aerial photos, personal impressions, or any other data concerning the May 1942 missions to Deboyne Island (New Guinea)? I am conducting research into the loss of my uncle, Lt. Tom Domville, 2d Bomb Squadron, 22d Bomb Group, and I urgently wish to obtain any additional material that will flesh out USAAC and RAAF records.

I will, of course, pay any copying costs and postage and also will cite all sources in any publication. I am extremely grateful for all the help that readers have been able to offer so far.

Patti D. Hall
3561 Iris Circle
Seal Beach, Calif. 90740
Phone: (213) 493-5130

B-66 Destroyer

I would like to hear from anyone associated with any version of the Douglas B-66 Destroyer. The purpose of my research is to gather material for several articles. I will also compile a current address list to help put old friends back in touch.

Please contact me with any information at the address below.

Warren E. Thompson
7201 Stamford Cove
Germantown, Tenn. 38138

6147th Tac Control Gp.

I would like to correspond with veterans of the 6147th Tactical Control Group, the famed "Mosquitoes" of the Korean War. My purpose is to write a detailed unit history.

I would also like to hear from Korean War fighter-bomber pilots who worked with the 6147th.

Richard Groh
P. O. Box 364
Wyandotte, Okla. 74370

Harvard Refugee Project

I am a research sociologist working at UCLA. I would like to interview Air Force personnel who worked at the Human Resources Research Institute, Maxwell AFB, Ala., from 1950 to 1954 on the Harvard Refugee Interview Project.

Please contact me at the address below.

Charles T. O'Connell
Sociology Department
UCLA
405 Hilgard Ave.
Los Angeles, Calif. 90024

AFROTC Det. 905

Attention, all alumni of AFROTC Detachment 905 at Washington State University/University of Idaho:

Under the auspices of Project Warrior, Detachment 905 is instituting a "Hall of Fame" collection and display about distinguished Detachment 905 graduates. We would like to receive any biographical information, photographs, or career highlights from former Detachment 905 cadets.

Please contact the address below.

AFROTC Det. 905
Thompson Hall #6
Pullman, Wash. 99164

Making Basic

The Global Press is seeking personal anecdotes, tips, photographs, cartoons, or poetry dealing with the experiences of Air Force personnel in basic training at Lackland AFB, Tex. This information is to be used in the upcoming book, "Making Basic," a guide to Air Force training. All active-duty, retired, and reserve personnel who attended basic at Lackland AFB are encouraged to participate for the benefit of the basic airmen for whom the book is intended.

Material will be returned if possible, but Global Press cannot assume responsibility for loss or damage of submitted items. Submissions should be sent to the address below.

John Wharton
℅ The Global Press
2239 E. Colfax Ave.
Suite 302
Denver, Colo. 80206

South Pacific

I am anxious to make contact with guys who were stationed in the South Pacific between 1935 and 1945.

I am especially interested in the Pan American DF stations that were set up on the various islands in the mid 1930s and the men who served with the 77th Bomb Squadron, 5th Bomb Group, Thirteenth Air Force.

I am doing research on Amelia Earhart and MIAs and missing planes in the Pacific and need additional data before making another trip to the Pacific. At the conclusion of my research, I will write a book about my endeavors. I would be happy to acknowledge the help of anyone who can assist me with information.

Don Wade
560 Campbell Hill
Marietta, Ga. 30060
Phone: (404) 422-7369

Fourth Air Force

I am a writer who's researching a proposed magazine article on aerial operations off the US West Coast during World War II. In particular, I'm trying to locate veterans of the Fourth Air Force who may have flown antisub missions or otherwise been involved in the sporadic and little-known incidences of actual Japanese attacks along the West Coast. These attacks

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involved sub-launched aircraft raids, bomb-carrying balloons, etc.

Any firsthand accounts of such operations would be sincerely appreciated. Please contact me at the address below.

Mike Minnich
86 Milverton Blvd.
Toronto
Ontario M4J 1T8
Canada

Hondo Navigation School

I am writing a history of the Army Air Forces Navigation School at Hondo, Tex., during World War II. I would like to hear from anyone stationed at the base during the war.

I am seeking old photographs of the base, base personnel, or aircraft used for training during the war. I am also seeking any information or interesting stories about the base. I have a questionnaire to send to anyone who served at this post.

All material will be carefully handled, copied, and returned (if requested). Material not returned will be placed in the Medina County Museum in Hondo.

Please contact me at the address below.

Robert Thompson
Bandera Star Route
Box 49
Hondo, Tex. 78861

B-17 Gunsight

The Arizona Wing of the Confederate Air Force is looking for an N-6 gunsight for the Bendix chin turret on our B-17G *Sentimental Journey.* This particular sight is nearly impossible to find. If any readers have or know of where this sight can be obtained, I would like to hear from them.

Sentimental Journey has been almost completely restored to its original combat configuration, but the sight is one of the few items that the Arizona Wing needs to make the aircraft 100 percent original.

The Confederate Air Force is a patriotic organization dedicated to preserving, in flying condition, combat aircraft flown by the US in World War II and to perpetuating in the hearts of all Americans the spirit in which these great aircraft were flown.

Steve Johsz
6313 W. Cortez St.
Glendale, Ariz. 85304

Women in SEA

A research study is being conducted at Cleveland State University regarding women who served in Southeast Asia in any capacity (*i.e.,* officers, adminstrators, etc., both military and civilian) during the Vietnam War. This is an extension of research information that has been collected by others since the early 1980s.

By means of a confidential questionnaire, I want to learn more about women's experiences in Southeast Asia and how such experiences influenced their lives. This research could lead to the possible establishment of a network for these women.

In order for this study to be representative of the many women who served in SEA during this period, your help is needed. If you wish to participate in this study and would like more information, please contact me at the address below. (All replies will be held in strict confidence.)

Margaret A. Gigowski
Psychology Department
Stilwell Hall
Cleveland State University
1960 E. 24th St.
Cleveland, Ohio 44115

Looking for . . .

I would like to contact anyone from pilot training Class 49-B who trained at Perrin AFB, Tex., and Enid AFB, Okla.

Please contact me at the address below.

Lt. Col. John A. Stolly,
USAFR (Ret.)
11323 Cotillion
Dallas, Tex. 75228

I am searching for any information on a John Harry Hatfield. He was enlisted in the Air Force and was a sergeant at Goodfellow AFB, Tex., in 1948.

Any information can be sent to the address below.

R. E. Michulka
P. O. Box 5155
San Angelo, Tex. 76902

I am trying to locate Leslie Green, who is the son of Thomas L. Green. He was recently transferred from Barksdale AFB, La., to Alaska.

Leslie is a good friend of mine. Any information as to his whereabouts would be greatly appreciated. Please contact me at the address below.

James Schmidt
4800 General Bragg
Bossier City, La. 71112

The pilots forming the 9th Fighter Squadron when it was at Darwin, Australia, in 1942 are trying to find Lawrence P. Smith and Mitchell Laurisza.

Anyone knowing where they are now is urged to write to me at the address below.

Jesse Peaslee
9208 26th Pl., N. W.
Seattle, Wash. 98117

The P-51 Mustang Pilots Association is interested in hearing from all pilots who flew any version of the P-51. We would like to contact them about forming local P-51 groups.

Please contact the address below for more information.

R. M. Peters
210 Shady Hollow
Casselberry, Fla. 32707

The 95th Bomb Group Association is seeking all former personnel who served in England with the Eighth Air Force during World War II (1943–45). We are writing an anthology and want your input.

Please contact the address below.

Leonard W. Herman
Project Director
Benson Manor, Suite 109
P. O. Box 313
Jenkintown, Pa. 19046

I am trying to locate the other twenty-nine Army Air Forces officers who were aboard the USS *Wyoming* when it was torpedoed near the Azores on March 15, 1943. The USS *Champlin* rescued us, and we landed in Casablanca on March 20, 1943.

Please contact me at the address below.

Richard H. Roseman
9000 SW 86 St.
Miami, Fla. 33173

We are trying to locate people who were stationed at Truax Field, Wis., during the Cuban Crisis in the fall of 1962.

If you fall into this category, please drop a line telling your rank, unit, and job at Truax during the fall of 1962, and include information on what you are doing now. We hope to get out a roster if the response is great enough.

Please send all information to the address below.

Robert S. Kittel
12201 Lomas NE, #216
Albuquerque, N. M. 87112

Collectors' Corner

I collect military patches, and I am trying to obtain patches from my old units.

I am looking for patches from the following bases: Webb AFB, Tex.; RAF Greenham Common, UK; Minot AFB, N. D.; Shaw AFB, S. C.; RAF Upper Heyford, UK; and the USAF Academy.

I also need the following patches: any patch from Vietnam, a bright-colored "Eagle Commander" patch and an "Eagle Maintenance" patch, and tech sergeant and master sergeant prop-and-wing chevrons.

Anyone who has such items is invited to contact me at the address below.

TSgt. Richard Elrod, USAF
2204-B Lawson Dr.
Charleston AFB, S. C. 29404

I would like very much to receive donations of USAF, ANG, AFRES, and military aviation unit and aircraft patches from former and active military pilots, ground crew, etc. I am particularly looking for patches from the Korean War, Vietnam War, and current patches.

Please mail any donations to the address below.

Johnny Signor
3418 Carolyn Lane
Cocoa, Fla. 32926

I have been gathering and displaying military memorabilia since 1968. One section of my collection that is deficient is that dealing with items concerning general officers—autographed photographs, headgear and uniforms, etc.

If there are any active or retired general officers who can donate items to my collection, I would be deeply grateful and appreciative.

Please contact me at the address below.

Robert M. Brienik
P. O. Box 152
North Jackson, Ohio 44451

I am an avid aviation fan and collector of patches, but I'm just starting my collection and have very few items. I would appreciate donations of patches of any kind, especially those dealing with fighter, bomber, and missile units.

Thanks for the great issues each month. I really enjoy reading your great magazine.

Scott Dillman
323 McFayden Dr.
Fayetteville, N. C. 28304

I am in the process of making a personal collection of old aviation items and would appreciate hearing from anyone having the following items for sale: helmets, goggles, goggle frames, oxygen masks, headphones, sunglasses, caps, jackets, etc.

Please contact me at the address below.

Col. William L. Evans,
USAF (Ret.)
4390 N 125 W
Ogden, Utah 84404

CAPITOL HILL

By **Kathleen G. McAuliffe**, AFA DIRECTOR OF LEGISLATIVE RESEARCH

Washington, D. C., Nov. 27

Election Impact on Defense

The modest GOP gains in Congress that accompanied the President's landslide reelection may be enough to give the Administration a razor-thin margin of safety on some critical defense programs. But they almost surely are too few to alter the trend in Congress to reduce the overall plans of the Administration to increase defense spending. In fact, the Administration may find opponents closing ranks and intensifying efforts to stave off the continued modernization of defense forces.

The fifteen-seat addition to Republican ranks in the House is offset somewhat, in defense terms at least, by the loss of eight southern Democrats—four in Texas, three in North Carolina, and one in Georgia—who supported most if not all of the President's plan for national defense. Still, the GOP gain and perhaps a renewed, albeit short-lived, honeymoon with Congress could make a difference in the two MX votes—one to authorize and one to appropriate $1.5 billion for production of twenty-one missiles in FY '85—expected to come before the House about April 1. A change of just one or two votes last May 31 could have made the MX outcome more favorable to the Administration.

The change in the Senate, now fifty-three Republicans and forty-seven Democrats, could mean just the opposite. Last June, the Vice President had to break a forty-eight to forty-eight split on an amendment to postpone MX production. The new balance represents a net loss of at least one vote for the President's defense plans. This time, much will depend on the ten GOP Senators who did not vote with the Administration on the last go-around and on a handful of Democrats, including Sen.-elect Albert Gore, Jr. (D-Tenn.).

Future for Deep Basing?

Congress gave the Air Force an ultimatum to manage its ICBM deep-basing R&D program better, at the risk of its termination. The deeply buried silo option is on a back burner, since superhardening of silos and the hard mobile schemes appear to be nearer-term solutions for ICBM basing. *(See December '84 "In Focus," p. 20.)*

Congress believes the deep-basing program is now faltering because of inattention by the Air Force. The problem is that deep basing doesn't appear to have a clearly defined mission, and no payoff is in sight to justify even the low funding levels. But the Air Force, while not considering it a priority program, believes that deep basing could have a payoff in the long term—fifteen to twenty years. Hence, it plans to continue the program, which is in early advanced development. It's being looked at for a possible reserve strategic missile base and, according to a Defense Department spokesman, "increasingly as a survivable national command and control center."

The strongest advocates of the deep-basing program are found in the Defense Nuclear Agency, which has put some of its own funds into the program, and in some elements of the office of the Under Secretary of Defense for Research and Engineering. One of the primary reasons for the interest in deep basing is the fact that the Soviets are immersed in a similar development program. That may be sufficient reason to continue low-level research since, as one DoD spokesman close to the program said, "it helps us learn what the other side is doing."

No more than $20 million is expected to be requested for deep basing in FY '86. Future congressional support for the deep-basing R&D will be contingent on submission by the Secretary of Defense of a firm five-year development program to include program milestones, objectives, and funding. The report is to be complete no later than January 1, 1985.

SDI a Priority

The Administration is gearing up for a big battle with the Ninety-ninth Congress over funding for the Strategic Defense Initiative (SDI). The White House—at least in congressional terms—considers SDI to be a priority national security program, second only to MX. Sources close to the SDI program believe its outcome in Congress next year may well be tied to the outcome of the crucial MX vote in the spring. If MX survives in April, members of Congress could then be tougher on the Administration's plans for SDI, at least for FY '86.

The SDI organization did not back off its original plan for funding—$3.6 billion to $3.8 billion in FY '86 and $26 billion over five years—early in the budget sessions this year. This level, however, will be subject to final scrubbing by the Pentagon and the National Security Council before submission to Congress. If the level holds, it will be more than double the $1.7 billion request for FY '85 and almost three times the $1.4 billion finally appropriated.

Some SDI opponents in Congress may seek to kill the program because of its implications for the Antiballistic Missile (ABM) Treaty. Such concern is viewed by program proponents as a red herring, since research of the numerous technologies constituting the program would not bump up against Treaty provisions.

Theater Nuclear Forces

Congress directed the Administration to submit a report by January 19, 1985, certifying whether or not the US should begin a long-term renovation of NATO theater nuclear weapons. The directive is part of the FY '85 Defense Authorization.

The purpose of the study is to find ways to raise the nuclear threshold in Europe, to reduce pressures to resort to early first use of short-range nuclear forces, and even to further reduce the number of theater nuclear systems in NATO. Specifically, the Administration must consider possible elimination of NATO's reliance on short-range nuclear weapons, possible deployment of longer-range launchers capable of attacking Warsaw Pact targets outside the Soviet Union, elimination of dual-capable nuclear/conventional weapons, and placement of theater nuclear weapons in a single NATO command. ■


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NASA's Station in Space

By Edgar Ulsamer, SENIOR EDITOR (POLICY & TECHNOLOGY)

A modular structure, taken up in segments by the Space Shuttle, might remain on orbit for thirty years. USAF is interested, but does not see it as a compelling need.

Washington, D. C., Dec. 3

Sometime in April of this year, NASA and its team of industrial contractors will start detailed systems studies of a manned permanent US space station that is scheduled to be assembled in orbit early in the next decade and that will remain there for at least twenty-five or thirty years thereafter. The modular structure that will be carried aloft in segments by the Space Shuttle is expected to be about 400 feet long and to include photovoltaic solar panels roughly one acre in size.

NASA's Associate Administrator for space station development, Philip E. Culbertson, recently told this writer that NASA thinks of the Space Station "not [as] a mission, but [as] a facility" where large structures can be assembled, as a waystation en route to geosynchronous orbit, the moon, the planets, or beyond, and as a laboratory. Recent soundings by NASA of the members of the European Space Agency—Great Britain, France, Germany, and Italy—as well as of Canada and Japan suggest that these countries are interested in participating in and underwriting this space venture to the tune of some $3 billion, according to Mr. Culbertson. Overall cost of building and putting the Space Station into orbit, ready to operate, is expected to reach about $8 billion. President Reagan committed the nation to this endeavor last year.

In addition to the manned element, the Space Station program will include two unmanned elements, cloned mainly from components and subsystems of the main station. One of these elements will be a polar platform, probably deployed at "sun-synchronous inclination and altitude" and possibly in an elliptical orbit so that it can be brought down easily to the Space Station for refurbishing and repairs as necessary. The third element of the program will be a maneuvering platform.

The manned Space Station, according to present NASA plans, will probably be deployed in an orbit declined about twenty-eight degrees from the equator, which, according to Mr. Culbertson, is "the most efficient orbit for us to get to [with the Space Shuttle] and for launch of higher altitude stages." While the Space Station is meant to be continuously inhabitable, the system will also be able to function without a crew aboard.

The ability to function in an unattended fashion is essential, since the crew might, at times, be debilitated. NASA plans to make the system as "autonomous as possible," meaning only minimal dependence on assistance from the ground under such circumstances. NASA believes further that such autonomy of operation is essential because there simply won't be the money to support the system with a thousand or more people on the ground, as is the case with the Shuttle. The crew cycle envisioned for the Space Station is about three months. Because of the extreme longevity of the facility, it will be designed from the outset to permit expansion and modernization on a flexible basis.

At this time, NASA plans on an extensive three-year definition phase of the program, with the first request for development funding expected to show up in the FY '87 budget.

NASA, Mr. Culbertson made clear at a recent MITRE-sponsored symposium, views skeptically the Pentagon's contention that there is no national security requirement for a manned Space Station. "We are," he stressed, "working very closely with the Defense Department, so that if DoD ever wakes up and decides to use the Space Station, it won't be too much of a surprise to us."

AFSC Commander Gen. Lawrence A. Skantze, in response to this NASA contention, said the Air Force has been grappling with the question of the utility of manned military space operations "ever since MOL [USAF's abortive Manned Orbiting Laboratory]. We just had Aerospace [Corp.] take another look at the question. It seems that, on a cost-competitive basis, machines can do [the space mission] better. We want to participate in the manned Space Station, but we see it more as an R&D tool." The Air Force, he stressed, "is not saying that we are uninterested, only that we don't see a compelling need" for the Space Station from the military point of view.

Gen. Robert T. Herres, Commander of Space Command, suggested that the Space Station is likely to produce some technological spinoffs beneficial to military missions. More significantly, he contended that it might hasten the advent of a new military mission—namely, to defend, if needed, US civilian and commercial space assets in the way the US Navy is called upon to defend freedom of the seas. In this context, General Herres pointed out, the Defense Department and the Air Force are not interested in taking over the Space Shuttle program from NASA: "We are not equipped to be a carrier for civilian payloads, and we, therefore, don't want to take the Shuttle off NASA's hands since, for one, there is no easy way to spin out commercial and civilian operations" from military missions.

NASA, meanwhile, has linked up with the Pentagon's Strategic Defense Initiative (SDI) program to help "in the development of the space transportation and operations technology plans," according to that agency's Associate Administrator for Aeronautics and Space Technology, Dr. John Martin. A key area that NASA is supporting under the SDI umbrella centers on concepts for reducing launch and on-orbit support costs. In-

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cluded here are initial studies of a huge new launcher system that can accommodate larger and heavier payloads than the Shuttle can handle.

Soviet Space Programs

Two recently issued, authoritative assessments of Soviet space plans underlined both the accelerating pace as well as the increasing militarization of the USSR's operations in that medium. An unclassified study of Soviet military space doctrine by the Defense Intelligence Agency (DIA) concluded that the central Soviet goal is to provide the Soviet Armed Forces "with all resources necessary to attain and maintain military superiority in outer space sufficient both to deny the use of outer space to other states and to assure maximum space-based military support for Soviet offensive and defensive combat operations on land, at sea, in the air, and in outer space."

The DIA study contends that Soviet military space doctrine has both a political and a military-technical thrust. The doctrine emphasizes "the primacy of the offensive application of superior military force to achieve Soviet objectives, and it recognizes the combined-arms approach to combat operations." These twin pillars of Soviet military space doctrine mandate that "the USSR [maintain] a vast, continually expanding military space program, capable of performing most, if not all, of the military support functions of the US space program as well as [of providing] additional space weapons that are beyond current US capabilities, [including an ASAT]."

In line with basic Soviet military doctrine, which hinges on the attainment of superiority of its terrestrial forces, Moscow won't consider "anything less in outer space," the DIA theorized. The USSR seems to pursue the two key military space functions—support for terrestrial operations and the ability to wage war in space—impartially and with equal intensity, presumably based on the recognition of the mutual dependence of these two missions.

Soviet military space doctrine, the DIA study suggests, recognizes that the "ability to provide space-based military support for terrestrial combat operations requires the freedom to operate in, if not outright dominance of, outer space." Moreover, the DIA suggests, Soviet doctrine accepts the imperative of disrupting or destroying US command control and communications assets: "Outer space is becoming more and more vital . . . to military forces in this respect, and, therefore, the Soviet leadership can be expected to pursue both functions with equal vigor, for the ability to conduct warfare in space and to provide space-based support for combat operations on earth are both dependent on the attainment and maintenance of military superiority in . . . space."

Meanwhile, a recently released analysis of the Soviet space program by the Senate's Committee on Commerce, Science, and Transportation found "increasing evidence" that the Soviets are developing at least one and possibly two reusable manned space transportation systems. Predicting that test flights of a giant Soviet spacecraft, comparable in size to the US Apollo program's Saturn V, are imminent, the committee's analysis suggests that this system might achieve operational status within a year or two.

For the long-term future, the Senate committee finds that the Soviets have "grand plans, including large orbital complexes composed of manned and unmanned modules in different orbits, and manned flights to other planets." Just when the Soviets hope to realize these ambitious space goals, the committee admitted, remains unclear.

Turning to the somewhat hazy area of military experiments carried out in space by the Soviets, the committee's analysis speculates about the value of visual observations from the Salyut space station, such as those that involve "observing [the] bioluminescence produced by plankton when it is disturbed, which might give clues to submarine location." Although confining itself to somewhat elliptical references because of security classification concerns, the committee's analysis suggested that "the resolution of military reconnaissance satellites may be as good as five [centimeters], while designing for broad area observations would probably require less spatial resolution, perhaps on the order of meters."

Technological Hesitance and the Quiet Soviet Sub

The Soviets are gaining technological ground on the US because this country, in the military sector, tends to be conservative in exploiting and applying advanced concepts and approaches, according to Dr. Robert Cooper, Assistant Secretary of Defense for Research and Technology. That is the reason why Soviet submarines now "are as quiet as our [own], and our sensor systems are not advanced enough to keep up with that." At the same time, he pointed out recently, Soviet military aircraft are getting "as advanced as ours; they carry a load of silicon [an allusion to sophisticated avionics] almost as great as ours."

US failure to take advantage of available advanced technology, he told MITRE's 1984 National Security Issues Symposium, has reached "a point where we see [US-developed] technology incorporated in [captured] Soviet systems before we have applied it ourselves."

Washington Observations

★ US intelligence sensors have detected a Soviet nuclear test that apparently produced a yield in the 600-kiloton range, or four times the yield limit of 150 kilotons imposed by the Limited Threshold Treaty governing underground tests of nuclear devices. The seemingly illegal test occurred on October 26, 1984.

★ Work by the Air Force and the Defense Nuclear Agency (DNA) on superhard ICBM silos is paying off well beyond initial expectations. Success of these efforts has led to the launch of a follow-on program known as the enhanced hardness project.

The initial hardening effort aims at proving out advanced hardening techniques that enable silos to withstand overpressures of 25,000 pounds per square inch (psi). Recent tests involving one-third-scale structures proved that such hardened structures can survive overpressures of more than 50,000 psi. The first round of silo-hardening work is scheduled to be completed and ready for operational application by 1989.

The enhanced program trails this effort by almost two years, meaning that it should be completed by 1991. Initial tests of the enhanced hardening technologies have already demonstrated resistance to overpressures of 80,000 psi—the goal set for this follow-on program—and there is high confidence that silos of this type can be made to survive even higher overpressures.

Attainment of such high overpressure resistance points the way to basing modes that can affect the so-called drawdown ratio—the number and size of warheads the Soviets have to expend against such targets in order to achieve a reasonable P_k (probability of kill)—to a dramatic degree. Not only would the Soviets have to increase the size and weight of their ICBM warheads to yield between three and five megatons, but they would also have to dispatch against each superhard silo at least one warhead set for groundburst and another fuzed for airburst.

Such a two-on-one sequence exacts further penalties, for the Soviets would have to time the attack in such a way that the airbursting warhead arrives about thirty minutes after the groundbursting one. Otherwise, the debris and other effects of the first attack could have "fratricidal impact" on the second warhead.

Current calculations suggest that it would take about half the payload of an SS-18, the largest Soviet ICBM, to ensure successful attack on a US silo hardened to the levels that the enhanced hardening program has already achieved. These extreme hardness levels might also force the Soviets to develop terminally guided maneuvering reentry vehicles (MaRVs). MaRVs are extremely costly and technically demanding and eat up considerable throw-weight.

★ Terming the Soviet Union an "enemy who is either in step or slightly behind us technologically," the Director of the National Security Agency, Lt. Gen. Lincoln D. Faurer, USAF, recently told an AFA technical meeting that the Soviets have made enormous commitments to boost their signal-intercept capabilities, including eavesdropping on sensitive US governmental and commercial phone conversations. It has become imperative "that we button up our national communications with respect to the defense interest. The major prohibitor to date has simply been cost, and, to some extent, the difficulty of acquiring secure telephones in proliferated numbers."

The National Security Agency, he stressed, is "working very hard to make available at affordable cost secure phones that are user-friendly," meaning that they should not be burdened by massive encoding and decoding paraphernalia and ought to retain the basic clear-voice qualities of present speakers. Current plans are to make available about 500,000 secure, user-friendly telephone instruments, at an affordable price, over

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"the next few years to government and defense industry users."

Questioned about the consequences of releasing publicly the communications between Soviet aircrews and ground controllers leading up to the downing of the Korean airliner KAL 007 in the summer of 1983, the NSA Director explained that "there was no quick release of that information, in the sense of it being done precipitously and without consultation." The release occurred expeditiously, he said, "after an appropriate, responsible discussion of the problem. Those involved at the time concluded that the Soviet Union had perpetrated such an unbelievable and horrible act in shooting down an airliner with more than 260 people aboard [and that this action would] not be believable internally in this country, or internationally, just on the assertion of the President of the US."

In order to make an airtight case for what happened, more backup was needed than an undocumented charge, General Faurer said. It, therefore, became imperative that "there be sufficient intelligence released" to substantiate the facts surrounding the attack: "We did that . . . with the full knowledge that there would be adverse impact on our intelligence capabilities." He added that it is "fair to say that we will pay some penalty for this, [but] I don't think there was a choice."

★ Speaking at the same AFA meeting, the head of Air Force Space Command, Gen. Robert T. Herres, stressed the importance of backing up work on the Strategic Defense Initiative with systems that can defend the US against Soviet precursor attacks involving low-observable air-breathing weapons, such as bombers and cruise missiles. Pointing out that "we are getting better support for our atmospheric defense forces than we have had in years," General Herres called special attention to two unusual announcements by Soviet President Konstantin Chernenko about the USSR's stepped-up cruise-missile program.

Normally, the Soviets let the US find out about the test and deployment of new weapon systems without prior announcement, but in this instance "they have made quite a point about their cruise-missile development and deployment program [involving] sea-, ground-, and air-launched cruise missiles. From the point of view of the strategic aerospace defense mission, we are very concerned about the development of these capabilities."

★ At the same occasion, the head of the Air Force Space Command pointed out that Congress's decision to hold the US ASAT test program to three launches against space-based targets—regardless of whether or not these tests prove successful—might have to be revised. The Administration's request was for congressional approval of a program culminating in two "successful" intercepts of space-based targets.

General Herres suggested that the US would gain "a pretty credible deterrent if we get two successful shots out of the three [authorized and funded by Congress]." On the other hand, "if we have only one successful shot out of the three [tries], then I think we will have to go back to the well" and ask for authorization of additional tests.

★ A just-released comprehensive net assessment of NATO and Warsaw Pact forces by the North Atlantic Treaty Organization concludes that, "while we can be reasonably satisfied with our performance in the past, the future gives less room for comfort. Disparities in a number of critical areas exist which, if left unattended, could further reduce the flexibility of response necessary for credible deterrence."

Pegging Soviet military spending at between fourteen and sixteen percent of the estimated Soviet GNP, the NATO analysis finds that Moscow continues to increase its defense budgets at a net growth rate of about two percent a year. The Warsaw Pact's active and reserve forces include 246 divisions, plus twenty-nine brigades, with 61,000 main battle tanks, and Pact air forces are equipped with almost 13,000 aircraft. The Pact's standing force numbers about 6,000,000, of whom 4,000,000 face NATO forces in Europe.

NATO's standing forces total about 4,500,000 personnel, of whom about 2,600,000 are stationed in Europe. Total active and reserve forces belonging to NATO nations—but not exclusively committed to the Alliance—include eighty-two divisions and more than 180 independent brigades (the rough equivalent of another sixty divisions) with about 25,000 main battle tanks, and air forces equipped with approximately 11,200 aircraft. ■

AEROSPACE WORLD
News, Views & Comments

By James P. Coyne, SENIOR EDITOR

Washington, D. C., Dec. 4

★ In one of the strongest statements of policy by an Administration leader in a long time, Secretary of Defense Caspar W. Weinberger told the National Press Club in Washington that the United States must carefully weigh the requirement to use military force in a given situation, and, once the go-ahead decision is made, such force must be used decisively and in enough strength to win convincingly. He cited Grenada as an example. The Secretary also specified six major tests to be applied when deciding whether or not to use US forces abroad. The principles laid out in his speech are being referred to in Washington as the Weinberger Doctrine.

The Secretary noted first that Congress has assumed a very active role in foreign policymaking and in the decision-making process for employment of military forces abroad, thus compromising the centrality of decision-making in the executive branch. At the same time, he pointed out, Congress has not been willing to accept responsibility for the outcome of military employment decisions that it has limited or influenced.

In the future, he said, military forces should be employed only with a clear understanding of what we hope to achieve. Without that clear understanding, the support of both the public and the military would be lost. It could, he said, "earn us the scorn of our troops, who would have an understandable opposition to being *used*—in every sense of the word." This would affect morale and recruiting and would mean an end to the All-Volunteer Force, which he said is working "spectacularly well."

Secretary Weinberger expressed support for the policy of Flexible Response, providing that the government has received a clear mandate from the people to carry out military decisions until the intended goals have been achieved. In the past, he said, that mandate has been difficult to establish.

But today, he went on, the American people have signaled that they will support a strong policy, "and the American people have sent such a signal by reelecting a strong Chief Executive." He cautioned that this does not mean the US must fight foreign conflicts alone. We should offer economic and military aid to friends and allies, he said, but "usually we cannot substitute our troops or our will for theirs. We should engage *our* troops if we must do so as a matter of our *own* vital interest."

And when they have been committed, Secretary Weinberger said, "We must commit them in sufficient numbers, and we *must* support them as effectively and resolutely as our strength permits. When we commit our troops to combat, we must do so with the sole object of winning."

He then laid out the six major tests for deciding whether or not to commit US combat troops abroad:

- The engagement must be vital to our national interest or our allies'.
- We must send the troops "wholeheartedly," with the clear intention of achieving our objectives.
- We must have clearly defined political and military objectives and know precisely how we can accomplish them.
- The relationship between our objectives and the size, composition, and disposition of our forces must be continually reassessed and adjusted if necessary.
- Before forces are committed, the government must have reasonable assurance of the support of the American people and Congress. (Fighting overseas *not* to win, as in Vietnam, Secretary Weinberger said, is the antithesis of this.)
- The commitment of US combat forces should be a last resort.

The Defense Secretary reiterated several times the thesis that if we fight, we are going to fight to win, supporting our forces to the fullest possible extent. He warned against isolationism and the kind of national timidity that allowed World War II to develop. Conversely, he said, the President will not allow our military forces "to creep—or be drawn gradually—into a combat role" anyplace in the world.

Application of his six principles, Secretary Weinberger said, will "avoid the danger of this gradualist incremental approach, which almost always means the use of insufficient force."

To make his policy work, he stated, requires strong leadership and strong public support. "I believe the United States now possesses the policies and leadership to gain that public support and unity."

★ The Boeing E-4B Advanced Airborne Command Post has been equipped with hardened communications and electronics gear, including display systems manufactured by SAI Technology Co. (SAIT), that withstands the electromagnetic pulse (EMP) and transient radiation effects on electronics (TREE) associated with nuclear attack.

The E-4 *(see photo)* is a specially designed flying command control and communications post for use by the National Command Authorities (NCA) in nuclear and nonnuclear conflict situations. The E-4 is essentially a roomier version of an older system, the Boeing EC-135.

The first E-4B entered service in 1980 and was a significant advancement over the EC-135. In addition to considerably more floor space (4,620 vs. 873 square feet), it has a much greater communications capability, increased nuclear blast protection, and a much larger battle staff.

The aircraft carries thirteen types of external communications systems employing forty-nine antennas. For on-board communications among battle staff and system operators, a battery of intercoms and telephones is available. In addition, there are twenty-eight telephones capable of being patched into ground networks via a 111-line switchboard.

Voice data is encrypted on twelve secure telephones for transmission to other aircraft and ground units. Message switching and routing duties are handled by a Burroughs AUTODIN computer. Operating frequencies of E-4B equipment are spread across the very-low-frequency (VLF), low-frequency (LF), high-frequency (HF), very-high-frequency (VHF), ultrahigh-frequency (UHF), and super-high-frequency (SHF) wavebands.

The SHF SATCOM system is designed for two-way communication with military satellites. It permits maintenance of long-distance links with major military and civilian centers worldwide. The computer-aimed SATCOM antenna is mounted in a radome on top of the fuselage—the only external evidence that the E-4B is not a Boeing 747 airliner.

Information gathered by the antenna is reduced to raw data and directed to a Computer Antenna Pointing System (CAPS) "black" processor, where it is separated into unclassified and classified data. The unclassified data is decoded and routed directly to the proper command post computer terminal and display.

The classified data is routed to a unique plasma display system, which is separated into three electronically and physically separate components that permit foolproof routing of classified information to only the proper display panels.

For VLF communication, the E-4B transmits through a 200-kilowatt amplifier and a dual trailing wire antenna (DTWA). The DTWA houses a short wire antenna 4,600 feet long and a long trailing wire antenna 26,500 feet in length. Signals can be received through a small antenna mounted flush with the fuselage. VLF is used to communicate with aircraft and land- and sea-based nuclear forces.

★ The first Rapier low-level air defense squadron has been declared operational at RAF Lakenheath, UK. In a unique arrangement, No. 66 Squadron, Royal Air Force Regiment, will provide sole ground-to-air defense of the USAFE base. The US funded the purchase of the Rapier missiles and support equipment manufactured by British Aerospace Dynamics Group.

An outgrowth of a 1981 Memorandum of Understanding between the United States and the United Kingdom, Lakenheath is the first of seven Third Air Force bases that are to be defended by British troops. At the "rollout" ceremony, Lt. Gen. Carl H. Cathey, Jr., Vice CINC, US Air Forces in Europe, noted that Rapier was the first off-the-shelf weapon system to be purchased by the US from a foreign nation.

A total of thirty-two Rapier systems assigned to 6 Wing, RAF West Raynham, will eventually be operational. A Rapier training unit at West Raynham will train all RAF Regiment Rapier crews, including those defending RAF airfields in Britain, Belize, the Falklands, and West Germany. The training unit will include a USAF training flight and a small number of USAF personnel handling administrative and logistics duties.

The E-4B Advanced Airborne Command Post is designed to survive in nuclear war, with communications, electronics, and display systems hardened against electromagnetic pulse (EMP) and transient radiation effects on electronics (TREE).

★ A low-key "Notice to Correspondents" stating that an unclassified version of the "Militarily Critical Technologies List" (MCTL) is now available signaled the end of a quietly simmering feud between the staffs of Richard D. DeLauer, former Under Secretary of Defense for Research and Engineering, and Richard N. Perle, Assistant Secretary of Defense for International Security Policy.

Dr. DeLauer circulated a proposed unclassified MCTL about a year ago, a result of a decision made in the late 1970s to produce such a document. Technologies listed in the MCTL cannot be exported for sale or use abroad, except to specified allies and friends, because they have vital military applications.

When the MCTL was classified, a manufacturer applying for an export license for products incorporating or stemming from critical technologies

A British-produced Rapier low-level air defense missile is test-fired against a target in England. Rapier is the first off-the-shelf weapon system to be acquired by the United States from a foreign nation.

would not know of the sensitivity of what he was trying to export until the license application was made. A long delay would then ensue as a decision was made on whether or not the destination country was cleared for the critical technology. As often as not, the export license request was denied, after the manufacturer had spent months or years setting up the sale.

Dr. DeLauer's staff produced an unclassified document so that the information would be easily available to prospective exporters in advance of their sales efforts.

Mr. Perle's staff, on the other hand, pointed out that publishing such a list gave foreign powers, in effect, a list of "espionage targets." The logic here is that if the United States doesn't want something exported because it is valuable militarily, then a foreign power would certainly want to know in detail about it. Providing such a list just makes the job of the spies easier.

The list bounced around the DoD staffs, gathering comments by friends and foes. The Joint Staff supported Mr. Perle.

The list just released is a compromise, carrying twenty categories of "Arrays of Know-How" and lists of "Keystone Equipment," "Keystone Materials," and "Goods Accompanied by Sophisticated Know-How."

Some critical technologies not on the unclassified list are on another, longer, list, which is still classified.

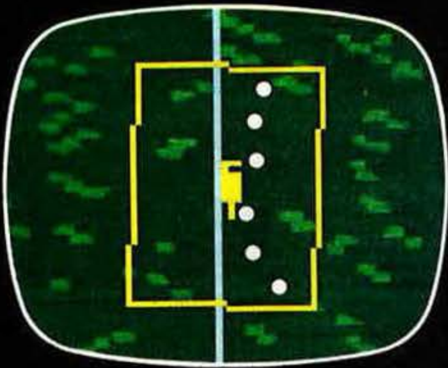
The AH-64 Apache attack helicopter, billed by Hughes Helicopters Inc. as the only helicopter in the free world capable of around-the-clock, all-weather combat operations, performs its treetop mission. So far, Hughes has delivered eleven of these helicopters to the US Army—the first increment of a total 675.

★ The McDonnell Douglas F-15 Eagle logged its one millionth flight hour on a flight between Langley AFB, Va., and Tyndall AFB, Fla., crewed by Gen. Jerome F. O'Malley, Commander, Tactical Air Command, in the front seat, and Lt. Col. Paul Hester, 94th Tactical Fighter Squadron operations officer, in the back seat.

The F-15 is the Air Force's top air-superiority fighter. McDonnell Douglas has delivered 862 F-15s, and the Eagle is in service around the world. With a loss rate of four aircraft per 100,000 flight hours, it is the safest fighter ever built.

USAF plans to buy 392 F-15Es; these will be dual-role fighters. The first F-15E will be delivered in December 1986. The Eagle has also been selected as the Air Force's short takeoff and landing (STOL) demon-

A McDonnell Douglas F-15 Eagle air-superiority fighter launches a Sparrow missile on a training flight. The Eagle logged its one-millionth flying hour on a flight piloted by Gen. Jerome F. O'Malley, Commander of Tactical Air Command.



In combat, time is of the essence. Winning or losing can hinge on the real-time detection and attack of advancing armor.

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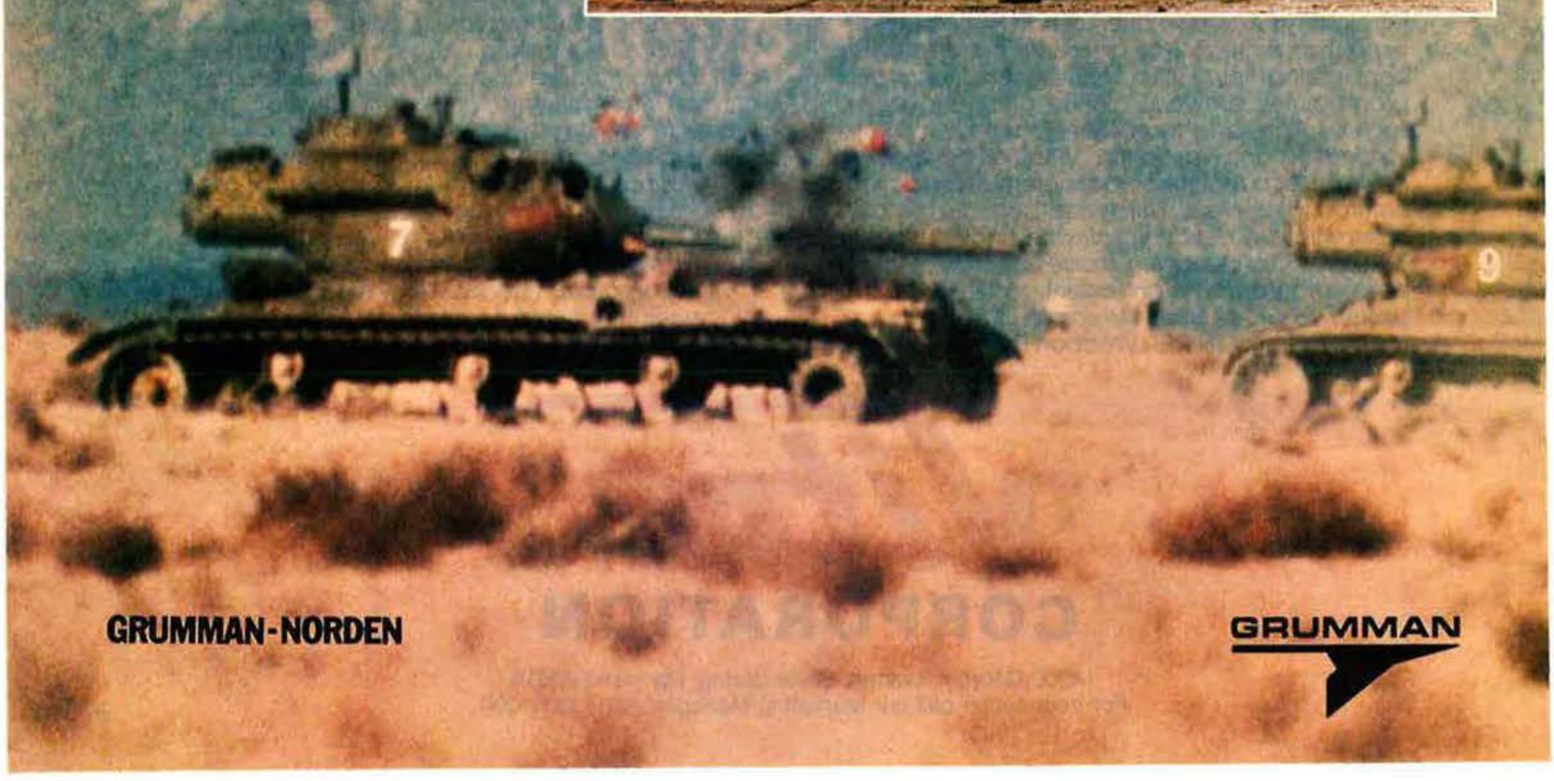

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strator. Equipped with vectored- and reverse-thrust engines, canards, and other innovations, the aircraft will demonstrate technology required to operate high-performance fighter aircraft from bomb-damaged airfields.

★ The Soviet Union is developing two new cruise missiles, one of them possibly deployable sometime this year, according to the new edition of *Jane's Weapons Systems*.

One of the missiles is similar to the US Tomahawk now in place in NATO, *Jane's* said, and the other would be much larger, sixty to seventy percent bigger than the Tomahawk. The larger one will probably not be deployed for two or three years.

Both are believed to be capable of carrying nuclear warheads. Conventional warheads would come later, when more accurate guidance systems have been developed. The Soviets are developing both air- and sea-launched versions of the Tomahawk-type missile, *Jane's* said.

★ In what must constitute a record for changing sizes of assigned aircraft, the 105th Military Airlift Group, New York Air National Guard, is preparing to transition from the tiny

AEROSPACE WORLD

Cessna O-2 Skymaster, smallest aircraft in the USAF inventory, to the Lockheed C-5A Galaxy, largest aircraft in the world. The unit will gain eight C-5As in 1988.

Also, the 105th is moving to Stewart International Airport, N. Y., where the nation's biggest Air Guard-Reserve Forces construction project, a $125 million facility, will soon be under way.

★ Two 1984 Tactical Air Command readiness records have been set by the 23d Tactical Fighter Wing at England AFB, La. The unit's A-10s were mission-capable 91.4 percent of the time and fully mission-capable 89.7 percent of the time.

Mission-capable means all major systems are working, while fully mission-capable indicates the aircraft can meet any operational tasking.

★ There may be extended life ahead for the F-4 Phantom II fighter manufactured by McDonnell Douglas, depending on the outcome of an Air Force Request for Proposal (RFP) to industry for a modification/demonstration to validate a concept for updating the export version of the F-4.

The program would include installation of new, high-technology engines and conformal fuel tanks and studies to determine what integrated avionics subsystems could be used to improve mission capabilities and weapon-system accuracy while reducing crew work load.

In another program, Israel is working on a concept to reengine F-4s procured from the US by installing the engine designed for the new Israeli-developed fighter, the Lavi, which is yet to be built.

★ LTV Aerospace and Defense Co. has begun deliveries of a second group of modernized A-7P Corsair IIs to the Portuguese Air Force under a $90 million contract funded under the US Foreign Military Sales and Military Assistance Programs.

The Portuguese acquired twenty A-7Ps in 1981 and 1982. The first PAF A-7 squadron is now fully operational. The second contract will provide thirty additional Corsairs. Portugal employs them in sea surveillance of the lines of communication (LOCs) between its mainland and offshore territories and to fulfill its NATO commitments.

★ The first USAF helicopter to pass the 10,000-hour flying mark, a UH-1F with the call sign BEVER 15, will be honored at a ceremony this month at Malmstrom AFB, Mont. BEVER 15 has been in continuous service at Malmstrom since its acceptance from Bell Helicopter Textron in 1966.

Utilized for rescue and to support the missile sites of the 341st Strategic Missile Wing (SAC), the helicopter, assigned to Det. 5, 37th Aerospace Rescue and Recovery Squadron (MAC), has flown more than forty search and rescue missions in Montana, Idaho, Canada, and Greenland.

BEVER 15 supported fire-fighting teams at Glacier National Park, Mont., and Bonner's Ferry, Idaho, combating the giant forest fires that raged across those states in the late 1960s.

★ A $69 million contract to construct internal and external communications facilities at the Consolidated Space Operations Center (CSOC), Colorado Springs, Colo., for use on both Space Shuttle and Satellite Control missions has been awarded to Space Communications Co. (Spacecom), Gaithersburg, Md.

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Spacecom will also provide the Timing, Weather Support Unit, and Operations Command subsystems for CSOC. Spacecom also developed, owns, and operates for NASA the Tracking and Data Relay Satellite System.

★ For the first time, a 40-mm guided projectile (not a missile) was fired and changed its course in flight.

The projectile, developed by Ford Aerospace & Communications Corp. for the Air Force Armament Laboratory at Eglin AFB, Fla., was guided by a tiny on-board computer to maneuver significantly off its initial ballistic trajectory during a very short (1,000 meters) test-range firing.

A 40-mm guided projectile developed by Ford Aerospace & Communications Corp. changes course in flight by responding to guidance impulses from two rectangular jet ports near the nose.

Telemetry showed that all electronic components survived the more than 30,000 Gs of force generated by the launch from a special cannon. Further testing over extended ranges will take place at the Army's Fort Bliss, Tex., range.

★ Upgrade of the position of Commander in Chief, United States Central Command, from three to four stars has been approved by the President. Lt. Gen. Robert C. Kingston, USA, CINC USCENTCOM since January 1983, received his fourth star and will continue as Commander in Chief of the command.

General Kingston was born on July 16, 1928, in Brookline, Mass.

★ Northrop Corp. has started work on its fourth F-20 Tigershark. It will be built in a fully operational configuration. The new aircraft will incorporate avionics and other operational advancements that have evolved over the twenty-seven-month Tigershark flight-test and demonstration program.


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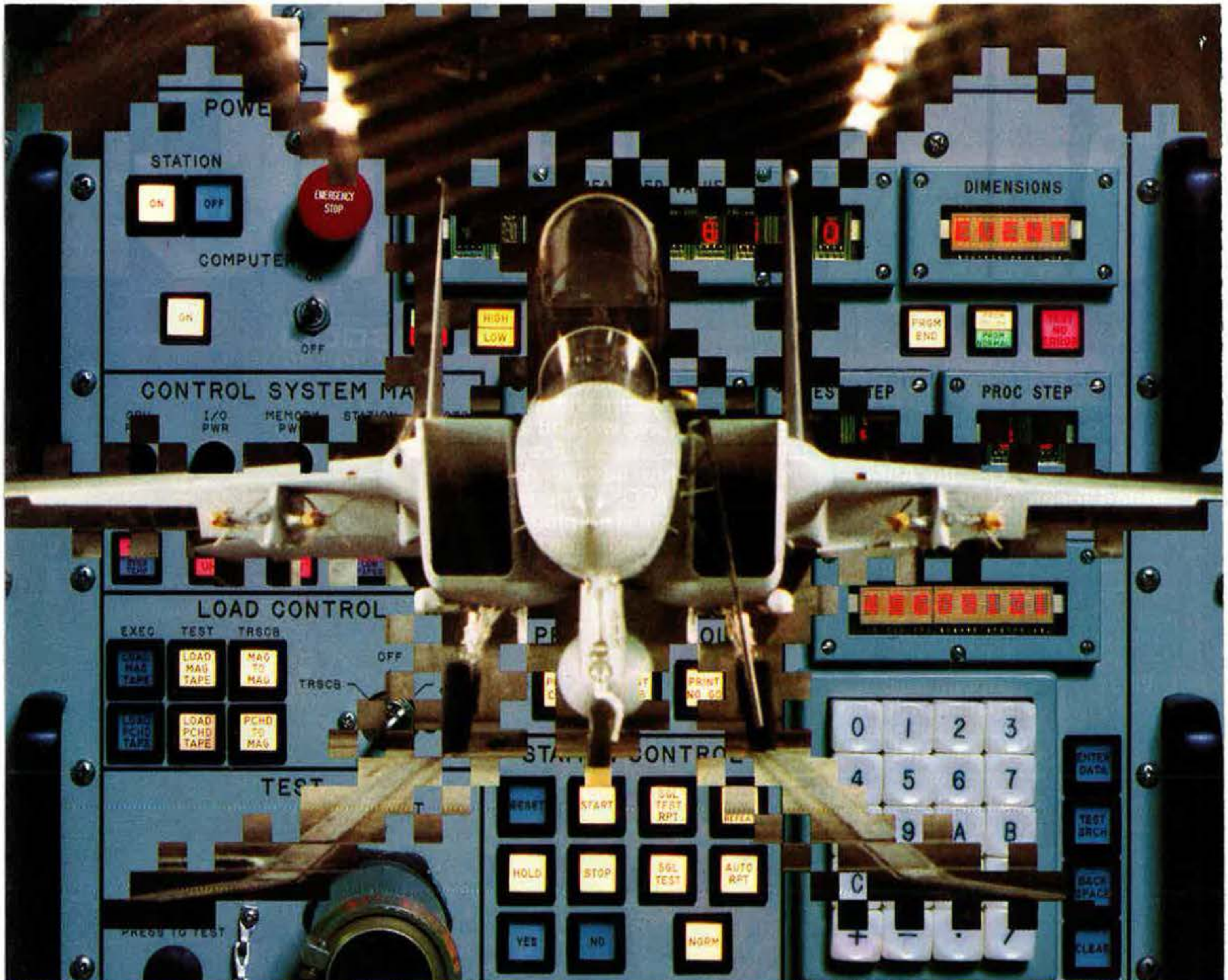

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Northrop said that manufacturing this newest F-20 in the latest operational configuration is a significant step in readying the Tigershark for full-scale quantity production. This year, Northrop expects to invest approximately $150 million in the program. More than $800 million of Northrop's money has already been invested in the program, which has had no US government funding.

(For more on the F-20, see the article "Trials of the Tigershark" starting on p. 71 of this issue.)

Maj. Gen. Wayne C. Gatlin, ANG, completes the last flight of his forty-two-year flying career.

★ The last actively flying World War II combat pilot in the Air National Guard has retired after forty-two years of military service.

Maj. Gen. Wayne C. Gatlin, Chief of Staff, Minnesota Air National Guard, led a flight of four F-4s the day before his retirement.

General Gatlin entered the Aviation Cadet Program in 1942 and received his wings and commission in 1944. He flew 264 combat hours in Europe and was credited with shooting down one and a half Messerschmitt Me 262s. Returning from the war, he joined the Texas Air National Guard and then moved to his home town of Duluth, Minn., and the Minnesota ANG.

General Gatlin has logged 7,000 hours of fighter time in aircraft ranging from the P-51 and P-47 through the RF-4C and his last aircraft, the F-4D. ■

ASD is translating aeronautical technology into combat capability.

Coming On and Coming Up

BY JAMES W. CANAN
SENIOR EDITOR

YOU'RE an F-16 pilot in Europe. You hear all the ballyhoo about the forthcoming wonders of the new avionics system called LANTIRN, meaning Low-Altitude Navigation and Targeting Infrared for Night.

With LANTIRN, you hear, you will be able to attack ground targets at night from altitudes as low as one hundred feet, under weather, hit them with great precision, and live to fly again.

You're a typical show-me fighter pilot, and you're skeptical. Then you hear from the States that, sure enough, LANTIRN is in deep trouble. It pushed too many tenuous technologies too far, too fast. Just another pipe dream of the R&D mavens.

Tactical Air Command seems to think differently, however. TAC is placing its bets on LANTIRN, pushing hard for it, and giving it top priority. There must be something to it.

The next time you take notice, in late 1984, LANTIRN is coming right along. Its navigation element is being tested on an F-16, at night and under combat conditions, with outstanding results. Its targeting element isn't yet ready for testing because its development has been much rockier. But it is a lot better and more amenable to fixing than its critics—many of whom are misinformed about what it's supposed to do—have made it out to be. Confidence in its eventual success is, in fact, building.

The story is the same across a broad spectrum of programs that Air Force Systems Command's Aeronautical Systems Division (ASD) has brought along, sometimes bumpily, for several years. Concepts once considered in some circles to be too ambitious or not worth the candle, or both, are now being transformed into more capable airframes, avionics, and engines. Hardware contracts are being awarded all over the place.

These days, aeronautical systems newly in production, in flight testing, or well along in engineering development characterize the work of ASD at least as much as do those still in design or early in development.

Harvest of High Technology

The serendipity of all ASD programs firmly in hand or farther out is becoming more and more obvious. Each takes advantage of such advanced technologies as microelectronics, nonmetallic materials, and aerodynamic shapes that are fundamental, in varying degrees, to all.

For example, ASD's blue-chip Advanced Tactical Fighter (ATF) program is assimilating what is being learned about those technologies and others in their application to such current production aircraft as the upgraded F-16C and F-16D, such technology demonstration aircraft as the forward-swept-wing X-29 *(see "Forward Sweep," p. 60)*, and the Advanced Fighter Technology Integration (AFTI) F-16 and F-111 aircraft. ASD manages all these programs, and all benefit, in one way or another, from work done by ASD's Air Force Wright Aeronautical Laboratories (AFWAL) in flight dynamics, avionics, propulsion, and materials.

ATF program officials and contractors will also keep close watch on the maneuverability characteristics of the F-15 short takeoff and landing (STOL) demonstrator aircraft that ASD contracted to build late last year. The modified F-15 will incorporate engine nozzles for inflight reversing and vectoring of thrust, a feature the ATF is likely to adopt. It could well provide the key to operating from bomb-damaged runways and thus staying in the fight.

Taken together as an increasingly logical whole, ASD's programs promise unprecedented combat capability for the Air Force. It is happening right now.

The B-1B bomber is in production. The highly upgraded single-seat F-16C and two-seat F-16D fighters, both wired for LANTIRN as well as for the Advanced Medium-Range Air-to-Air Missile (AMRAAM), began entering the Air

Force's operational inventory in December.

A top-of-the-line Combat Talon C-130, with highly advanced avionics, is now being introduced to the Military Airlift Command's special operations fleet. The two-seater F-15E, having gained acceptance (if not full funding) in the Department of Defense and in Congress, needs only a final decision on the disposition of its cockpit technologies and on the division of duties between its frontseater and backseater in order to begin moving swiftly through final development.

The ATF, too, is coming on fast. DoD approval was imminent at press time. Design contracts are scheduled to be awarded to three airframe contractors, or three teams of such contractors, late next summer. One will be selected in late 1988 to start building the ATF, and it should be flying by 1991—only six years from now.

The ripening of so many interrelated ASD R&D programs at the halfway point of the 1980s is not the result of any all-embracing aeronautical master plan conceived years ago. Rather, it represents a fortuitous confluence of programs—many of them driven by advances in the microelectronics of sensors, signal processors, and data processors—that were instituted individually over the years to stay ahead of the growing, many-sided Soviet threat in the air.

"Our business is to manage projects that keep adding up to a running total of increased capability for the Air Force," declares Lt. Gen. Thomas H. McMullen, ASD's Commander. "We try to solve problems as they come—as we see them coming—in the aeronautical world."

ABOVE: An F-16 tests the high-priority LANTIRN avionics system. Navigation pod is mounted on the left of the aircraft; targeting pod, on the right. RIGHT: Artist's sketch shows how the Short Takeoff and Landing (STOL) and Maneuver Technology Demonstrator aircraft, a modified F-15, will take off from damaged runways.

LANTIRN Lights the Way

High on the list of such problems is how to attack ground targets at very low altitude, at night and under the weather, with precision. This is why the LANTIRN system, made up of a navigation pod, a targeting pod, and a head-up display (HUD) for the cockpit, is so important. It answers the "how."

"I think LANTIRN is doing real well, particularly in the navpod," General McMullen declares. "The targeting pod is a challenge, but I don't think there's any insurmountable problem with its technology. We're taking a little more time with it to make it well."

The navigation pod is the less intricate of the two. It embodies a wide-field-of-view, forward-looking infrared (FLIR) sensor, a terrain-following radar (TFR), supporting electronics, and an environmental control system. It has posed some problems of power sufficiency and of cooling, but these are relatively straightforward and are being rectified.

A widely overlooked attribute of the LANTIRN system is that its navigation pod, acting independently of its targeting pod, should enable single-seat aircraft to overfly and bomb targets in the dark, down low, more safely and effectively than any tactical aircraft anywhere (including the dual-seat F-111 with its terrain-following radar and its Pave Tack pod) have been able to manage in the past.

The targeting pod is a prerequisite for precision strikes at night. But even without it, the navigation pod would make USAF's ground-attack aircraft threats to be reckoned with around the clock.

As explained by Col. James A. Fain, Jr., ASD's LANTIRN program director, "If the target is big enough that I could see it in the daytime, then I could hit it at night with a navpod, because whatever I can do in the daytime—within certain limits—I can also do at night with the navpod. But the targets have got to be large, and I'd generally be using area-type weapons against them. We're not talking about surgical removal of high-value targets."

The bottom line, says Colonel Fain, is that with LANTIRN's navigational pod alone "we can take a big portion of the night away from the enemy . . . but if we want to be able to rule the battlefield at night the way we do in the daytime, then we need the targeting pod."

As depicted here, the LANTIRN system's "night window" cockpit HUD should enable ground-attack aircraft crews to fly and fight confidently at high speeds and low altitudes at night and under the weather.

That pod is a technological humdinger. It contains a FLIR sensor system with both wide and narrow fields of view, a laser designator and laser ranger, automatic target trackers, a missile boresight correlator, all manner of supporting electronics, and an environmental control system.

Like the navpod, it must be fully integrated with the avionics of the aircraft carrying it. Those aircraft will be the F-16C, the F-16D, the F-15E, and the A-10. The targeting pod will enable them to deliver laser-guided glide bombs and imaging infrared (IIR) Maverick missiles.

Targeting Pod in Sight

The targeting pod was designed by Martin Marietta, builder of the LANTIRN system, to be effective at night against targets as small as tanks. The idea was that if the system could pick out a tank, it would have no trouble picking out larger high-priority targets like SAM sites, bridges, command centers, and dams.

"Hitting tanks has been oversold in a lot of cases," declared Colonel Fain. "People ask why we want to go hit an individual tank with a very expensive airplane. But that's not the issue. We designed the targeting pod to be able to hit a tank because if it can do that, it can hit all the other targets it's assigned to hit."

The LANTIRN targeting pod is very densely packaged. At first, its innards sprang leaks, and wires and connectors broke. It was taken out of testing and repackaged. But then it proved to be incapable of attacking small tactical targets at required ranges. The Air Force considered giving up on this capability.

But the Air Force didn't. Instead, it took two new tacks on the targeting pod. One was the incorporation of a number of tracking improvements to allow the pod to acquire smaller targets farther away. This did not turn out to be satisfactory, however.

The other, more laborious approach was to improve the pod's optical chain by "cleaning it up from end to end, redoing it as much as we can to improve its transmissivity," says Colonel Fain.

This is being done. Some improved targeting pods were scheduled for delivery to USAF in December 1984. Others, even better, will be delivered in March of this year.

Colonel Fain expressed confidence that, by then, "the pods should have the capabilities we think are necessary to attack small tactical targets at the ranges we think are adequate for a single-seat [aircraft] work load.

The first production-line F-16C rolls out at General Dynamics Corp.'s Fort Worth, Tex., plant. USAF plans to order at least 1,800 F-16C and two-seater F-16Ds. Both are wired for LANTIRN and the Advanced Medium-Range Air-to-Air Missile (AMRAAM).

"We're talking about vast improvements in the optical chain through the pod," the Colonel added. "We're talking about almost a doubling of capability."

The software of the targeting pod's tracker, which works hand in hand with its FLIR sytem, is also being upgraded. This will allow the tracker to lock on to small targets at greater standoff ranges.

The control loop between the targeting pod and the Maverick is complicated. The FLIR system in the pod and the FLIR system in the missile continuously pass digital data to the pod's missile boresight correlator. It matches up such data. Then it signals the Maverick to lock on and the pilot to launch.

According to Colonel Fain, ASD anticipated that its improved targeting pods would be in shape to start handing off Mavericks in flight around the first of this year. These tests "will not include all the yanking and banking we're looking for, but we're expecting that capability in the March–April time frame," he said.

Initial go-arounds with the targeting pod's laser designator have been promising. Verification of the pod's boresighting accuracy for laser-guided munitions is well under way and looks good.

Night Into Day

Final testing of the LANTIRN navigation pod on an F-16 over Canada began last October 15 and was scheduled to end by mid-December. Under the terms of a joint agreement between the US and Canada, the testing took place in the vicinity of the Canadian Forces base at Gagetown, New Brunswick, where a European-type climate prevails. Test flights originated at Loring AFB, Me.

The navigation pod had already done very well in more than a year of testing at night, sometimes in highly humid conditions that threatened the workings of the pod's FLIR-protecting environmental control system.

The test flights were tough ones. Test pilots and TAC pilots logged about 480 flight hours over an estimated 15,000 miles, flying at an altitude of 500 feet or below. Above unfamiliar US terrain both flat and hilly, they dropped down to 200 feet at speeds ranging up to 615 miles per hour and down to 100 feet at up to 550 mph.

They reported that the navigational infrared display on their HUD, which brings into the cockpit what the system "sees," enabled them to fly with confidence, as if in daylight.

Reliant as it is on optics, the LANTIRN system will make aircraft capable of attacking at night *under* the weather but not *in* the weather. Existing FLIR systems do not see through clouds. It is tough enough to make the transition from day to night attack, let alone to attacking in weather.

Even so, LANTIRN's TFR navigational capability will give pilots some in-weather leeway.

"Depending on their need, they should be able to top ridge lines, hit clouds, and punch over to clear air on the other side," says Colonel Fain. "They're not going to do that kind of thing in training, but in combat they could. They might have to do so."

In aeronautics, one advancement always leads to another. ASD's Avionics Laboratory is experimenting with highly advanced FLIR technology for the Advanced Target Acquisition Sensor (ATAS). This could give future combat aircraft, notably the Advanced Tactical Fighter, true weather-beating capability.

Right now, though, the issue is LANTIRN. An Air Force System Acquisition Review Council (AFSARC) decision on whether or not to finish developing and start producing LANTIRN navigation pods is expected early this year. The IOC date for the pod is classified, but it seems that USAF's ground-attack aircraft could be pretty well equipped with them by the turn of the decade.

And if ASD's optimism about the LANTIRN targeting pods is justified, production should be only a year or so behind.

The latest in the evolutionary line of F-16s will be on the ramps at operational bases awaiting the arrival of LANTIRN pods. The F-16C and F-16D two-seat trainer variant have just begun entering USAF's inventory of combat aircraft. Both were rolled out at General Dynamics Corp.'s Fort Worth, Tex., production plant just six months ago. The Air Force plans to order at least 1,800 F-16Cs and F-16Ds.

Good Gets Better

The F-16C represents the fruits of the Multinational Staged Improvement Program (MSIP) undertaken four years ago by USAF and, to some extent, the four European governments participating in the F-16 program. It is a prime example of how to upgrade an existing aircraft—and to make it ready to accept such future systems as LANTIRN and AMRAAM—without rebuilding it from nose to tail.

The litany of improvements in the F-16C is a lengthy and impressive one. Its AN/APG-68 radar, featuring a software-programmable signal processor and a dual-mode transmitter, greatly extends its target detection and tracking ranges. Its fire-control computer has double the memory capacity and processing speed of that in the A and B models.

It is a stronger, heavier aircraft, too, the better to bristle with weapons. Its gross takeoff weight is 37,500 pounds, or 2,100 pounds heavier than earlier F-16 variants.

To manage its weapons more smartly, the F-16C embodies the Advanced Central Interface Unit (ACIU). This feeds the airspeed and inertial and radar targeting data from the aircraft's computer to the missiles, such as the Maverick, and to other smart weapons. The ACIU also makes it possible for those weapons to keep that computer up to date on their status.

The pilot sees all this, and much more, on two new television screen cockpit displays that replace and do the work of many dials. He can call up on either screen, or both, any sensory or weapons data he needs at any time.

The F-16C also features a solid-state computer cartridge system for loading mission and navigational data. All innovations on the F-16C make it more quickly versatile in flight—for example, in switching from the air-to-ground mode with LANTIRN and Mavericks to the air-to-air mode with AMRAAMs.

USAF's F-15 has come a long way in evolution from this early model. Emphasis is now on fast development of the two-seater F-15E with great firepower and highly advanced avionics and cockpit technologies.

F-16 pilots now have to enter weapons and navigation instructions into the aircraft's electronic memory while sitting in the cockpit prior to takeoff. This can take up to fifteen minutes. With the new system, the pilots can prerecord such data on a computer cartridge in the briefing room and load it into the computer system in less than a minute—almost like changing cassettes in a car radio.

The F-16C also has a wide-angle HUD for displaying more information over a larger area. This helps the pilot keep his head out of the cockpit, something he desperately needs to do while flying low-altitude ground-attack sorties.

The F-16C will have a better shot at surviving, too. Its rudder island assembly was reconfigured so that its tail can now accommodate two Airborne Self-Protection Jammer (ASPJ) electronic countermeasures black boxes. The sophisticated ASPJ system will be installed in production-line F-16Cs in about two years and retrofitted at that time in F-16Cs already in service.

Reworking the F-16 to make it more capable now—and amenable to even greater capability in the near future—is a prime example of ASD's latter-day emphasis on getting the most out of what USAF already has in the way of combat aircraft.

As General McMullen puts it: "History shows we'll be going to fewer systems. One of the shifts we're already in the midst of is keeping airplanes and engines longer, and improving their capability to do things that nobody even thought of when they were new—offensively and defensively, surviving in a high-threat environment. Electronics adds tremendously to our capabilities."

The late-model F-16s surely show this to be true. And so does the F-15E, no longer dubbed the dual-role fighter but designed to be one, nonetheless.

"One Damn Good Weapon System"

A demonstrably superb air-superiority fighter, the basic F-15 Eagle is also an inherently very capable air-to-ground machine as well—robust, big, with lots of room for ground-attack stores. The two-seater F-15E will incorporate avionics, such as LANTIRN, to carry out the long-range interdiction mission at night and under weather against high-priority targets.

The F-15E will also have almost all of the capabilities of the B-1B strategic bomber, such as terrain-following, navigation-update, and weapons-delivery avionics and internal electronic countermeasures. Like the bomber, the F-15E will be a software-intensive aircraft. Its offensive and defensive avionics can

be reprogrammed to keep it ahead of increasingly sophisticated and profuse threats from air and ground. It will contain a fully programmable set of armament controls for air-to-air and air-to-ground weapons.

In fact, the original F-15 was built for growth in air-to-ground capability. Its HUD technology and bombing modes made the original F-15 comparable, as a ground-attack aircraft, to the doughty A-7, which showed its mettle against ground targets in Vietnam.

"For the F-15E, we expanded all that and made it programmable," explains Col. John S. Smith III, ASD's F-15 deputy systems program director. "And we have a central computer to manage the requirements of the airplane that's a tenfold improvement over the computer in the basic F-15A."

Naturally, the LANTIRN system is coveted by F-15E program officials. They claim that even though LANTIRN's navigation pod would enable the F-15 to carry out many ground-attack missions at night and under the weather, the aircraft would also need LANTIRN's targeting pod to perform the full range of such missions envisioned for the aircraft.

Those missions would impose a very demanding work load on the F-15E's two crew members—one that, in many instances, would be comparable to the work load of the B-1B bomber's four crew members. This is why TAC and ASD are paying a great deal of attention to dividing the crew duties aboard the F-15E in the best possible manner and to determining the optimum configuration and placement of the aircraft's front-seat and back-seat technologies.

Initially, the idea was to give the frontseater control of air-to-air and air-to-ground weapons; the backseater, limited control of air-to-ground weapons and full control of radar navigation. But this was changed to give the backseater some air-to-air control as well. Defensive avionics were originally destined for the front cockpit. Now they will probably be put in the rear cockpit for management by the WSO.

Putting potential F-15E pilots and WSOs through their paces in cockpit simulators has been a big help in making decisions about such things. "We match them up in different scenarios, and they make their own assessments and tell us what symbology they want in there and let us know about extremes of work loads," says Colonel Smith.

The simulator was built by McDonnell Aircraft Co., which is working with a steering group, representing ASD, TAC, USAFE, and PACAF, in making decisions on F-15E cockpit configuration and symbology.

However it comes out, F-15E cockpit technology is certain to represent "a real jump" over any such technology in existing fighter aircraft, says Lt. Col. Robert E. Lupini, ASD's F-15E program manager. Air Force officials acknowledge that the cockpit technology and layout of the F/A-18, produced by MacAir for the Navy, is—as one such official described it—"the very best now flying."

But the F-15E's cockpit will surpass it, they claim, with the best and latest in digital displays. "It will be a whole generation beyond," Colonel Smith asserts, "with a lot bigger HUD, symbols a lot sharper and brighter, and in colors instead of all green."

Even though the cockpit is the major technological challenge on the F-15E, a very big and related one, too, is the integration of all the aircraft's systems.

"We're not making any major steps in technologies," says Colonel Lupini. "We are integrating proven technologies into one system, onto the airplane. Redoing the basic F-15A to accomplish this would have been a monstrous task."

"The F-15E," declares Colonel Smith, "is going to be one damn good weapon system."

Birth of a Great Baby

At some point in the future, if this indeed turns out to be true, and if the new and maybe even future variants of the F-16—almost certainly the F-16F—also live up to their billing, critics of USAF's mosaic of fighter programs are almost certain to start questioning why USAF needs the Advanced Tactical Fighter in view of the highly versatile, highly capable fighters it already has. Such questioning will be especially severe if defense budgets grow more slowly.

USAF's answer will be—and already is—that the ATF, being designed to incorporate and integrate engine, avionics, and other technologies that are maturing fast but are not quite ready, is sure to be the finest combat aircraft ever, far outstripping even the best, most versatile F-16s and F-15s imaginable—moreover, that USAF is not planning to build the ATF just for the hell of it, but to keep the fast-improving Soviet air and air defense arms from wiping the skies clean of US aircraft if war should come.

"The ATF will be in the same ball park as the F-15 in terms of size and gross weight, but it will have far, far better capabilities because it will have to deal with some very advanced threats," predicts Col. Albert C. Piccirillo, director of the ATF System Program Office under ASD's Deputy for Tactical Systems.

Picking up steam, the ATF program moved into ASD's tactical arena and out of its development planning arena last July.

At the time, Brig. Gen. Gerald C. Schwankl, ASD's Tactical Systems director, declared that "development planning gave birth to a great baby, and now everyone is eager to help with its growing up."

He was not exaggerating. The ATF program involves a host of ASD shops, such as those for propulsion, avionics, electronic coun-

Aeronautical Systems Division (ASD) will choose three contractors, or three contractor teams, late next summer to compete for full-scale development of the Advanced Tactical Fighter (ATF), shown here in generic design.

termeasures, aerodynamics, and materials. It is also being supported by AFSC's Armaments Division at Eglin AFB, Fla., by Electronic Systems Division at Hanscom AFB, Mass., and by Aerospace Medical Division at Brooks AFB, Tex.

TAC and Air Force Logistics Command officers have moved into the ATF office on a full-time basis. This is because the ATF program has entered the real-world, critical phase of getting down to cases in defining its operational requirements.

Taking the users' approach to the ATF, the TAC people are proxies for USAFE and PACAF, too. The logisticians are making sure that the fighter's reliability and maintainability are not slighted in designing it to do what the pilots need it to do or what the technologists would like to see it try to do.

Excitement about the ATF program is palpable at ASD. "We're not dreaming; it's happening," Colonel Piccirillo declares, "and this next year should be extremely interesting."

You bet. It is getting on toward crunch time for the seven companies—Boeing, General Dynamics, Grumman, Lockheed, McDonnell Douglas, Northrop, and Rockwell International—now in competition to design the ATF. Three of them, or three teams of them, will be chosen, probably in August, to get down to the nitty-gritty of ATF design and plans for its early development. Three years from then, one will be chosen, and full-scale development will begin posthaste. First flight is scheduled for 1991.

This is a high-stakes program for the aerospace industry. Give or take, the seven companies have spent an estimated $10 million to $20 million apiece on it so far. The winner, or winners as a team, will almost certainly dominate USAF fighter production, and possibly fighter avionics integration, in the 1990s.

Losers will risk being in tough shape in those years unless they move into different kinds of combat flying machines, such as the Transatmospheric Vehicle (TAV) now being conceived by several of them in concert with ASD.

What ATF Will Do

At this juncture, no one knows what the ATF will look like, but there is no mystery about what it is expected to embody and to do.

Its ultrasophisticated avionics for fire controls, flight controls, weapons delivery, and whatnot will be totally integrated from scratch. It just might have movable canards. Much of its airframe will be built of tough, lightweight advanced composites.

It will be capable of cruising at supersonic speeds and yet be very efficient with its fuel. It will be supple, agile, and proficient at attacking ground targets in a secondary role. It will be hard to spot by radar and by infrared and optical seekers. The ATF will be able to cruise supersonically without afterburners because each of its two engines is expected to provide more than twice the thrust, in relation to its weight, of any current, state-of-the-art fighter engine. Advanced composites should make it possible to build an ATF airframe that is fifteen to twenty percent lighter than it would be were it totally metallic in structure.

Its avionics, characterized fully by light, compact circuit boards with very-high-speed integrated circuitry (VHSIC) in the form of tiny, reliable semiconductor chips, should allow for additional, enormous savings in weight.

Given that the ATF is expected to weigh about as much as an F-15, such savings presumably mean that it will be able to carry vastly more fuel and weaponry and will feature more fight per pound.

The ATF may well be the first fighter to cost less, rather than more, as a result of its incorporation of highly advanced engine, structural, and avionics technologies. The reason is that fighters—indeed, all aircraft—are always priced pretty much by their poundage. And in order to build it to do what it will need to do, an ATF without those weight-saving high technologies might cost as much as $60 million, knowledgeable officials estimate.

But the ATF will very likely come in at one-third less than that, and its life-cycle costs, given the reliability that can be predicted for its engines and avionics, will be way down as well.

The possibility that the ATF will have movable canards and a variable-camber wing is why its designers show great interest in the X-29 and AFTI/F-111 technology demonstration aircraft. The AFTI/F-111 is the test-bed for the Mission Adaptive Wing (MAW) developed by ASD's Flight Dynamics Laboratory and Boeing Airplane Co.

Wings that change shape, and other surfaces that also move—all managed by superfast flight controls reacting automatically to conditions of flight and demands of maneuverability—should team up with thrust-reversing and thrust-vectoring engine nozzles to give the ATF wasp-like agility and elusiveness.

It really won't need those vectoring nozzles for short takeoffs, according to Robert J. May, manager of ASD's Joint Advanced Fighter Engine program. Mr. May claims that the ATF's engines will be powerful enough to get it airborne "in fairly short distances," nozzles or no nozzles.

The nozzles will be a big help in landing, however, "especially on a wet or an icy runway," says Mr. May, because they will make slow approach speeds possible and will rapidly provide high levels of reverse thrust on touchdown.

An Engine for ATF

Details of the advanced fighter engine being developed for the ATF by Pratt & Whitney and General Electric are highly classified. However, Mr. May provides a general description of it as follows:

"We are seeing a lot of advanced materials incorporated in the design and tremendous improvements in the form of advanced aerodynamics—so we're going to see a great reduction in the number of stages in the engine and about fifty percent reduction in parts.

"That means reliability, right there. Also, we're seeing improvements in cooling effectiveness so that we can run high turbine temperatures and get the performance, and yet still get the durability, we want.

"Some really advanced structural concepts will help us save weight. And we're going to the full-authority digital electronic control. This, too, will improve the reliability of the engine. Control is one of the more unreliable elements in current engines."

The current P&W F100 fighter engine has thirteen compressor stages and four turbine stages. The GE F110 has twelve compressor stages and three turbine stages. The ATF engine will likely reduce the number of such stages "on the order of fifty percent," Mr. May predicts.

P&W and GE have learned a great deal about how to design an engine for the ATF as a result of their work on upgrading the F100 engine and on developing its latter-day competitor, the F110 engine, respectively.

Artist's rendering shows how fighter aircraft may someday take off from air-cushioned platforms that propel them to rotation speed over bomb-damaged runways.

Air Cushions and Fast-Acting Sensors

Imagine a fighter aircraft taking off from a bomb-damaged runway by sliding over the craters and gaining airspeed atop an air-cushion platform that the fighter itself propels along the ground.

Imagine that same fighter, or any other, losing a vital chunk of its wing or tail to enemy fire—and continuing not only to fly but to fight.

Air Force Systems Command's Aeronautical Systems Division (ASD) has passed beyond the point of merely imagining such prospects. It is well along with research and development programs aimed at turning them into reality.

Much of ASD's work is concentrated on "sortie generation," one of its Flight Dynamics Laboratory's four "major thrusts" of research and development. The "pivotal program" in that regard, says FDL Deputy Director James J. Mattice, is the Short Takeoff and Landing (STOL) and Maneuver Technology Demonstrator aircraft, an F-15 now being modified to embody movable canards and thrust-reversing and thrust-vectoring nozzles.

But FDL is also developing the Air-Cushion Equipment Transportation System (ACETS) and the Self-Repairing Flight Control System, both of which could someday make Air Force aircraft much more capable of joining and sustaining combat.

FDL has tested an air-cushion equipment transporter in a joint program with, and in, Canada. The test-bed platform successfully carried aircraft and other heavy equipment over rough terrain and over craters thirty feet in diameter.

That platform has its own engines. They push air into rubber cushions, or skirts, beneath the platform, enabling it to float on air over rough terrain, much as a hovercraft floats on air over water.

Among other things, it has great potential for transporting combat equipment to and from intratheater airlifters over rough or scarred countryside in combat zones.

With data in hand from the tests in Canada, FDL is now looking at the possibility of an air-cushion transporter that would get its thrust from the aircraft mounted on it. When the platform reaches the aircraft's rotation speed, the aircraft would disengage and take off.

FDL is also exploring the feasibility of using an air-cushion transporter as a carrier of the Transatmospheric Vehicle (TAV), now being conceived under ASD's direction for takeoff and direct ascent through and above the atmosphere.

Fast-acting sensors and computers have given rise to FDL's high hopes for aircraft that can take heavy damage to control surfaces and then compensate—instantaneously and automatically—for such damage in order to stay airworthy.

For example, the aircraft's flight control computer would reconfigure other control surfaces—such as rudders, flaperons, ailerons, and stabilators—to take up the slack induced by the loss of part of a wing.

For another, the loss of one side of a stabilator on the tail of an F-16 would cause a control problem requiring instant rectification. The pilot probably could not provide it. He likely would not be aware of exactly what was wrong, and even if he were, he likely could not react fast enough.

But the combination of sensors and flight control computer that FDL has in mind, and is preparing to develop and test, could presumably reconfigure the F-16 in a flash by substituting a combination of, say, flaperons and speed brakes to permit the pilot to keep control.

The computer and its associated sensors would have two main tasks: diagnosing the problem and doing something about it immediately. It would then tell the pilot what the aircraft is still capable of doing—whether he can continue the mission or should head for a friendly airfield.

"Telling him what the failure is doesn't tell him what he needs to know," says Boris J. Tirpak, FDL's program manager. "He needs to know what capability he has remaining, such as his maximum Gs are four, his altitude is limited to 30,000 feet, and so forth. He needs to know if he still has control of the airplane, and how much."

—J.W.C.

Col. Howard E. Bethel, ASD's Deputy for Propulsion, describes both the new F100-PW-220 engine and the GE F110 as "super" in durability and reliability, compared to their predecessors now on USAF fighters.

Both of these engines incorporate advanced materials, cooling techniques, and electronic controls that are precursors of such innovations, to be even more advanced, in the engines of the ATF.

The technologies of those engines are "converging very nicely," says Colonel Piccirillo, and "the engine program is on a good schedule. It will be ready in plenty of time, and we'll be able to upscale it easily if necessary."

Accelerated mission testing of the ATF engine is expected to begin in just a little more than two years from now.

Avionics—The Toughest Challenge

The ATF's avionics are the "toughest challenge," Colonel Piccirillo claims, "because there are so many things going on in avionics—a real explosion. We have so many technologies coming out of the labs that have to be integrated [in the ATF] that our problem is going to be in deciding where to cut it off in order to get an airplane on the ramp."

All avionics for the ATF are being integrated in an "architecture" being devised in the ASD Avionics Laboratory's Pave Pillar program. It is heavily dependent on the advent of the VHSIC chips and on their performance and reliability as advertised.

Those chips promise improvements of computational speed, of reliability, and of weight and space savings that "blow my mind," says Col. Frank Moore, director of the Avionics Laboratory.

For example: The existing F-15 radar signal processor weighs fifty pounds, contains 5,000 integrated circuits (chips), and needs 1,600 watts of power. Doing its job with VHSIC chips would require one thin circuit-board card containing only forty-five chips, weighing a total of only three pounds, and requiring only fifty watts, claims Colonel Moore.

Moreover, he says, the use of such a card would reduce the number of connectors in the radar signal processor (connectors are responsible for a great many failures of avionics) "by a factor of one hundred to one." This could increase the reliability of the aircraft's avionics by a factor of ten and cut maintenance in half.

Each F-16 now contains fifty-eight avionics black boxes, each weighing about fifty pounds. Called Line Replaceable Units (LRUs), they are manufactured by several different contractors and are not standardized. Consequently, each F-16 also requires, at operational bases, 437 separate types of LRU replacement spares.

According to Colonel Moore, it would take only forty-three VHSIC Line Replaceable Modules (those three-pound cards) to do what that entire assortment of avionics black boxes does in the F-16.

Reduction of weight would be compounded throughout the aircraft. Given the rule of thumb that a saving of one pound in an aircraft's avionics translates into a saving of five pounds in its takeoff weight (in the form of structural racks, cables, fuel, and the like), an aircraft replete with VHSIC cassette-like circuit boards, such as the ATF is expected to be, would trade off tons of "dead" weight for "live" weight—as in weaponry and other features that embellish its performance.

This prospect gives the ATF designers tremendous leeway. It also makes the logisticians happy. They foresee the ATF's maintenance crews simply pulling defective avionics modules from the ATF, inserting new ones on the flight line (the module cards can be carried in one hand), and shipping the bad ones back to the States for repair after having collected a batch of them—no hurry.

The ATF will not be the only beneficiary of VHSIC technology. Plans are afoot to retrofit existing aircraft with the superchips wherever feasible over time.

All Aboard!

In anticipation of those chips, which are now being manufactured at very slow rates and upgraded by the six contractors in the VHSIC program, Pave Pillar officials are bent on integrating all signal processors, data processors, and sensors destined for the ATF.

The final trick will be to provide the pilot with displays that make it easy for him to take notice of, and act on, the disparate information from the sensors that the computers show him in coherent fashion. Designers of such displays for the ATF have been given a big leg up by work on cockpit technologies in the AFTI/F-16 program and by such work for the latest variants of the F-16 and for the F-15E.

The AFTI/F-16 program, now entering its second phase; is also exploring technologies that may permit the ATF pilot to speak some of his commands to the aircraft. Given the urgency of the ATF program, however, it is unlikely that such voice-control technologies will be ready for employment in the fighter right off.

The ATF's technologies will be "frozen," says Colonel Piccirillo, in less than three years in order to get it built with technologies then available. But like all fighters, the ATF would undoubtedly be upgraded through several successive models, and the original ATF is being designed with an eye to technological growth into the twenty-first century.

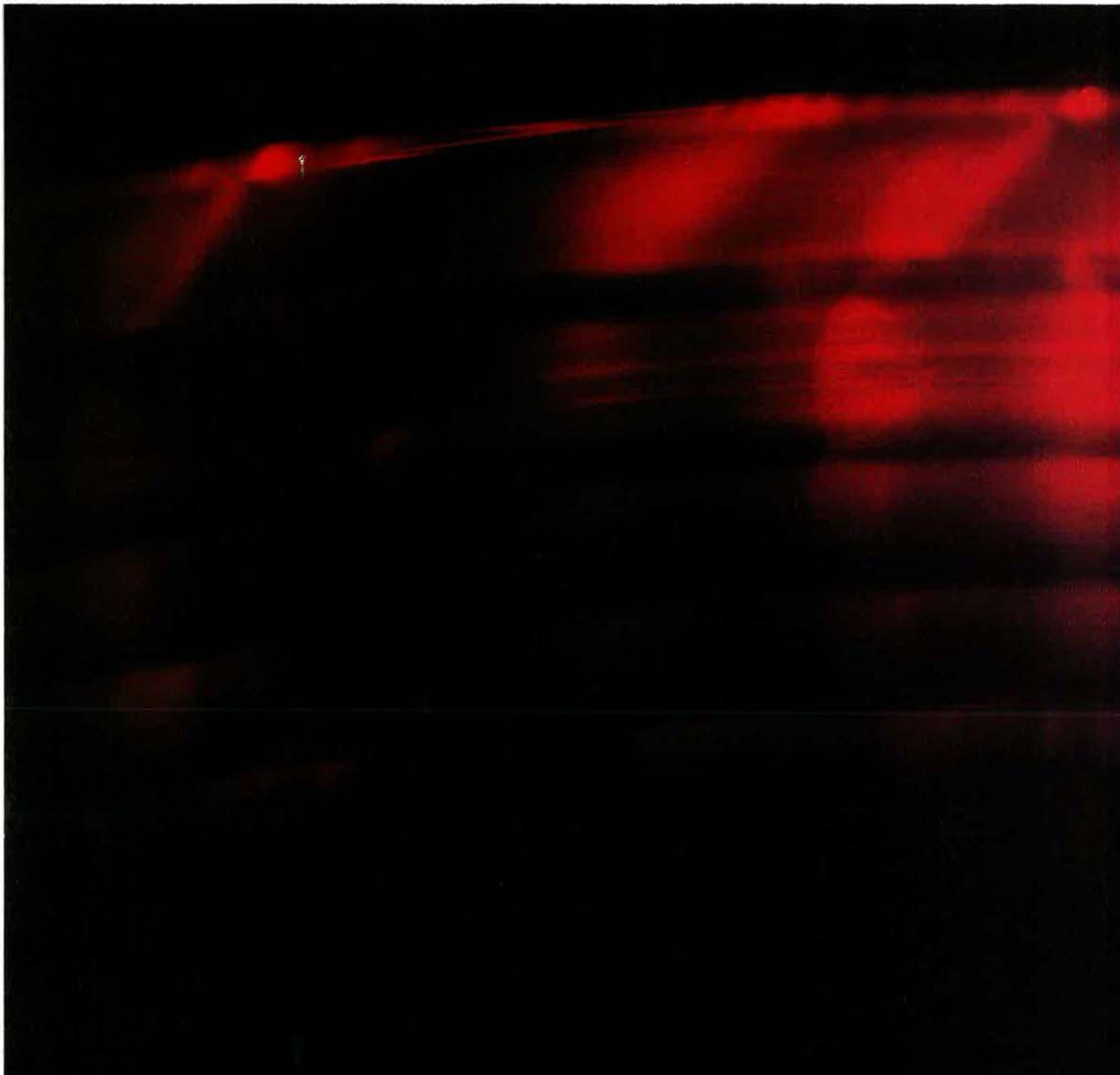
Many programs subheaded under Pave Pillar should produce avionics systems ready for incorporation in the ATF.

The Ultra Reliable Radar (URR) is a big one. Another is the Integrated Inertial Reference Assembly (IIRA) system that pools information from all gyroscopes, accelerometers, and other positioning equipment on the aircraft (even gunsights have gyroscopes) to keep the pilot constantly posted on the state of the aircraft and its systems.

Yet another endeavor pegged to the ATF is the Integrated Communications, Navigation, and Identification Avionics (ICNIA) program, which will provide, in a few fault-tolerant units, all externally received radio, navigation, and Identification Friend or Foe (IFF) information, even from satellites, needed on tactical missions.

These and other programs supporting Pave Pillar are already under contract.

"This train," asserts Colonel Moore, "is running." ■



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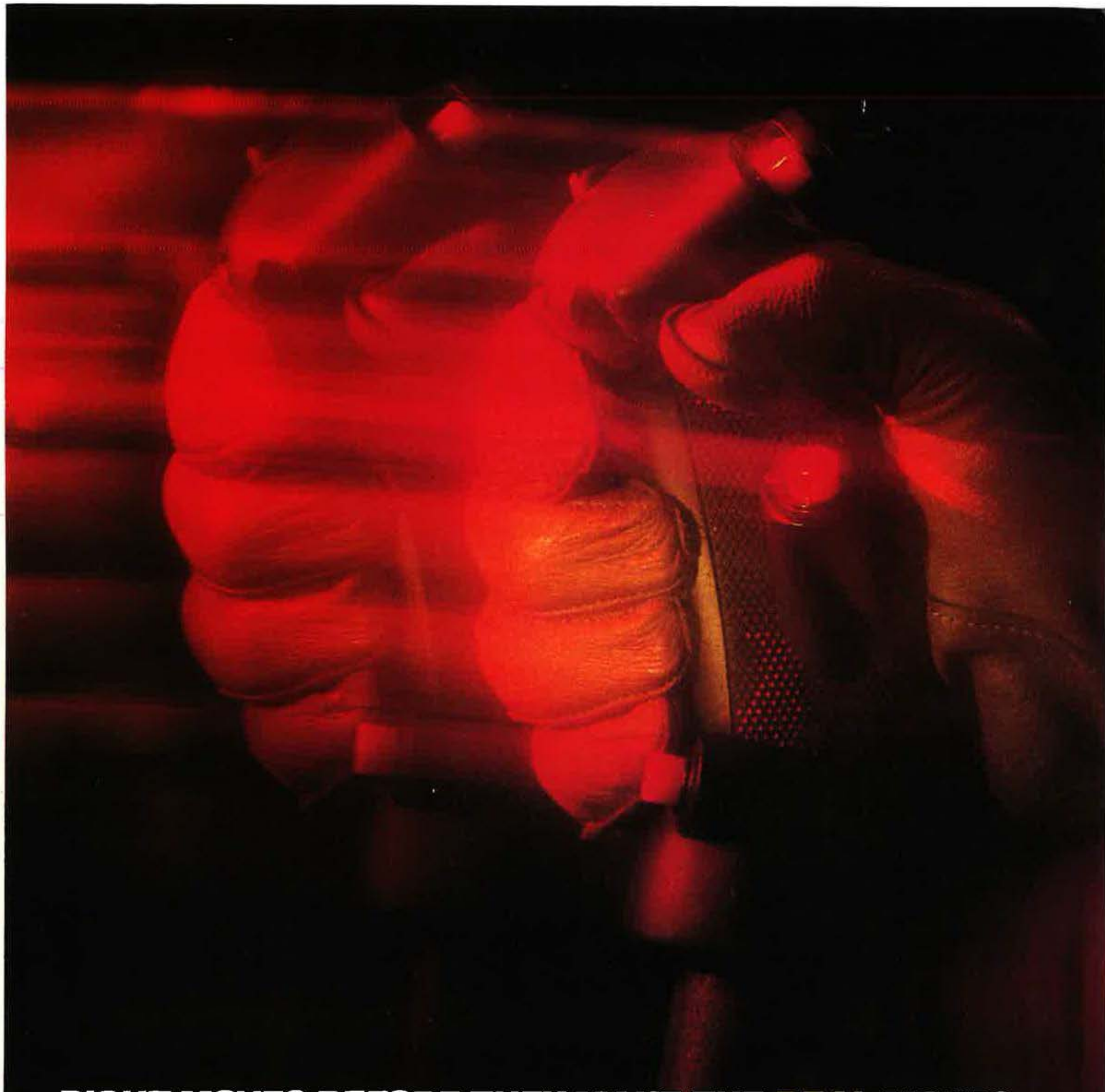

RIGHT MOVES BEFORE THEY MAKE THE REAL MOVES.

maintenance training for the navigation crews of every Poseidon and Trident submarine.

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Training people to make the right moves—before they make the real moves. It all comes from listening and the ability to integrate the right systems for the job at hand. Sperry Corporation, Great Neck, New York 11020.

SPERRY

WE UNDERSTAND HOW IMPORTANT IT IS TO LISTEN.

What's Happening in Aeronau

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 Acts as the DoD executive agent for combat identification systems and evaluates active and passive identification techniques for application to USAF weapon systems platforms. Currently developing Mark XV IFF as a secure, antijam, high-reliability, triservice, and NATO-interoperable replacement for the current Mark XII IFF.	Definition, Evaluation, Development	Veda, Inc.; Bendix; Texas Instruments
Modular Automatic Test Equipment (MATE) System A standardized USAF management system governing procedures, architecture, and hard/software tools for acquisition of systems employing automatic test equipment (ATE). Objective is to preclude proliferation and reduce life-cycle cost of system-peculiar ATE. Current applications include the A-10 and B-1B aircraft.	Development/Production	Sperry Systems Management; Emerson Electronics & Space Div.
Life Support Life Support Systems provides centralized management to develop life-support equipment/subsystems to assure maximum aircrew capability throughout all mission environments, including emergency situations.	Development/Production	Many
Avionics Subsystems Acquires standardized avionics systems for use in several aircraft systems. Programs include standard inertial navigation unit, standard central air data computer, digital audio distribution system, microwave landing system, and standard ground proximity warning system.	RDT&E and 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
Support Equipment These programs develop improved aircraft ground-support equipment capable of supporting several types of aircraft. Current programs include ground power generator, large aircraft start system, universal aircraft towbars, mobile aircraft arresting system, and generic integrated maintenance diagnostics.	RDT&E and Production	Many
Productivity, Reliability, Availability, and Maintainability Program (PRAM) Reduce current and potential USAF operations and support costs without sacrificing operational systems effectiveness 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 adaptation 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	None
Deputy for Airlift & Trainer Systems (AF)		
C-17 Development and acquisition of the C-17 airlift system for the rapid deployment of today's modern Army from the CONUS directly to overseas areas of conflict, and 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
T-46A Development and production of a training aircraft to replace the aging, operationally deficient T-37B. T-46A system characteristics include fuel-efficient twin F109-GA-100 turbofan engines, a pressurized cockpit, ACES II ejection system, improved performance, better adverse weather capability, greater range, and reduced maintenance costs. A total of 650 aircraft, with associated support equipment, technical data, training equipment, and eleven Operational Flight Trainers (OFT), is being acquired.	Full-Scale Engineering Development/Production	Fairchild Republic; Garrett
C-5B Acquisition of fifty C-5B aircraft to fulfill the immediate need for additional intertheater airlift capability to support national strategy goals and the mobility requirements of a modern-day Army. The aircraft is basically a C-5A (with the C-5A wing mod) with minor configuration changes intended to improve reliability. The C-5B aircraft will provide airlift of substantial payloads, including outsize combat equipment, over intercontinental ranges without refueling and delivery of this equipment/cargo for rapid intertheater deployment of combat forces.	Production	Lockheed-Georgia
KC-10A Acquisition of an advanced tanker/cargo aircraft possessing both refueling and cargo mission capability. Augments 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; twenty-seven have been delivered.	Production/Deployment	Douglas; American Airlines
KC-135R The KC-135 reengine program modernizes the USAF tanker fleet by replacing the fuel-inefficient and pollution-prone J57 engines with new-technology, state-of-the-art CFM56 turbofan engines. Modification kits for sixty aircraft are on contract; delivery of the reengined KC-135Rs to SAC at McConnell AFB, Kan., began in July 1984. Plans are to reengine the total tanker fleet of approximately 640 aircraft.	Production/Installation/Deployment	Boeing; CFMI

tics at ASD

NAME AND MISSION	STATUS	CONTRACTOR
KC-135 Improved Aerial Refueling System (IARS) Development and test of new and improved aerial refueling systems and subsystems to improve upon the 1950s technology of the current KC-135 Air Refueling (AR) system.	Development	J. C. Carter; Sargent-Fletcher; XAR Industries; Dataproducts New England
HH-60A Development and acquisition of a highly survivable combat rescue helicopter able to function effectively in worldwide geographic, climatic, and day/night low-level terrain-masking flight conditions. The ninety-aircraft program provides for installation of necessary avionics and modifications on the production UH-60A helicopter to meet combat rescue mission requirements.	Full-Scale Engineering Development/Production	IBM; Sikorsky; General Electric
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 the Special Operations Forces of the Military Airlift Command.	Production	IBM; Lockheed-Georgia
C-130H Domestic and Foreign Military Sales The C-130H Domestic and Foreign Military Sales program provides cargo, search and rescue, and tanker aircraft for both US domestic and foreign users.	Production/Deployment	Lockheed-Georgia
C-23A This program acquires eighteen aircraft to provide assured theater distribution of critical spare parts in Europe.	Production/Deployment	Short Brothers Ltd.
C-20A This program provides worldwide air transportation for the President and Vice President of the United States, Cabinet members, and other high-ranking dignitaries of the United States and foreign governments. The eleven-aircraft C-20A program replaces the aging C-140B fleet and provides the Special Airlift Mission (SAM) fleet with intercontinental range and ability to operate from short runways. The C-20A provides a fuel-efficient, low-maintenance, and longer-range system.	Lease/Acquisition/Operations	Gulfstream Aerospace
C-12F/C-21A This program replaces the current CT-39 fleet, acquired in the late 1950s and early 1960s, with 120 off-the-shelf business-type jet (C-21A) and turboprop (C-12F) aircraft. These aircraft are being leased and operated at a cost less than would have been required to operate the C-39s.	Lease/Operations	Gates Learjet (C-21A); Beech Aircraft (C-12F)
Air National Guard Support Aircraft Acquisition, modification, and support of four commercially available Boeing 727 aircraft to be operated by the Air National Guard for use as operational support airlift aircraft.	Acquisition	Boeing
Joint Vertical Lift Aircraft (JVX) The JVX Program will fill the need for an aircraft with increased Special Operations Forces (SOF)/Rescue capabilities by using the tilt-rotor design demonstrated on the Bell XV-15, and other advanced technologies. The JVX will have the maneuverability and lift capability of a helicopter and speed of a fixed-wing aircraft. The JVX is intended to replace the SOF H-53 aircraft and supplement the MC-130 aircraft.	Development	Bell-Boeing
Airdrop Program Development and test of new and improved airdrop systems in coordination with the Joint Technical Airdrop Group. Approved activities include development of aircraft aerial delivery equipment, enhancement of airdrop capability, and conduct of system studies of improved airdrop concepts for existing and future aircraft.	Development	None
Deputy for Avionics Control (AX)		
Avionics Standardization Support to the USAF avionics standardization program. Maintenance of architectural standards, such as MIL-STD-1589, 1750, support of government industry users groups. Initiating subsystem development programs under the Joint Service Review Committee. Publish USAF Avionics Master Plan and maintain avionics data bases.	Continuing	ARINC, TASC, PSS, SDC Systems; Applied Sciences Corp.
Deputy for B-1B (B-1)		
Deputy for B-1B Largest of ASD programs with a baselined budget of $20.5 billion (in FY '81 dollars), the B-1B program provides the 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 standoff roles. First operational B-1B entered testing at Edwards AFB, Calif., in October 1984. First delivery to SAC at Dyess AFB, Tex., will be in June 1985, with Initial Operating Capability (fifteen aircraft) scheduled for September 1986. The full complement of 100 B-1Bs will be delivered by the end of 1988.	Development/Production/Deployment	Rockwell International; Boeing Military Airplane Co.; Eaton Corp.'s AIL Div.; General Electric
Deputy for Engineering (EN)		
Avionics Integrity Program (AVIP) A program modeled after the aircraft structural integrity program (ASIP) and the engine structural integrity program (ENSIP) that is targeted to improve the readiness of avionics hardware. It consists of both a system engineering acquisition process and a deterministic technical approach to improving and measuring durability (lifetime). It also includes key maintainability and fault-tolerance interface issues.	Application; Continuing Development	Battelle; Columbus Labs; Gould
Value Engineering This program seeks to reduce program costs by using conventional value-engineering techniques as well as innovative approaches for the latest state-of-the-art technology insertion into current systems that are already in production.	Ongoing	All current acquisition contractors

NAME AND MISSION	STATUS	CONTRACTOR
MIL-PRIME Program The MIL-PRIME Program is an initiative to reduce the tiering effect of military specifications and standards that are put on contract during the acquisition process. Each MIL-PRIME document produces a specification or standard that can be tailored to a specific weapon system. An associated handbook containing data and lessons learned accompanies each MIL-PRIME.	Ongoing	None
Deputy for Reconnaissance/Strike and Electronic Warfare (RW)		
Low-Altitude Navigation and Targeting Infrared System for Night (LANTIRN) Provides the tactical air forces (F-16, A-10, F-15E) with a day and night low-altitude navigation/precision attack capability in visual or under the weather conditions. System consists of a navigation pod, targeting pod, and head-up display, which displays forward-looking infrared (FLIR) video.	Development	Martin Marietta Corp.; Marconi Avionics
Tactical Reconnaissance System (TRS) The Tactical Reconnaissance System technical concept features an integrated tactical reconnaissance sensor suite (on an existing air vehicle TR-1); a data link, both up- and downlink, for communication of information and data between the airborne and ground segments; and ground segments for rapid processing of received data, preparation of exploitation reports in near real time, and rapid dissemination of exploitation reports via common user and dedicated communications circuits.	Development	Ford Aerospace Corp.
Advanced Synthetic Aperture Radar System The Advanced Synthetic Aperture Radar System (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 the ASARS Deployable Processing Station (ADPS) and ASARS.	Production	Hughes Aircraft Co.
TR-1 Aircraft Acquisition of aircraft to support the Tactical Reconnaissance System (TRS) for the Air Force. Includes the role of integrator for the airborne equipment with other mission equipment and with the aircraft.	Production	Lockheed-California Co.
Area Reprogramming Capability (ARC) A highly interactive man/computer operation that provides the user the ability to produce validated EW system change package as required.	Procurement	Teledyne Systems Co.
EF-111A Upgrade Program Program to update the AN/ALQ-99 Jamming Subsystem of the Air Force EF-111A Tactical Jamming System in order to maintain mission effectiveness through the 1990s. This program will upgrade encoder, processor, and jammer capabilities. The EF-111A mission is to jam hostile radars in order to prevent detection of friendly aircraft operations.	Full-Scale Development	Eaton Corp., AIL Div.
Precision Location Strike System (PLSS) PLSS detects, accurately locates, identifies, and directs strikes against enemy radar emitters in near real time. To accomplish its location function, PLSS uses information from intercepted RF signals and computes emitter positions within seconds by employing time-difference-of-arrival techniques.	Development	Lockheed Missile and Space Co.
Improved (Pyrophoric) IR Flare Develop and deploy an improved infrared countermeasures decoy (flare) using pyrophoric technology for USAF aircraft beginning with the B-52G/H aircraft.	Demonstration/Validation	Hycor; Tracor-MBA; Space Ordnance Systems
Integrated Electronic Warfare Systems (INEWS) Provide crew warning and countermeasures response for combat aircraft operational in the post-1990 time frame. Joint Air Force/Navy development to provide a generic next-generation electronic warfare system to give full spectral warning and countermeasures capability. Five Joint-Venture teams are competing during the initial phase.	Concept Exploration	ITT/Litton; Hughes/Loral; Raytheon/Northrop; Sanders/GE; TRW/Westinghouse
Tactical Countermeasures Dispenser Upgrade/ALE-47 Develop 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.	Demonstration/Validation	Goodyear; Tracor
MJU-2/B Decoy Flare Provide IR missile decoy protection for the RF-4C aircraft. Procure and qualify for Air Force use the Navy-developed flare.	Production	Kilgore Corp.; Bermite Corp.
Air Force Electronic Warfare Evaluation Simulator (AFEWES) A facility with capability to simulate numerous radar threats.	Procurement	General Dynamics
MJU-10B Decoy Flare Provide IR antimissile diversionary protection for the F-15 aircraft. Procure low-rate initial production of the flare in direct support of the F-15 Countermeasures Dispenser program. Competitive production contract anticipated in FY '85.	Production	None
Have Charcoal A program to develop improved infrared countermeasure jammers to protect C-137 and E-3A aircraft from selected infrared-seeking missiles.	Ground- and Flight-Test Program	Northrop; Sanders; Loral Electro-Optical Systems
Airfield Damage Assessment System (ADAS) Development of a high-resolution airborne/ground-based sensor system capable of locating/identifying/classifying airfield damage and able to identify a 50′ × 5,000′ minimum operating strip (MOS) following a conventional attack.	Development	None
Electronic Warfare Management This Directorate is a plans organization charged with the responsibility of developing an electronic warfare system investment strategy for Aeronautical Systems Division. The investment strategy supports Program Objective Memorandum activities by establishing a coherent set of laboratory and system program office developments for Air Force defensive weapon system requirements. The Directorate is developing an electronic combat analysis capability that will significantly improve ASD's capability to do early technique development and alternative system improvement assessments. The system is known as the Electronic Combat Digital Evaluation System (ECDES). Existing hybrid and digital simulations are being used wherever	Development	Multiple

NAME AND MISSION	STATUS	CONTRACTOR
possible to minimize cost. The system will support program office engineering, laboratory, and Foreign Technology Division analysis requirements. Initial operating capability for selected components of ECDES will be achieved by early FY '86, depending upon funding levels achieved.		
Pave Tack A single pod system consisting of a forward-looking infrared (FLIR) and laser target designator that provides fighter aircraft (F-111F, RF-4C, F-4E) long-range target acquisition and precise weapon delivery.	Operational	Ford Aerospace
Peace Hawk V Foreign Military Sales (FMS) Provide developing/finishing equipment for mobile and fixed facilities in Saudi Arabia. The existing Peace Hawk V mobile system and one fixed facility will be modified with state-of-the-art equipment to enhance their processing capabilities. A new mobile system will also be procured.	Development	Goodyear Aerospace Corp.

Deputy for Tactical Systems (TA)

NAME AND MISSION	STATUS	CONTRACTOR
F-15E Enhancements to the F-15 provide the F-15 airframe with long-range, adverse-weather, air-to-surface delivery capability needed to augment the fully committed and aging F-111 tactical force and to replace the attriting F-4 multimission fighters. The F-15C/D MSIP configuration is the baseline to which the following items will be added: missionized crew stations for two crew members, LANTIRN pods to provide automatic terrain following and target detection and tracking, and a digital flight control system.	Development	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
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, planned to be validated during the Demonstration/Validation phase starting in FY '85, 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 supersonic persistence and a greatly increased combat radius. The program includes the development/demonstration of advanced-technology fighter engines under the Joint Advanced Fighter Engine (JAFE) project.	Concept Exploration/ Demonstration/Validation	Boeing; Grumman; General Dynamics; Rockwell International; McDonnell Douglas; Lockheed; Northrop; General Electric; Pratt & Whitney
Air Force Infrared (IR) Maverick (AGM-65D) 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 Co.
Navy Infrared (IR) Maverick (AGM-65F) Similar to the Air Force AGM-65D, but with software optimized for use against ship targets, a larger warhead, and delayed fuzing.	Full-Scale Engineering Development	Hughes Aircraft Co.
Marine Corps Laser Maverick (AGM-65E) 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 Procurement programs primarily for Foreign Military Sales. Currently buying aircraft for USAF (to support FMS training) and for Tunisia. Coproduction programs include shipsets for Korea and Taiwan.	Acquisition	Northrop Corp.
RF-5E Reconnaissance Aircraft Currently procuring aircraft and photo-processing equipment for Saudi Arabia (Peace Hawk IX).	Acquisition	Northrop Corp.
F-20 Tigershark Aircraft Contractor-developed/funded fighter, designed primarily for Foreign Military Sales. Three aircraft currently undergoing extensive flight test at Edwards AFB, Calif., in anticipation of future sales. Foreign and USAF/USN personnel have participated in demonstration flights in the past year.	Development	Northrop Corp.
Tactical Electronic Warfare (TEWS) Intermediate Support System (TISS) TISS will provide the user with test equipment capable of supporting the new state-of-the-art TEWS suite (ALR-56C and ALQ-135 Band 3) being developed and produced for the F-15. The TISS will have the capability to test the new and existing TEWS systems, with additional room for growth.	Competition, Development, Production	McDonnell Douglas Aircraft
Pave Tiger Minidrone The Pave Tiger program covers the development and production of a lethal minidrone system designed to counter a specific high-priority target in nonnuclear theater warfare. The low-cost, expendable air vehicle has been designed for long-term storage in a launch/storage/transportation container and minimal maintenance. Pave Tiger has been designated a Quick Reaction Capability (QRC) program in order to field the system as quickly and effectively as possible.	QRC Development	Boeing Military Airplane Co.
Low-Altitude Warning System (LAWS) An in-house-developed lead-computing terrain-clearance warning system for use by tactical fighter aircraft during hard maneuvering close to the ground. This system provides CFIT protection for ±150° bank angle maneuvers and accelerated dives (semi-inverted loaded pulls) as well as steady dives and rising terrain.	Continuing Development and Test	None
Mishap Investigation Visual Aid Development An in-house development analysis process for providing visual aid data in the form of videotapes of real-time computer graphics displays of simulated mishap maneuvers. The process starts with a simulation of the mishap maneuver, which is then displayed on a color CRT as it would appear from actual and simulated eyewitness reference points. Transparent map overlays and variable aircraft scaling have also been used to enhance the utility of this visual aid process in support of Mishap Investigation Boards.	Continued Refinement of Capability	None

NAME AND MISSION	STATUS	CONTRACTOR
Deputy for Development Planning (XR)		
Strategic Future Systems Mission Analysis To identify promising future strategic aeronautical system concepts and the supporting technologies. The analysis focuses on the strategic offense aspects of a central conflict, using aeronautical systems (including atmospheric and transatmospheric vehicles).	Preconcept Definition	GRC: SRL & Subcontractors, Boeing, Lockheed, McDonnell Douglas
Chemical-Biological Warfare Defense Mission Analysis To determine the ability of the USAF to maintain air base operations and generate sorties in a chemical-biological attack environment and identify technologies and equipment for future Air Force investments.	Preconcept Definition	Quest; VERAC; SRL, Vought; IITRI
Mobility Mission Analysis To develop an integrated plan for improving intratheater airlift capability worldwide into the twenty-first century, and to establish an analysis capability with appropriate models and data bases to perform continuing analyses as necessary in the mobility mission area.	Preconcept Definition, Source Selection	To be determined
Far-Term Fighter Force Modernization Investigation To keep the F-15, F-16, A-10, and F-111 first-line fighters through the early twenty-first century. This force modernization effort will identify key new technologies and will develop plans to incorporate these technologies into our current tactical aircraft.	Defining Configuration Options	SAIC; General Dynamics; McDonnell Douglas; Fairchild
Strategic Penetration Investigation Feasibility Analysis of Penetration Aids Investigate practical means to maximize the ability of strategic aeronautical systems to survive enemy defensive actions.	Preconcept Definition, Source Selection	To be determined
Transatmospheric Vehicle (TAV) To identify concepts for and evaluate the military effectiveness of an aircraft system, with quick reaction global-range capability, operating from military airfields in CONUS and performing multiple missions.	Preconceptual Definition	Science Applications International Corp.; Subcontractors, Boeing, Rockwell, GD, Lockheed, McDonnell
Optical/EO/IR Counter Countermeasures Assessment To identify the most effective sets of responses that can be made to counter the potential introduction of threat laser systems on the tactical battlefield over the 1985–2000 time period.	Preconcept Definition	IITRI & Subcontractor, VERAC
Minimum Maintenance Fighter Concept To develop viable 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 to be fully mission-capable for 250 flight hours with little or no maintenance.	Preconcept Definition	None
Embedded Training Concepts for Tactical Aircraft To define concepts in which various training functions will be integral or intrinsic to an operational aircraft. For instance, embedded computer-generated threats and targets weapon release and scoring could provide a quantum advance in continuation training, both in conjunction with training at ranges and at arbitrary locations. The embedded trainer would be part of the aircraft design. Applications could include aircraft in-flight and possibly aircraft on-the-ramp training.	Preconcept Definition	Quest; DRC
Aeronautical/Space Assets Interface Investigation To identify opportunities for aeronautical systems to operate in conjunction with space-based systems. This is a cooperative approach among ASD, SD, ESD, FTD, Space Command, and others. The result of this effort will be recommendations for future aeronautical and space systems concepts.	Preconcept Definition	None
Follow-On Close Air Support Aircraft Investigation Determine and analyze the deficiencies of existing Air Force assets to perform the close air support role in the mid- to late-1990s. Develop new weapon system concepts and/or improvements to current weapon systems to overcome these deficiencies.	Preconcept Definition	SAIC
Vanguard The AFSC Development Planning process and methodology that plans for the research, development, and acquisition of a force structure that would allow us to counter the threat throughout a twenty-year time frame. Through analysis, Vanguard identifies deficiencies in the capabilities of the current and programmed forces to counter the present and growing threat. This establishes goals for improving this capability. Satisfying these goals, then, will allow us to achieve the capability necessary to counter the threat throughout a twenty-year time span.	Preconcept Definition	None
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 the F-16C/D models with the capability to employ advanced systems, such as Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) and 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, Korea, Pakistan, Venezuela, and Turkey.	F-16A/B: Production/ Deployment; F-16C/D: Development/Production	General Dynamics (prime); Pratt & Whitney (F100 engine), General Electric (F110 engine); SABCA (final assembly-Belgium), Fokker (final assembly-Netherlands); Fabrique National (Belgium), Kongsberg (Norway), Philips (Netherlands)-F100 engine
Deputy for Advanced Technology Bomber (YS)		
Advanced Technology Bomber 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

NAME AND MISSION	STATUS	CONTRACTOR
Deputy for Simulators (YW)		
T-46A Development of a prototype T-46A Operational Flight Trainer (OFT) complex and acquisition of ten production complexes. An OFT complex consists of four simulated T-46A cockpits. Two complexes will be located at each undergraduate pilot training base and one complex at the pilot instructors training facility.	Development	Reflectone
B-52 Offensive Avionics Station (OAS) Block II Development/production of nine B-52 Weapon System Trainer (WST) and four Offensive Station Mission Trainer (MT) Modification Kits.	Planning	To be determined
B-1B Development/production of a training system to meet the training needs of all B-1B crew members. Included are five WSTs, which simulate all four crew positions, two MTs, which simulate only the offensive/defensive positions, and Cockpit Procedures Trainers (CPTs).	Development	Boeing
F-16A/C Procurement of forty-five OFTs, thirty-nine Digital Radar Landmass Simulation Devices, forty-five Electronic Warfare Training Devices, and four LANTIRN kits.	Continuing Development & Acquisition	Many
F-15 Ongoing production of the F-15C/D OFTs will result in a total buy of fourteen simulators. Development of the F-15E WST will begin early in 1985. Total F-15E production will be six simulators.	Continuing Development & Acquisition	Goodyear
Advanced Tactical Fighter (ATF) Program addresses training system concept development, concept validation, and full-scale development for the next-generation manned tactical fighter aircraft.	Planning	None
C-17 Development and acquisition of a prototype WST, CPT, and Air Refueling Part Task Trainer (ARPTT) and yet to be determined quantity of production WSTs, CPTs, and ARPTTs.	Planning	None
C-5 Aircrew Training System (ATS) Production of an aircrew training system to meet the training needs of all C-5 crew members. Included are WSTs, CPTs, and Computer-Aided Instructions (CAI) that simulate all four crew positions. Also included will be the operation and maintenance of the system.	Preacquisition	To be determined
EF-111A Development and procurement of two OFTs to support EF-111A Tactical Jamming System (TJS) training.	Continuing Development & Acquisition	AAI
C-5/C-141 ARPTT Development of one prototype and production of six units that provide fundamental visual, audio, flight control, and buffet cues necessary for realistic air refueling training.	Continuing Development & Acquisition	Reflectone
Guided Bomb Unit (GBU-15) A stand-alone Part Task Trainer (PTT) to provide training for tactical weapon system officers in GBU launch and guidance tasks. Three PTTs will be used for the F-4E, one for the F-111, and two for the F-15E.	Planning	To be determined
KC-135/MB-26 Refurbishment of all nineteen MB-26 CPTs with digital system and visual system that provides peripheral cues for engine-out training.	Planning	To be determined
Simulator Development Activity Engineering development of aircrew flight simulator techniques and training devices to satisfy current training requirements.	Ongoing	Many
Data Base Transformation Program A joint development project initiated through the Joint Logistics Commanders to develop a standard simulator digital data base and common transformation programs.	Ongoing	Many
Simulator Modularity Design Program Continuous development and validation of design that will capture functional commonality existing across most flight simulators.	Ongoing	Many
Reliability and Maintainability Program Multitask effort to study/develop ways of improving reliability/maintainability of simulators.	Ongoing	Many
Simulator Ada Integration Develop design/cost metrics for future simulator acquisitions using the Ada higher-order language.	Planning	To be determined
LANTIRN Development/production of PTTs in F-15E, F-16, and A-10 configurations to train aircrews in LANTIRN switchology, symbology, and modes of operation. A second program, the LANTIRN CORE, will be developed and integrated with the F-16 and A-10 simulators to provide a real-time simulation of the LANTIRN mission.	Planning	To be determined
HH-60A Development/production of one WST, one CPT, and ten PTTs to allow full range of training for combat rescue helicopter operations.	Planning	To be determined
C-130 Visual System Production of two follow-on units to the highly successful visual system operational at Little Rock AFB, Ark. Integrating with C-130 Operational Flight Trainer, real-world data base allows tactical low-level training, low-altitude parachute extraction (LAPES) training, assault landing practice, and night-vision goggle operations.	Production	General Electric
Tanker Transport Bomber (TTB) Procurement of twenty-nine OFTs using already existing, off-the-shelf capabilities to allow initial and continuation training of TTB crews.	Planning	To be determined
Model Aircrew Training System (MATS) Develops total organic aircrew training system for the C-130 that encompasses the range of training experiences from initial entry through continuation training.	Planning	To be determined
Generic Infrared Training System (GIRTS) Development/procurement (quantity 110) of stand-alone devices to support Imaging Infrared training.	Planning	To be determined

NAME AND MISSION	STATUS	CONTRACTOR
Deputy for Strategic Systems (YY)		
Advanced Cruise Missile Development and manufacture of an air-launched advanced cruise missile (ACM) to supersede the AGM-86B air-launched cruise missile (ALCM) in production in the later 1980s. The ACM will have improved range, accuracy, survivability, and targeting flexibility.	Development	General Dynamics/ Convair Div.
Common Strategic Rotary Launcher (CSRL) A rotary launcher for internal carriage of weapons common to the B-52H and the B-1B. The CSRL development program will develop a multipurpose launcher capable of uniform or mixed weapons payloads that can accommodate current and projected cruise missiles, short-range attack missiles, and gravity weapons.	Full-Scale Development	Boeing Military Airplane Co.
ALQ-172 Electronics Countermeasures (ECM) Set Major modification of the ALQ-117 ECM set on B-52G/H aircraft to provide an ECM defense against agile and monopulse surface-to-air missile and advanced interceptor threats.	Production	ITT Avionics Div.
Attack Radar Set (ARS) Upgrades the reliability/maintainability/supportability of the F/FB-111 Attack Radar Set (ARS), correcting the current decreasing trend in the availability of the attack radar. The program provides for a field verification test as a means to verify the guaranteed reliability.	Full-Scale Development	General Electric Co.
Terrain-Following Radar (TFR) Upgrades the reliability/maintainability/supportability of the F/FB-111 terrain-following radar (TFR). This program will increase the Mean Time Between Failure (MTBF) of the TFRs. The program provides for a field verification test as a means to verify a guaranteed reliability.	Full-Scale Development	Texas Instruments
Digital Flight Control System (DFCS) Acquires a replacement for the electronic portion of the F/FB-111 Flight Control System. The program involves considerable development effort and is scheduled for contract start in FY '86.	Full-Scale Development	To be determined
OAS Block II Software 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.
Deputy for Propulsion (YZ)		
F101 Engine Program 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 Engine Program Development and acquisition of the F110-GE-100 engine for the Alternate Fighter Engine (AFE) program. This engine will be installed in new F-16 aircraft and potentially in new F-15s. Future production procurements will be competed each year with the P&W F100-PW-220 for a share of the F-15/F-16 market.	Qualification Jan. '85	General Electric
F100-PW-220 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 from the digital electronic engine control (DEEC) provide the -220 with unrestricted throttle movement throughout the flight envelope. The -220 will enter production in FY '85 for incorporation into the F-15C/D.	Development/Production	Pratt & Whitney
F109 Engine for the T-46A Acquisition of 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. It will see its first flight in a T-46A in April 1985.	Full-Scale Development	Garrett
F108 Engine for the KC-135 Acquisition of the commercially available and procured CFM56 engine for use in reengining the KC-135 fleet. Plans call for modification of approximately 400 aircraft through the year 1990 with this highly fuel-efficient engine.	Production	CFMI
F100 EMD (Engine Model Derivative) 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.	Advanced Development	Pratt & Whitney
F110 EMD The F110 EMD will demonstrate an increased performance version of the General Electric F110-GE-100. This engine will compete with the increased-performance F100 for F-15 and F-16 aircraft through the late '80s and early '90s.	Advanced Development	General Electric
Advanced Tactical Fighter Engine This program is developing two advanced-technology engines: the General Electric GE-37 and the Pratt & Whitney PW5000. These engines will compete for the Advanced Tactical Fighter in the early 1990s.	Advanced Development	Pratt & Whitney; General Electric
F107 Engine Program An uprated version of the air-launched cruise missile (ALCM) engine to be designated the F107-WR-104 and retrofitted into existing ALCMs.	Planning	Williams International
T700-GE-401 Engine for the HH-60A Acquisition of a turboshaft engine for integration with the HH-60A Nighthawk combat rescue helicopter (Triservice Program). This engine provides 1,690 shaft horsepower per engine to support USAF search and rescue mission.	Under review for start of Airframe Full-Scale Development	General Electric
Engine for JVX Acquisition of a turboshaft engine for integration with the JVX Advanced Vertical Lift Aircraft (Triservice Program). This is a multimission VTOL aircraft for the 1990s and beyond planned for the Air Force special operations role.	Request for proposals prior to Full-Scale Development	None

NAME AND MISSION	STATUS	CONTRACTOR
F112 Engine Program This is a small turbofan engine for an advanced cruise missile.	Ongoing	Williams International
Engine Component Improvement Program (CIP) Provides continuing engineering support for all air-breathing engines used in manned aircraft in the Air Force inventory. Effort directed toward correcting safety of flight conditions, improving durability/reliability, developing repair procedures, and reducing the life-cycle cost of engines. Eighteen families of engines currently being supported.	Continuing	All Major Engine Contractors
J402 EMD The Teledyne CAE J402-CA-400 powers the AGM-84 Harpoon missile and the MQM-107 target drone. This EMD program will develop an improved-performance, lower-cost version of this engine to enhance system performance.	Advanced Development	Teledyne CAE
F100 Engine Program Management Responsibility Transfer (PMRT) Transfer of management responsibility for the F100-PW-100/-200 engine and related support equipment and technical orders from AFSC to AFLC. The support equipment transfer began in April 1983 on an incremental basis to the respective Air Logistics Centers (ALC). All support equipment is scheduled to transfer by April 1985. The PMRT planning date for transfer of the engine to SA-ALC/MMP is October 1, 1985.	Ongoing	Support Systems Associates, Inc. (SSAI)
Automated Ground Engine Test System (AGETS) AGETS is diagnostic AGE being developed and procured for the F100-PW-100 and F100-PW-200 engine. It is a computer-aided, integrated test system that automatically acquires measurement data during F100 engine operation. This data is used to affect engine control system trim adjustments and/or identify and isolate faulty engine components. AGETS will reduce time and trim and fuel usage by about fifty percent and greatly enhance engine diagnostic capability.	Development	Pratt & Whitney
Propulsion Technology Modernization Advancing and implementing 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 treat, coatings, conventional and nonconventional machining, tooling, materials handling, manufacturing and mangement information systems, and advanced forging and castings.	Ongoing	General Electric (AEBG); United Technologies P&W; Williams International
PW2037 Engine for the C-17 Acquisition of the commercial PW2037 turbofan engine to power the C-17A aircraft. This fuel-efficient engine provides 37,600 pounds of thrust.	Development	UT/Pratt & Whitney
F113 Engine for the C-20A Engine management support for procurement of the commercial Rolls-Royce Spey 511-8 engine (F113-RR-100 military designation). This engine is being used to power the Special Airlift Mission aircraft (C-SAM) C-20A.	Procurement/Deployment	Rolls-Royce
T101 Engine for the C-23A Engine management support for procurement of the commercial Pratt & Whitney PT6A-45R turboprop engine (T101 military designation). This engine is being used to power the European Distribution System Aircraft (EDSA) C-23A.	Procurement/Deployment	UT/Pratt & Whitney
PT6A-42 Engine for the C-12F Engine management support for procurement of the commercial Pratt & Whitney PT6A-42 turboprop engine. This engine is being used to power the Operational Support Aircraft (OSA) C-12F.	Procurement/Deployment	UT/Pratt & Whitney
TFE-731-2A Engine for the C-21A Engine management support for procurement of the commercial Garrett TFE-731-2A turbofan engine. This engine is being used to power the Operational Support Aircraft (OSA) C-21A.	Procurement/Deployment	Garrett
Air National Guard Support Aircraft (ANGSA) Engine Support Program The ANGSA System Program Office. The engine selected is the Pratt & Whitney JT8D, providing 14,000 to 20,850 pounds of thrust, depending on engine model.	Acquisition	UT/Pratt & Whitney
TF39-GE-1C Engine for the C-5B The TF39-GE-1C engine is reentering production after more than ten years and will be used to power the C-5B aircraft. This high-bypass turbofan provides 41,100 pounds of thrust.	Acquisition/Operational	General Electric
Integrated Turbine Engine Monitoring System (ITEMS) This program will demonstrate a standardized monitoring system for aircraft turbine engines. The system will provide maintenance diagnostic data and data management inputs for USAF aircraft maintenance management systems.	Source Selection	To be determined

Air Force Wright Aeronautical Laboratories

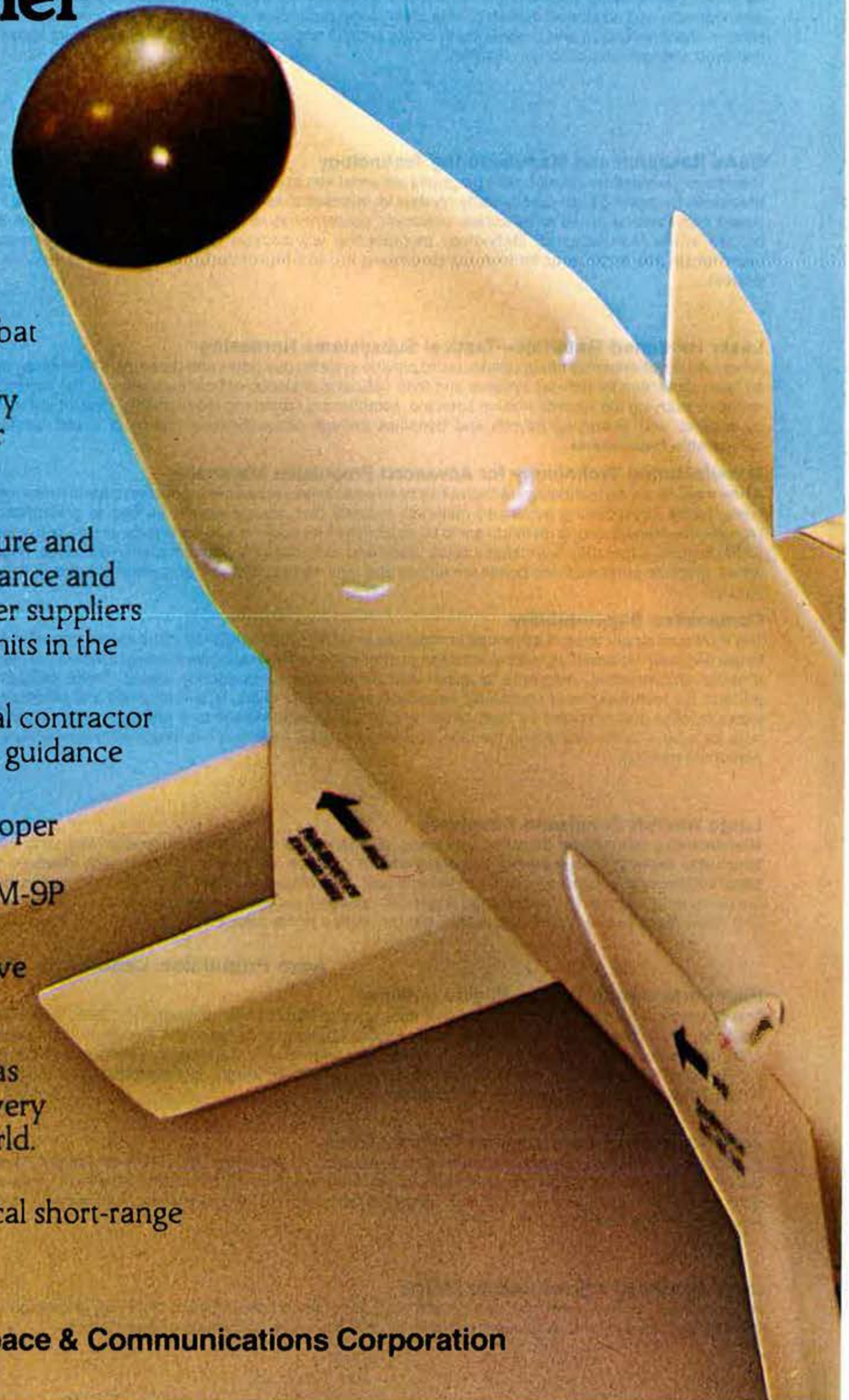
Avionics Laboratory (AA)

NAME AND MISSION	STATUS	CONTRACTOR
Cruise Missile Advanced Guidance (CMAG) Program 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
Infrared Search and Track System (IRSTS) ECM-resistant passive-detection technology being developed to enhance long-range radar fire-control systems for air-to-air fighter intercept missions. A high-sensitivity infrared sensor combined with advanced signal-processing equipment will provide high-resolution detection and multitarget tracking capabilities.	Development	General Electric; ITT Avionics
Pave Pillar The objective of this program is to demonstrate a next-generation system of avionics that will restrain cost, complexity, and proliferation of both airborne electronic equipment and associated test equipment while improving mission effectiveness. This will be accomplished using common modules, fusion algorithms across sensor systems, fault-tolerant system architecture, and such high-performance reliable component technologies as VHSIC.	Definition	Boeing; General Dynamics; Grumman; McDonnell Aircraft; Northrop

NAME AND MISSION	STATUS	CONTRACTOR
Very-High-Speed Integrated Circuits (VHSIC) This is an integrated circuit technology development program that will result in very high operating speed chip designs, pilot production capability, and initial system brassboards. The objective is to extend the US integrated circuit technology base by one or two orders of magnitude in density and throughput, resulting in high-performance, compact, reliable electronic systems.	Development/Production	Honeywell; Westinghouse; Hughes; IBM; TRW; Texas Instruments
VHSIC 1750A Computer An expandable, modular computer system consisting of a MIL-STD-1750A processor module, bulk memory module, external input/output module, and support equipment module. It is classified as a VHSIC insertion program to develop computer building-block modules. Advantages over current Very Large Scale Integrated Circuit technology besides the expandable, modular architecture include two to four times throughput improvement, greater environmental operational capabilities, significantly reduced size, and greater reliability.	Development	To be determined
Ultra-Reliable Radar (URR) Program to demonstrate an advanced airborne radar with a mean time between failure (MTBF) an order of magnitude greater than current radars. The development model radar will utilize advanced technologies, such as electronically scanned active element array, VHSIC-based common signal processing, and Pave Pillar fault-tolerant architectures. The URR is destined for the Advanced Tactical Fighter/Attack (ATF/ATA) aircraft.	Source Selection	To be determined
Common Signal Processor (CSP) Development program for a modular, high-performance, reliable, VHSIC-based, digital signal processor for next-generation avionics. It can be configured and programmed to satisfy a wide range of applications, such as radar, communications, electronic warfare, and electro-optical systems.	Development	To be determined
Integrated Communication Navigation Identification Avionics (ICNIA) ICNIA combines all existing and planned near-term Communications, Navigation, and Identification (CNI) functions in the 2 MHz to 2 GHz frequency domain into one airborne radio system for use in tactical aircraft and Army LHX helicopters. The system will incorporate VHSIC and Radio Frequency Large Scale Integration (RFLSI) technologies and fault-tolerant architecture to greatly increase mean time between mission critical failures and still incorporate new antijam CNI functions into the present CNI envelopes.	Development	TRW; ITT/Texas Instruments
Air-to-Air Battle Management This program will demonstrate, via man-in-the-loop simulation, improved survivability and lethality of single-seat fighter aircraft in a multitarget air-to-air combat scenario. These objectives will be met by increased pilot situation awareness and controlled work load, to be provided by innovative control and display technology integrated with advanced fire-control algorithms.	Definition	McDonnell Aircraft; Northrop; Veda, Inc.
Coronet Prince Prototype Program to 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.	RFP Preparation	To be determined
Terrain-Following/Terrain-Avoidance/Threat-Avoidance (TF/TA^2) A program to develop TF/TA^2 algorithms for an integrated avionics system that will provide a high-performance tactical aircraft with the capability to automatically perform low-altitude high-speed maneuvering, penetration, and attack missions. An emphasis is being directed toward reducing visibility to threat resources, reducing detectable emissions, and improving pilot work load.	RFP Preparation	To be determined
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, advanced flight control modes, pilot/vehicle interface, an automated maneuvering attack system, and an advanced weapon interface.	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 technologies of a forward-swept-wing aircraft that can provide new design options for future military and commercial aircraft. Technologies include an aeroelastically tailored forward-swept wing utilizing 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.	Nearing 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. A current supersonic 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.	Source Selection	To be determined
Strategic Boost Glide Vehicle In order to improve strategic delivery capability, the objective of this program is the development and technology flight demonstration of an aeroconfigured Strategic Boost Glide Vehicle for use with air- or ground-launch systems.	Technology Identification	General Dynamics; Martin Marietta
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 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.	Preflight Functional Testing	Boeing

NAME AND MISSION	STATUS	CONTRACTOR
Materials Laboratory (ML)		
Composite Materials Research and Development A wide variety of important new composite materials systems (fiber-reinforced organic resins) is under development to exploit their unique performance attributes for Air Force aircraft, spacecraft, tactical missiles, cruise missiles, and long-range strategic missiles. A highly integrated approach is being pursued to an entire class of structural materials: fibers; matrix materials; fiber/matrix interface; mechanics of fiber/matrix interaction; processing; quality control; and environmental effects.	Research & Exploratory Development	McDonnell Douglas; Boeing Co.; Lockheed; numerous universities, small businesses, and aerospace companies
Advanced Aluminum Powder Metallurgy Structural Alloys Rapid progress is being made in the laboratory's comprehensive powder aluminum structural alloy R&D program. It is structured to maximize the recent advances in rapid solidification technology that have opened up major new alloying possibilities heretofore impossible. This program couples research, exploratory development, and advanced manufacturing technology contractual efforts with a strong in-house research effort in characterization and processing to create and put into production a superior aluminum alloy having improved strength and corrosion resistance.	Research	Lockheed; Rockwell Science Center
	Exploratory Development	Pratt & Whitney; Lockheed-Calac; Boeing Co.
	Manufacturing Technology	Alcoa
GaAs Research and Manufacturing Technology Progressive exploratory development programs are under way to improve the yield and establish the optimum processes for growing high-quality GaAs crystals for microwave devices for satellite communications, space-based and airborne active array radars, electronic countermeasures, and missile seekers. Results will be utilized in the Manufacturing Technology program that will address generic manufacturing issues and demonstrate new techniques for low-cost processing to make higher performance and more reliable GaAs devices.	Exploratory Development	Texas Instruments; Rockwell International; Stanford University
	Manufacturing Technology in Procurement	None
Laser Hardened Materials—Tactical Subsystems Hardening Advanced development is being conducted to provide systems designers and developers technology options for laser protection for tactical systems and their optical and electro-optical subsystems. The methodology includes studying the system mission scenario, establishing hardening requirements, developing technology options, and assessing payoffs and penalties through comprehensive testing of actual hardware or comparable brassboards.	Advanced Development	Martin Marietta Corp.; Texas Instruments; McDonnell Douglas Co.; Goodyear Aerospace
Manufacturing Technology for Advanced Propulsion Materials A new manufacturing technology initiative has been established to provide production capabilities for engine components incorporating advanced materials systems that provide significant engine performance improvements. Manufacturing methods are to be established for titanium and superalloy integrally bladed rotor (IBR) designs; superalloy fabricated turbine blade and vane designs; titanium aluminide cases, rings, and vanes; graphite polyimide composite fan airfoils and front frames; and carbon-carbon composite liners and nozzles.	Procurement	None
Composites Supportability The increased application of advanced composites in USAF systems has led to the establishment of new in-house engineering expertise in advanced composites materials technologies relating to supportability and to a series of contractual programs to attack user composites supportability issues. These programs will address the technologies of composite inspection, repair techniques, repair materials and processes, and repair process quality control for field, depot, and battle-damage situations. It will also include establishing data for repairs performed during the manufacturing process, materials and structural failure analysis, and personnel training.	Exploratory Development	Northrop Corp.; General Dynamics Corp.; Boeing Co.; Southwest Research Institute; Iowa State University; other universities, small businesses, and aerospace companies
Large Aircraft Composite Structures Manufacturing technology activities are being pursued for large aircraft composite wing and fuselage structures, defining manufacturing technologies that produce composite structures with improved operational efficiency at a reasonable and predictable cost. For both 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.
Aero Propulsion Laboratory (PO)		
High-Performance Turbine Engine Initiative Focuses resources and generates programs necessary to demonstrate, through the 1990s, a revolutionary advancement in turbine engine technology. An integrated program between the Aero Propulsion Laboratory and the Materials Laboratory of AFWAL that ensures individually developed materials and component technologies are compatible with the overall objective of a thrust-to-weight engine technology direction of 100 percent over the Joint Advanced Fighter Engine (JAFE).	Exploratory Development	Pratt & Whitney; General Electric Co.; Allison Gas Turbine Div., GMC; Teledyne CAE; Garrett Turbine Engine Co.
Joint Technology Demonstrator Engine (JTDE) A complete technology demonstration 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	Allison Gas Turbine Div., GMC; Garrett Turbine Engine Co.; General Electric Co.; Pratt & Whitney Aircraft; Teledyne CAE
Joint Advanced Fighter Engine (JAFE) A competitive advanced development program to accelerate the development of critical propulsion system technologies for ATF and to demonstrate and validate the entire propulsion system design.	Advanced Development	General Electric Co.; Pratt & Whitney Aircraft

Ford Aerospace supplies and supports more Sidewinder missiles than any other contractor in the world.



The Sidewinder missile is the most successful air-to-air combat missile ever made. And Ford Aerospace is the world industry leader in complete Sidewinder missile systems experience.

- Ford Aerospace has more experience in the manufacture and upgrade of Sidewinder guidance and control sections than all other suppliers combined [over 100,000 units in the past 30 years].
- Ford Aerospace is a principal contractor for the Sidewinder AIM-9M guidance and control section.
- Ford Aerospace is the developer and only supplier of the all-up-round Sidewinder AIM-9P missile system.
- Ford Aerospace has extensive experience in complete integrated logistics support and training, and has designed and built nearly every Sidewinder depot in the world.

Ford Aerospace:
The world's first name in tactical short-range air-to-air missile systems.

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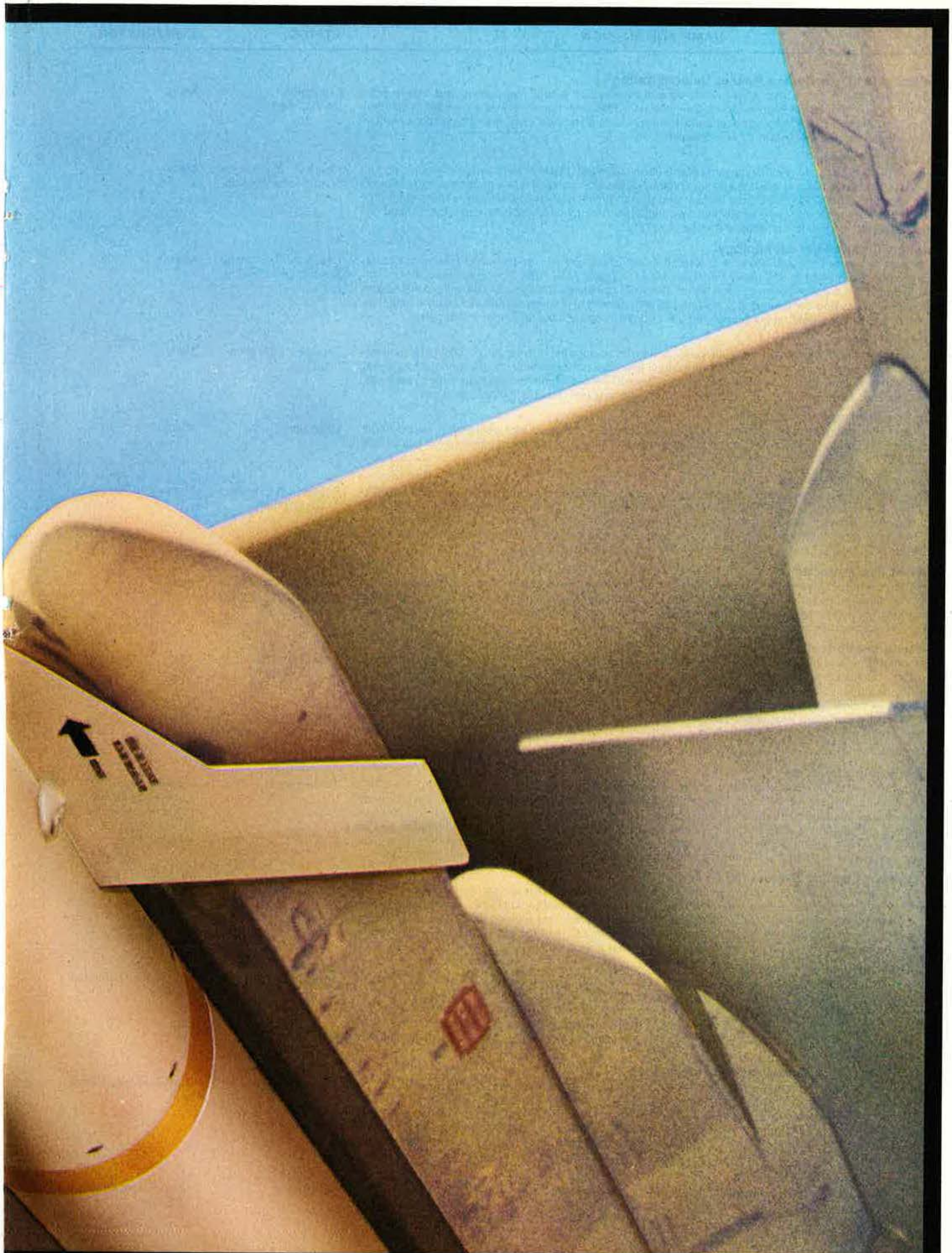
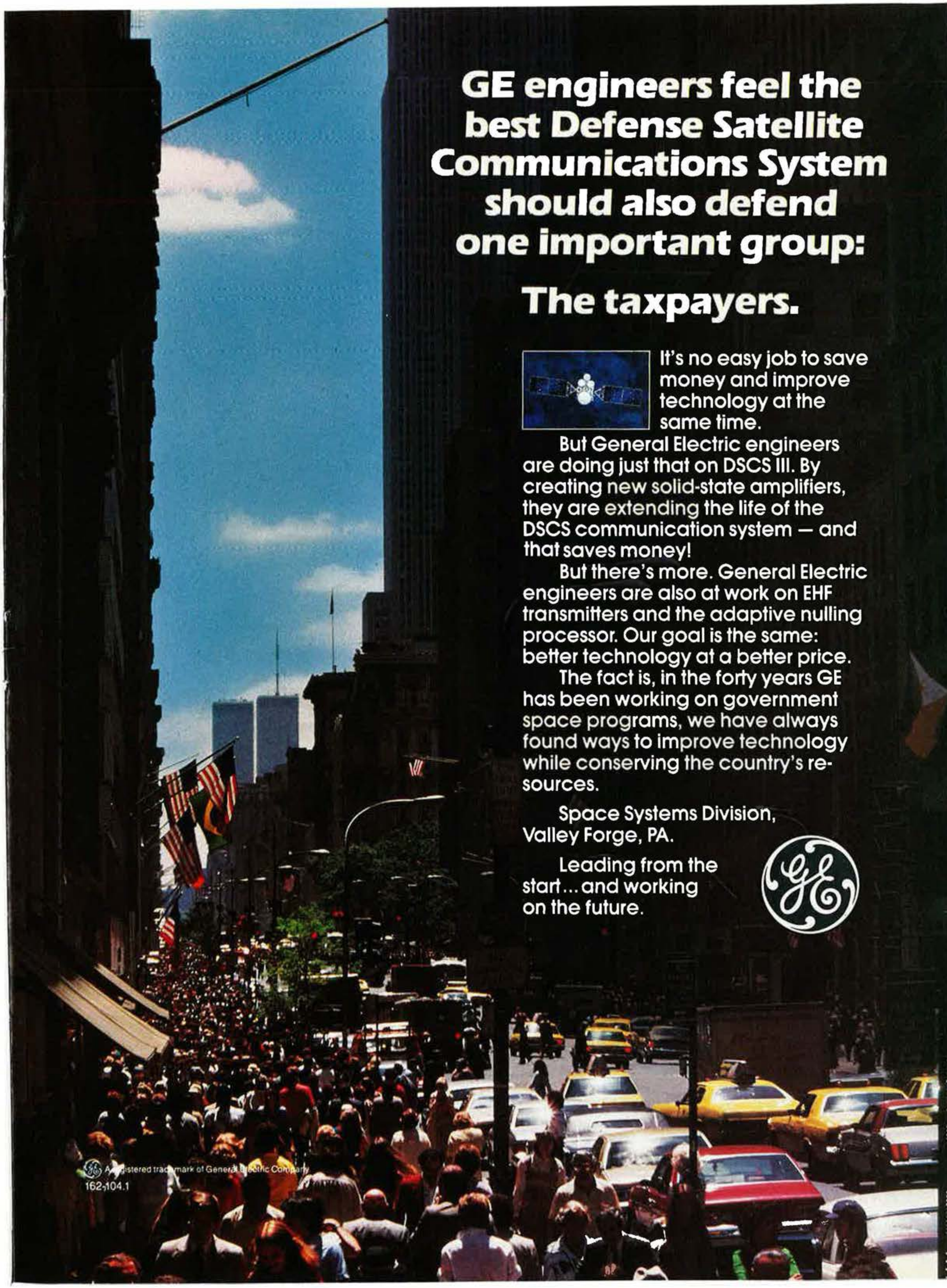


NAME AND MISSION	STATUS	CONTRACTOR
Variable Fuel Flow Ducted Rocket Demonstration This missile propulsion concept, when combined with advances in aircraft, fire control, and missile subsystems, can contribute to air-to-air superiority in the post-1995 time frame. An integral rocket ramjet that utilizes a fuel-rich solid-propellant gas generator for ramjet fuel can provide a two- to fourfold improvement in total range over rocket propulsion for an equivalent size.	Exploratory Development	Many
Spacecraft Power 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, thermal management systems, dynamic and thermionic energy-conversion devices, power conditioning components, and electrical energy storage concepts.	Research, Exploratory & Advanced Development	Many
Aviation Turbine Fuel Technology A program to improve the availability and lower the cost of military jet fuel produced from hydrocarbon resources, including petroleum, heavy oil, shale, tar sands, and coal. Fuels from these feedstocks, with varying properties, are being analyzed and tested. This will allow fuel specifications to be defined that ensure acceptable quality and compatibility of aviation fuel with present and future aircraft and engines. Improvements in safety and aircraft range through the use of higher density fuels are under investigation.	Research, Exploratory & Advanced Development	Many
Aircraft Power To advance aircraft electrical and hydraulic power system technology through the development of a nonflammable hydraulic system, a highly reliable fault-tolerant electrical power system, and the associated generation, distribution, actuation, and control components. Developments are carried out to reduce life-cycle costs, increase power extraction efficiency, decrease weight, and improve specific fuel consumption.	Exploratory Development	Many
Compressor Research Facility 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.	Operational	Multiple
Missile Fuel Technology A program to develop high-energy density fuels for volume-limited turbine and ramjet-powered missiles. Fuels with higher energy content on a volumetric basis have been shown to significantly increase the range of air-breathing missiles, such as the air-launched cruise missile. Current programs are concentrating on the formulation of slurry fuels containing aluminum, boron, and carbon, and of boron-augmented solid fuels. Combustion evaluation and fuel system design are progressing concurrently.	Research & Exploratory Development	Many
Aircraft Fire Protection A program to improve the fire safety and related combat survivability of aerospace systems through analytical, experimental, and full-scale demonstrations. This is accomplished by assuring the capability and the timely availability of fire and explosion prevention design criteria, containment, and hardening measures and detection and suppression equipment for future Air Force needs.	Research, Exploratory & Advanced Development	Many
Aerospace Lubrication A program to assure the availability of optimum lubrication system components and lubrication system condition monitoring techniques to meet the needs of USAF air-breathing propulsion and power systems. Lubricants, lubrication techniques, and test methods are being developed and evaluated to resolve current problems and meet projected requirements. Improved rolling element bearing and seal designs as well as gas- and solid-lubricated bearings for special applications are also being investigated.	Research & Exploratory Development	Many

4950th Test Wing

NAME AND MISSION	STATUS	CONTRACTOR
ARIA Scoring Systems Provide state-of-the-art broad ocean area coverage of reentry vehicles for weapon system testing. Functions previously requiring both EC-135 and P-3 aircraft will be combined in the EC-18 ARIA aircraft. The Sonobuoy Missile Impact Location System (SMILS) will acquire and process missile impact data. Impact locations of multiple reentry bodies will be precisely determined by SMILS using either deep ocean transponders or Global Positioning Satellites. Associated programs will collect optical data on reentry vehicles during the terminal phases of flight and will sample meteorological parameters from the surface to 100,000 feet.	Development	Applied Physics Laboratory (Johns Hopkins University); others to be determined
Microwave Landing System (MLS) Tests MLS is a new type of precision approach, missed approach, departure, and landing guidance system that will replace ILS as the standard precision landing system. It provides the capability to fly high-angle approaches, curved approaches, and segmented approaches, thus reducing noise and allowing precision approaches in areas of high terrain. Flight tests are scheduled for FY '85/'86 in a C-141A to obtain data needed to develop approach criteria for large aircraft and evaluate operational characteristics of the system.	Development	Lear Siegler; Bendix Corp.
EC-18B Conversion Current Advanced Range Instrumentation Aircraft (ARIA) EC-135 aircraft cannot adequately satisfy some mission requirements from remote staging locations. To satisfy ARIA requirements for telemetry data collection worldwide, the Air Force acquired and is converting used Boeing 707-300 series commercial aircraft. These aircraft will be reconfigured as EC-18B ARIAs, using Prime Mission Electronic Equipment removed from the existing ARIA fleet and an upgraded avionics suite to accomplish worldwide space and missile telemetry gathering missions.	Production	None—Air Force Modification
Airborne Digital Avionics Test System (ADATS) A palletized test-bed for flight-testing digital avionics systems that use the MIL-STD-1553B data bus. The ADATS system simulates the host aircraft's avionics suite to the test item, including navigation, air data, and time information. All inputs to and outputs from the system being tested are recorded, and in-flight inspection of the data is possible. Software in the ADATS system can be modified for new test items, saving the cost of building unique test apparatus for each avionics system. These software modifications are made at two Ground-Based Laboratories (GBLs), part of the ADATS project.	Operational	None—In-house Project
Testing Off-the-Shelf Aircraft Provides evaluation of civil aircraft against specific military requirements. Areas of evaluation include ground handling, flying qualities, performance, and human factors. Test results are used extensively in source-selection process. Recent evaluations of off-the-shelf aircraft have resulted in the selection and procurement of the C-12, C-20, C-21, and C-23 aircraft.	Continuing	Various aircraft manufacturers



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The taxpayers.
It's no easy job to save money and improve technology at the same time.
But General Electric engineers are doing just that on DSCS III. By creating new solid-state amplifiers, they are extending the life of the DSCS communication system — and that saves money!
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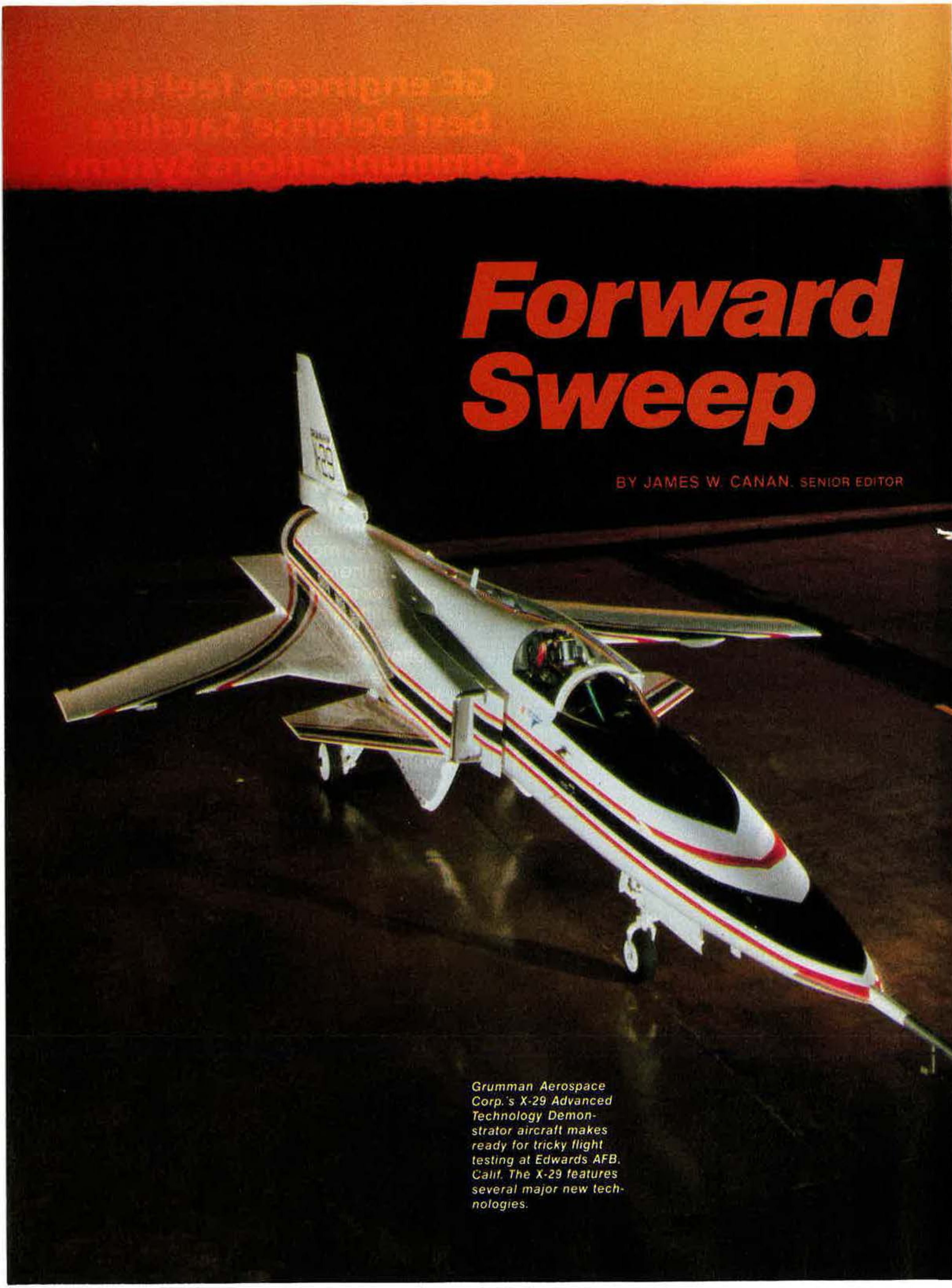
Forward Sweep

BY JAMES W. CANAN, SENIOR EDITOR



Grumman Aerospace Corp.'s X-29 Advanced Technology Demonstrator aircraft makes ready for tricky flight testing at Edwards AFB, Calif. The X-29 features several major new technologies.

The X-29 technology demonstrator aircraft promises to be fast, frisky, and fuel-efficient.

A STRANGE-LOOKING aircraft that seems to be flying backwards has taken to the air for some very tricky testing at Edwards AFB, Calif. It is the forward-swept-wing X-29 Advanced Technology Demonstrator aircraft, and it will be put through its paces at the NASA Ames Dryden Flight Research Center over the next year and a half.

The X-29 promises to be superlatively fast, frisky, and fuel-efficient all at the same time—providing, first, that it is found to be safe to fly.

Before they really wring out the X-29, its test pilots will have to demonstrate that it is "an aerodynamically viable vehicle," says Dr. Thomas M. Weeks, Deputy X-29 Program Manager with Aeronautical Systems Division's Flight Dynamics Laboratory (FDL) at Wright-Patterson AFB, Ohio. Dr. Weeks emphasizes that the testing program's initial phase will concentrate on "concept evaluation"—determining and documenting the X-29's aerodynamic structural integrity and its controllability as compared to predictions.

FDL manages the X-29 development program for Grumman Aerospace Corp., which designed and built two X-29 test aircraft, and for the Defense Advanced Research Projects Agency (DARPA), the X-29 supervisory and funding agency for the Department of Defense.

The X-29's pioneering configuration gives it a high margin of static instability (thirty-five percent) at subsonic speeds but provides high maneuverability from subsonic through supersonic speeds. The X-29 should also remain airworthy and agile at high angles of attack where aircraft with aft-swept wings normally stall. This is because the tips of forward-swept wings provide more lift at such angles than do the tips of aft-swept wings. Given its greater lifting propensities, the X-29 should also be relatively quick to clear runways.

All such attributes cause the X-29's champions to regard it as the legitimate forerunner of a family of future fighter aircraft that will sport forward-swept wings. At the moment, this is by no means certain.

What is certain, however, is that many of the major new technologies embodied in the X-29 demonstration aircraft are indeed pertinent to the design of future fighters. Thus, the X-29 test program will be monitored very closely by USAF and the Navy.

Some of those technologies, moreover, may well be applicable to future commercial aircraft designs as well.

To enhance lift and reduce drag, the X-29's thin, supercritical, nonmetallic wings, with a span of twenty-seven feet, are rooted at the bottom rear of the fuselage and sweep sharply forward at a sixty-degree angle from it. Their variable-camber trailing edges change curvature in accordance with flight conditions and aerodynamic demands. This means greater maneuverability.

In front of the wings and in the same plane are stubby canards that rotate sixty degrees down and thirty degrees up. They provide direct lift and trim and are the pilot's primary control surfaces.

"Movable, closely coupled canards are highly unique to this aircraft," Dr. Weeks explains. "They are one of the most important new methods of controlling high-performance aircraft."

Such canards are said to be fashionable in current competing designs for USAF's Advanced Tactical Fighter (ATF). Consequently, test data on the performance ups and downs of the X-29's canards should be valuable to USAF's ATF program office at Wright-Patterson and to ATF design contractors.

On the X-29, a triple-redundant digital flight-control system makes the whole affair possible. An advanced flight-control computer stabilizes the aircraft by adjusting the wing trailing edge, canards, and other control surfaces forty times a second. Without such a sophisticated system, pilots could not keep the aircraft from becoming unmanageable, officials say.

Along with advanced electronics, another key to the construction of the X-29 as a fighter-demonstrator was the development of very light, very strong composites and their "aeroelastic tailoring" process.

Forward-swept wings build up very heavy air pressure at their tips. Even if forward-swept metal wings could be made light enough to fly, this pressure would tear them off. But advanced composite materials now make it possible to build forward-swept wings, such as the X-29's wings of very strong graphite and epoxy composite, that weigh very little but can twist to resist "structural divergence." The X-29 wing—only one-third as thick as any previously built supercritical wing—is aeroelastically tailored to resist stress by virtue of its shape, thickness, and the "lay-up" direction of its bonded composite materials. ■

JANE'S Aerospace Survey 1985

The future looks anything but dull.

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

US AIRPOWER suffers from the often-overlooked factor that so many of its aircraft are designed and test-flown in the southern states. People accustomed to months of unbroken sunshine can easily fail to appreciate that Europe has no settled climate—only samples of weather that can change dramatically hour by hour. The writer was reminded of the significance of this during a recent briefing by General Dynamics personnel at Fort Worth, Tex. Under a slide depicting an F-111, projected on a large screen, appeared the words "TAC's only all-weather aircraft."

Lt. Gen. Thomas McMullen, Commander of USAF's Aeronautical Systems Division, had made a related comment at a ceremony marking the handing over of the first production AGM-65D Maverick imaging infrared missile for the Air Force. To explain its importance as a precision weapon able to kill hard targets, such as tanks, by day *and* night, he said that USAF's then current ability to fight at night was essentially nil, although Soviet forces were training for night combat and were putting night-vision devices on their tanks.

"In Europe, in winter, nighttime conditions exist for up to seventeen hours each day," continued General McMullen. "When you add the effect of bad weather, our fighting day is just four hours and forty-five minutes." The Air Force believes that IIR Maverick can treble the time available to deploy aircraft against tanks, but even this will leave nearly ten hours a day when hostile armored vehicles can operate in comparative safety.

Added equipment like LANTIRN (Low-Altitude Navigation and Targeting InfraRed for Night) pods will one day help A-10s, F-16s, and dual-role F-15Es find and destroy their targets in under-the-weather autonomous day/night operations, even in a dense ECM environment. Forward-looking infrared (FLIR) and terrain-following radar in the twin pods will help the pilot fly safely at night at low level; but none of these aircraft has the kind of flying control system necessary for automatic terrain following, and the cost of adding LANTIRN to the F-16 is about fifty knots in speed and a ten percent reduction in range.

Those who should know reckon that LANTIRN will be operational in 1988, though all its originally intended features may not be embodied. By then, also, progress should have been made in seeking answers to two other major weaknesses in NATO preparedness.

LANTIRN pods on an F-16. The shorter navigation pod is mounted on the port side of the aircraft, the targeting pod on the starboard side.

AWACS and V/STOL

Primary targets in the opening minutes of any future war will be AWACS aircraft and airfield runways in forward areas. Israeli experience in fighting over the Bekaa Valley in Lebanon has proved conclusively that interceptors guided by AWACS can inflict huge losses on an attacking force that lacks airborne warning of an ambush. Equally, the experience of the Royal Navy in the Falklands campaign showed the high cost of having no AWACS cover.

It is difficult to imagine how a slowly orbiting 160-ton chunk of metal like USAF's E-3 Sentry could be shielded from detection and attack when its whole purpose in life is to transmit signals for others to pick up. Air Force Systems Command believes that E-3 survival is possible, although USAF could take out Soviet Tu-126 Moss and Il-76 Mainstay SUAWACS aircraft. Nonetheless, it would be illogical for both sides not to seek alternatives to heavily manned and key targets of this kind.

A decade ago, Teledyne Ryan's big YQM-98A turbofan-powered Compass Cope RPV remained airborne for twenty-eight hours and reached an altitude of more than 55,000 feet during testing. One of its proponents

Boeing E-3A Sentry AWACS. The best in the world, it gives friendly fighters a great edge.

summed up its subsequent abandonment with the explanation that military men "get to be generals by flying SR-71s, not RPVs." Perhaps things have changed since then, as Lockheed-California is now devoting considerable effort toward developing a pilotless aircraft known as Solar Happ (Solar high-altitude powered platform), which will make even Compass Cope look small.

Solar Happ is envisaged as a delicate twin-boom aircraft spanning 322 feet. As its name implies, the single pusher propeller will be powered by solar cells that cover the wingtips and the two large fins, which will be located at about twenty-five percent span on each side. During daylight hours, the wingtip panels will be raised vertically to capture as much sunlight as possible, minimize induced drag, and aid controllability. At night they will extend to produce a full-span wing for maximum lift. Cruising speed is calculated at sixty mph while orbiting at a height of 65,600 feet. Endurance will be up to one year. Although NASA is funding the program as a means of monitoring crops in the central valley of California, there seems little reason why the 250-pound payload could not perform an AWACS function.

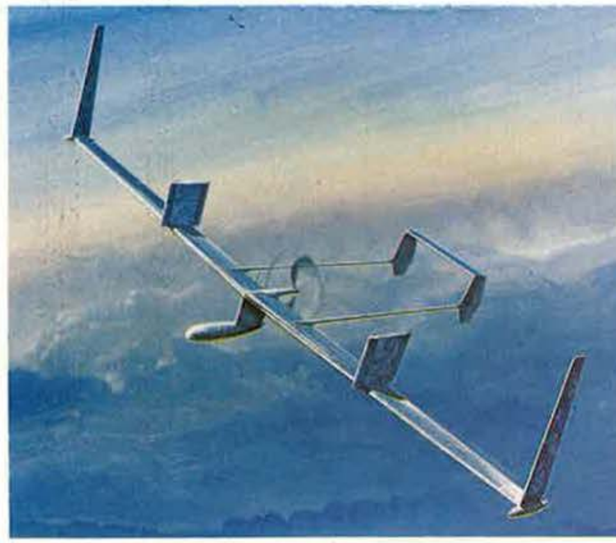
Advantages of a recoverable RPV of this kind are obvious. Operating costs would be low, and no lives would be lost if it were shot down. Nor would it need to be protected by piloted fighters. This is more of an advantage than it might seem, because the levels of radio-frequency radiation from an E-3 radar are so high that any pilot who flew within about 300 feet of the transmitter for six minutes would be subjected to unsafe exposure. During fighter escort to station, the radar would, of course, be switched off, although the rotodome would continue to rotate.

In the long term, RPVs like Solar Happ are likely to be superseded by space station AWACS with unlimited on-station life. Such Star Wars concepts may seem far off in the future, but even in 1984 an Air Force Systems Command briefing could easily extend into the next century, up to the period 2025 to 2050. By then the combat airplanes of today are expected to be superseded by boost glide vehicles. These are foreseen as spacecraft that would enter earth orbit, dive on their targets at more than 17,000 mph (Mach 25.75), and then return to low orbit. Fantastic as this may seem, work on such a vehicle could begin three years from now.

Meanwhile, how will combat aircraft technology advance during the forty years up to 2025?

The next stage, so far as USAF is concerned, seems likely to be the F-16F, around 1989. Its airframe is expected to resemble closely that of the "cranked-arrow" F-16XL, which was evaluated alongside the F-15E in the competition for the dual-role fighter contract. Being a single-seater, it will be "swing role," rather than dual-role. Graphite wing skins, over an aluminum substructure, are expected to save about 600 pounds of structure weight as well as to contribute to the fighter's low observability (Stealth). Conformal weapons carriage will offer all-round performance improvement.

In this respect, it is worth recording that the F-16XL



Solar Happ, Lockheed's proposal for a long-endurance solar-powered payload platform.

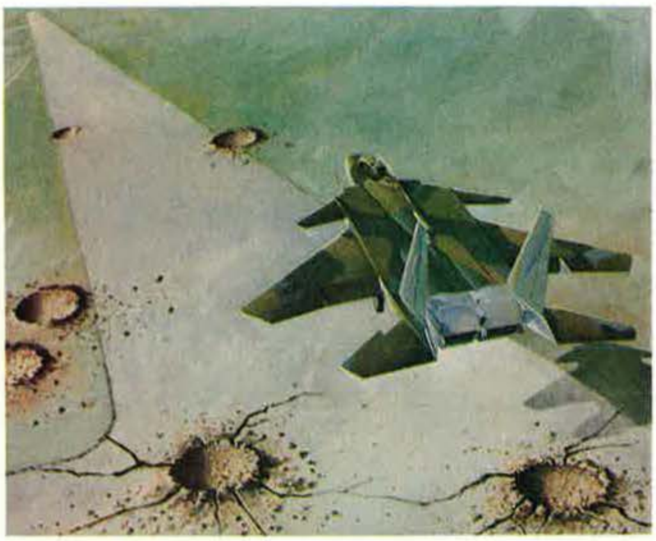
could take off and land in two-thirds of the distance required by an F-16A/C, carry double the weapon load (seventeen stores stations, with twenty-nine hardpoints beneath wings and fuselage), and operate over a forty-three percent greater combat radius on internal fuel or eighty-three percent with external fuel. Its increased cruise efficiency resulted from an eleven percent improvement in the subsonic lift-to-drag ratio (L/D) and thirty percent improvement in supersonic L/D. Pitch and roll rates were approximately doubled, penetration speed increased, and flying qualities improved—notably in terms of stability when weapons are fitted. A speed of ninety knots could be maintained at a thirty degree angle of attack.

The F-16F will have a larger air intake for its F110 augmented turbofan, perhaps with a variable-geometry inlet. A color moving-map display will add to the amenities of what is clearly, in the F-16C, a cockpit of the future, with sidestick controllers, wide-vision head-up display, AN/APG-68 improved multimode radar, and multifunction displays.

By the time the F-16F is airborne, McDonnell Douglas will be flight-testing an advanced technology version of the F-15. Fitted with foreplanes and vectoring nozzles, it is intended to share something of the STOL and in-flight thrust-vectoring capabilities of the Harrier, without degradation of the Eagle's basic supersonic and payload/range performance. USAF is aiming at an ability to take off and land in 450 meters (1,500 feet) for its future fighters, using this kind of technology. The big question is if one could find, between craters, a 1,500-foot airstrip on which to take off five minutes after the start of a major war. Even worse is the thought of trying to land a supersonic fighter between craters. Sometimes one wonders if those who draw up specifications appreciate the extreme vulnerability of runways.

ATF and Stealth

Beyond the adaptations of the basic F-15 and F-16 described so far, there appear to be two parallel USAF fighter development programs.



Advanced technology F-15, with foreplanes and vectoring nozzles, will operate from 1,500-foot strips.

One, which has been under way for at least seven years, is the so-called Stealth program, associated unofficially with Lockheed-California and the "missing" F-19 designation that must have preceded Northrop's F-20 Tigershark. People living around Burbank Airport tell of C-5 Galaxy transports that land at night, pick up well-wrapped shapes from the Lockheed plant, and whisk them off to a heavily guarded top-secret airfield in the Nevada desert. The Baltimore *News-American* has stated that, of 14,428 Lockheed employees at Burbank in October 1984, "only several thousand could be explained by unclassified programs." It predicted that between 300 and 400 of the Lockheed Stealth fighters will be delivered, beginning in 1986–87, in a program worth $1.4 billion annually by 1988.

True or not, USAF appears intent on developing also its ATF (the advanced tactical fighter) for the 1990s. Models—admitted to be unrepresentative—exhibited by companies like Rockwell at the 1984 AFA Convention displayed so many embryonic Stealth characteristics that ATF and Stealth could well merge somewhere down the line. General Dynamics' E-7 model is different, in that it seems to place more emphasis on V/STOL capability than Stealth in its illustratable form. (Maybe

Heavy-lift helicopters might be the best method of supplying combat areas having vulnerable or cratered runways. Welcome news in 1984 was that Boeing is to complete and test the XCH-62, with a lift capability of thirty-five tons, after the program was shelved for nearly ten years.

even released photographs are becoming stealthy, for security reasons.) In any case, the whole concept of the E-7 seems puzzling. It has large louvered intake slots in its wing roots, through which outside air can be drawn in to augment the thrust of the powerplant for STOVL and hovering. Yet jet induction schemes of this kind proved disappointing when utilized in Lockheed's XV-4A Hummingbird and the Rockwell XFV-12A fighter concept. Is it really worth trying again, when everyone knows that the simple vectored thrust scheme used on the British Aerospace Harrier works so effectively?

Critics of the Harrier insist that the price paid for V/STOL capability, in terms of reduced payload/range, is too high. They forget that flight refueling enabled Royal Air Force Harriers to fly 8,000 miles from the UK to the Falkland Islands, with one intermediate stop, in 1982. The aircraft landed on a Royal Navy carrier when they arrived—and this points to an often-overlooked advantage of vertical landing. A combat pilot must carry back to his base a heavy quantity of reserve fuel—which reduces his weapon load—if he is to ensure a safe landing at a busy time or in an area where runways are vulnerable to attack. A Harrier pilot can cut his reserves to the bone, as he can touch down virtually anywhere, even among craters. (But this does suggest an urgent need for V/STOL transports, or heavy-lift helicopters, to bring in weapons, fuel, ground personnel, etc., which could explain the Soviet Union's interest in the Antonov An-72/74 transport and Mil Mi-26 heavyweight helicopter.)

Knowing all this, why is Britain involved in the five-nation EFA (European fighter aircraft) program to produce a non-V/STOL canard delta rather than a supersonic Harrier type of aircraft? As in the case of so many current UK policy decisions, the answer must be concerned with monetarism rather than military common sense.

Even the US Marine Corps seems to have taken a deliberate step backward in getting McDonnell Douglas to work in partnership with British Aerospace to produce a new version of the Harrier that is a "bomb truck" with doubled payload/range. The AV-8B Harrier II gives them precisely what they requested, with the help of an uprated powerplant, increased fuel, and structural changes that include extensive use of carbonfibre and other composites in the wings.

These advanced technology materials save weight, which translates directly into increased weapon load. Unfortunately, the AV-8B's speed at sea level is 590 knots, compared with 635 knots for the RAF's Harrier GR.3 and the Royal Navy's Sea Harrier FRS.1. The UK services learned during the Falklands campaign that every mile per hour is important to survival when attacking well-defended targets.

It would seem that the fighter of the future should combine the V/STOL capability of the Harrier with supersonic speed, the low observability of Lockheed's

Europe's five-nation fighter of the 1990s could resemble this British Aerospace proposal, if it is ever built.

reported Stealth aircraft, and the practicable aspects of advanced technology discussed in James W. Canan's excellent features on the VHSIC program and the totally integrated airplane in the April and January 1984 issues of AIR FORCE Magazine, respectively.

Two Great Bombers

Is there any point in mere editors and engineers daring to tell governments and defense ministries what they are doing wrong?

When former President Jimmy Carter canceled B-1 bomber production in 1977, the Foreword of the 1977–78 *Jane's* began with the words: "If our planet is subjected one day to the unimaginable horrors of a third World War, 1977 might be recorded as the year in which the seeds of defeat for the Western Powers were sown. . . . It is . . . vital for all peoples to understand that the fragile coexistence maintained for a generation by balanced East/West military power is being allowed to slip, inch by inch, from our grasp. . . . To state this fact will be construed in some quarters as no more than a final, rather pathetic plea for the American B-1, mightiest bomber of all time but so costly that it was rejected deliberately in favor of cruise missiles."

It was not "a final plea." Year after year in *Jane's*

Harrier II: a formidable Marine "bomb truck" but forty-five knots slower than the RAF's Harriers.

Forewords, and in AIR FORCE Magazine Aerospace Surveys, the case for the B-1 was restated. It would be presumptuous to suggest that this had the slightest influence on reinstatement of the program in 1981, which led to the first flight of the first of 100 even-better B-1Bs one month before this Aerospace Survey was written. However, bearing in mind that the Soviet Union has been able to put its larger and faster Blackjack bomber in the air in advance of the B-1B because of the time lost in the US program, it may not be too soon for everyone to begin hollering about the way the ATF should be designed. Even now, there might be a supersonic Harrierski on the MiG or Sukhoi drawing boards.

Fortunately, the aircraft of any particular type that flies first, and is bigger or faster, is not always best. This was demonstrated by the failure of Russia's Tu-144 supersonic airliner and the success of the Anglo-French Concorde. The B-1B is the vital weapon that has been missing from the West's inventory for too long. As it nears its entry into USAF service, we can all say a fervent "Amen" to the words of Secretary of the Air Force Verne Orr at its rollout: "We don't build bombers to go to war. We build them to keep from going to war. May it never fly in anger."

The more that such aircraft can demonstrate their potential in peaceful skies, the more likely it becomes that they *will* never have to fly in anger. For that reason, the people of Germany, Italy, and the UK, coproducers of the Tornado tactical combat aircraft, had every right to feel a glow of pride and satisfaction after the RAF sent Tornados of No. 617 (Dambusters) Squadron to compete in SAC's 1984 bombing competition "Prairie Vortex."

In a field of forty-two aircrews, and competing against USAF F-111s and B-52s and Australian F-111s, the Tornados took first and second places in the contest for the Curtis E. LeMay bombing trophy. Although the Tornados had been operational little longer than one year and spend their working life almost entirely on low-level flying, the winning crew gained 2,616 points out of a possible 2,650 for both high- and low-level bombing and time control.

No. 617 also carried off the John C. Meyer trophy for

An interdictor/strike Tornado of the West German Luftwaffe. Similar aircraft, from the RAF's No. 617 (Dambusters) Squadron, captured two top awards in SAC's 1984 bombing competition.

the F-111 or Tornado crew compiling the highest damage expectancy from its low-level bombing, taking into account evasive tactics using ECM. It was the first time either trophy had been won by a non-American crew.

Coming at about the time when the US Navy confirmed its requirement for some 300 British Aerospace Hawk advanced trainers (to be coproduced with McDonnell Douglas) and when USAF began to take delivery of a fleet of Shorts Sherpas (built in Northern Ireland) as its European Distribution System Aircraft (EDSA), it helped to make 1984 a very good year for the UK industry.

Havoc and Hokum

What NATO military leaders must never forget is that the past twelve months have also given their Soviet counterparts plenty of cause for satisfaction. As more information on the latest Soviet combat aircraft becomes available, the entries in *Jane's* on such types as the MiG-29 Fulcrum, MiG-31 Foxhound, and Sukhoi Su-27 Flanker fighters and the Sukhoi Su-25 Frogfoot attack aircraft begin to reveal increasingly formidable equipment for the reorganized Soviet air forces.

It is confirmed this year that Frogfoot has a large-caliber gun, in addition to stores on ten underwing hardpoints. The Tu-22M/Tu-26 Backfire bomber is now known to have three carriers for Kitchen and Kingfish air-to-surface long-range missiles. Yakovlev's Yak-36MP Forger carrier-based fighter is transformed into the Yak-38 and is confirmed as being able to make STOL takeoffs, with an increased payload, as well as the originally observed vertical takeoffs.

Perhaps even more thought-provoking is news of the latest products of the Mil and Kamov helicopter design bureaus.

As readers of *Jane's* and these annual Aerospace Surveys will know, it is not difficult to predict the arrival of most new Soviet aircraft, both military and civil. If the air forces or Aeroflot foresee the need for a particular new type, its development will be started immediately to ensure that the inventory will always be complete. Furthermore, the new aircraft will be the very best that Soviet designers and engineers are capable of producing, regardless of cost.

There was a time when the Soviet best was far short of what could be put into service in the West. As a result, the two and a half to one numerical advantage enjoyed by Warsaw Pact air forces in Europe by comparison with NATO air forces was of no great concern. Today, the quality of aircraft like Fulcrum, Flanker, and Blackjack appears to be so high that the East/West technology gap is near to closing, and the numerical imbalance is becoming critical.

Nowhere is this more apparent than in the helicopter field. For years it has been assumed that any Warsaw Pact assault on NATO's Central Front would be led by a huge helicopter assault force of Mi-8/Mi-17 Hip troop carriers escorted by Mi-24 Hind gunships. The total

The heavy armament of Marat Tishchenko's Mi-24 Hind is said to be matched with a less bulky, more agile airframe in his new Mi-28 Havoc and counterair Hokum.

firepower of such a force is frightening, even if we disregard close support cover provided by fighter-bombers, Su-25 Frogfoot attack aircraft, and the extensive tactical missile and rocket batteries available to back up massed tanks and armored fighting vehicles on the ground.

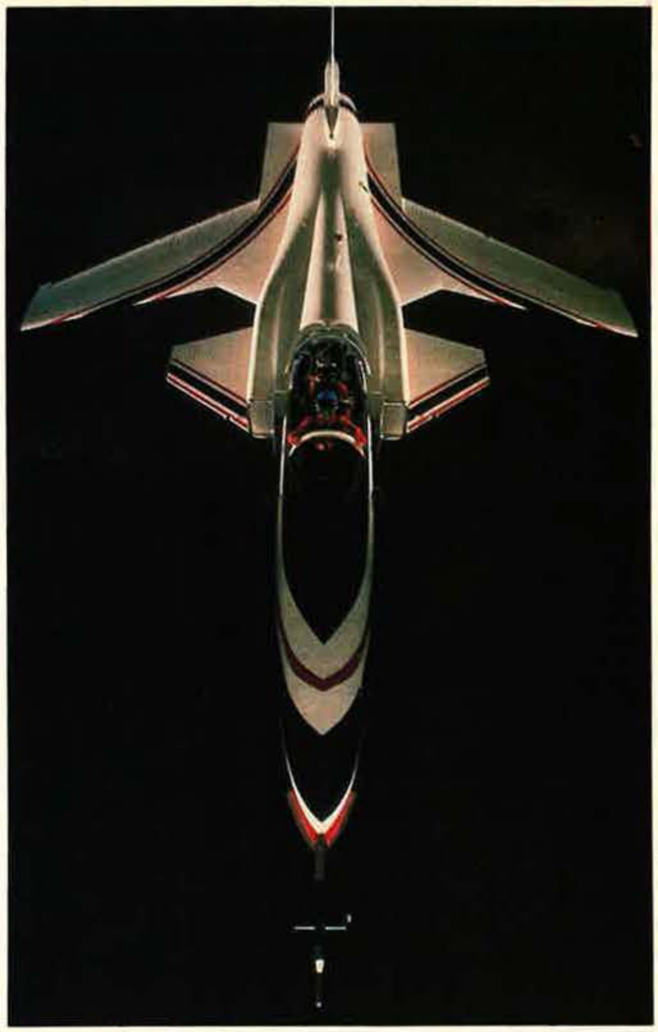
Hind began life as an assault transport and still has an armored cabin large enough to carry a squad of eight combat-equipped troops. This makes it a large target for ground fire, and it always seemed likely that the Soviet Union would develop a counterpart to the US Army's AH-64 Apache as a dedicated attack helicopter. This was confirmed in the 1984 edition of the DoD's *Soviet Military Power* booklet as the Mi-28 Havoc. A rather crude drawing made the US and Soviet types too similar in outline. In fact, Havoc is reputed to resemble the sleek and fast AH-56 Cheyenne, which Lockheed built in the early 1970s, rather than the strictly functional Apache.

Even the arrival of Havoc left one obvious gap in the Soviet helicopter inventory. Up to mid-1984, there was no suggestion that any design team in the world had completed a genuine, agile, air-to-air combat helicopter to clear the skies of the other side's helicopters in the path of an assault. All that appeared to exist was US design studies, like Sikorsky's proposed XH-59B, using the company's Advancing Blade Concept (ABC) coaxial rotor system. These ABC rotors had already been tested on the XH-59A research helicopter, which reached a speed of 303 mph and ceiling of 25,500 feet during its evaluation. No other rotary-wing aircraft had flown so fast without wings or had offered such high performance without degrading its handling or performance in the hover and low-speed flight regimes.

The proposed XH-59B seemed such a logical next step—capitalizing on proven technology to fill a glaring gap in NATO's front-line defenses—that it was included in the 1983–84 *Jane's* without question, despite the normal exclusion of any design until metal is cut for the prototype. Even now, no metal has been cut on the XH-59B; so it is a Soviet helicopter that is listed briefly in the latest *Jane's* as the already-flying prototype of an entirely new class of combat rotorcraft.

Nothing has been published concerning this aircraft, known to NATO as Hokum, at the time this survey is being written. All that *Jane's* has been able to record is that its coaxial rotor system identifies it clearly as a Kamov product, its takeoff weight is said to be in the 12,000-pound class, and a two-man crew seems likely.

If we compare the rotor system, weight, and crew complement with those of the Sikorsky XH-59B, they are broadly similar. This will persuade some people to say that the Soviet Union has again copied a concept that America was foolish to reject. Such remarks are unfair to extremely competent designers like S. Mikhéev of Kamov and Marat Tishchenko of Mil. The requirement was clear for everyone to see, and when two aircraft are designed independently to do the same job, with minimum technical risk, they have a habit of looking similar. All that really matters in terms of balance of power is that, once again, the East has a much needed piece of combat equipment in the air; the West does not.



Will Grumman's X-29A point the way to smaller, lighter, and less costly fighters?

Tilt-Rotors and Forward Sweep

During a visit to Bell Helicopters after the last AFA Convention, the writer was asked if he thought that the Soviet Union was working on tilt-rotor designs like the Bell-Boeing JVX. The answer was another question: "Is *your* JVX really as good as you suggest, and are you confident that it will perform all the multirole military tasks you have ascribed to it?" An unqualified, all-embracing "Yes" enabled the original question to be answered with the words: "In that case, of course the Russians have tilt-rotor programs. They would be foolish not to investigate such promising concepts, and they are seldom foolish."

What must be borne in mind is that we—meaning the general public, with no access to satellite intelligence—learn very little about Soviet research programs, or even military prototypes that are not selected for production. Occasionally, photographs of aircraft like Sukhoi's counterpart of USAF's XB-70 Valkyrie Mach 3 bomber become available years after all work on the program has been terminated. More usually they disappear into Moscow files, with little chance of seeing the light of day again unless some diligent, favored, Western researcher is allowed to have the key long enough to open the first few of a room full of locked drawers.

In the East, aircraft not considered suitable, or necessary, for series production tend to be regarded as failures, not worthy to be associated with the national aim of unmitigated success. This is sad for anyone who tries to compile *ALL the World's Aircraft*. The aim, clearly, is impossible of achievement, and the Editor can only wonder if, for example, he will ever see a photograph of the Myasishchev Bison bomber that was modified, like NASA's Boeing 747, to fly the Soviet Space Shuttle Orbiter between factory and launch site. Apparently it went off the side of the runway one day during what should have been its takeoff run, and the result did not make a happy picture. It would also be interesting to know if there is, under test perhaps at Ramenskoye, a small airplane with swept-forward wings, like Grumman's X-29A, or a Stealth fighter like Lockheed's F-19.

The X-29A had yet to make its first flight at the time these words were written. One wishes it success, because the thinking behind the concept is good, and it might just work now that new techniques of applying graphite epoxy skins over an aluminum alloy and titanium substructure permit the all-important flexing in flight without failing.

If the X-29A proves successful, it could point the way to a new generation of fighters that will be smaller, lighter in weight, less costly, but more efficient than current types. Theoretical advantages of forward sweep include improved maneuverability with virtual spin-proof characteristics, better low-speed handling, and reduced stalling speeds. Lower drag across the entire operational envelope, particularly at speeds approaching Mach 1, should permit the use of a less powerful engine. One area of concern is how much the addition of underwing missiles or other stores will affect wing flexing.

The last time somebody applied forward sweep to a jet was on the German Hansa executive transport. It was a success technically, but failed to find a worthwhile market—probably because conservative businessmen do not trust anything as unconventional as forward sweep. In the end, most of the fifty Hansas that were built passed into service with the Luftwaffe for ECM and VIP transport duties.

Is the Recession Receding?

Transferring our attention from military to civil aviation, the scene appears healthier than it did one year ago. After three years of losses, the 134 member airlines of the International Air Transport Association (IATA) recorded a break-even net result after interest and taxation in 1983. An after-interest profit of around $800 million on international scheduled services is predicted for 1984, rising above $1 billion thereafter. This sounds like a lot of money, but it is apparently far short of what will be needed to finance reequipment by the 1990s in the air and in terms of information transfer systems on the ground.

Boeing jet airliner sales have passed the 5,000 mark—an average of 172 sold every year during nearly three decades from October 1955. McDonnell Douglas, sensing that the long period of recession is easing, has begun once again to think in terms of increasing its range of available commercial transports. Having abandoned its planned new MD-50 and MD-100 a year ago, this time it is being less ambitious. The 173-seat MD-89 will be a stretched addition to the company's popular MD-80 family. Two MD-11X variants are envisaged as developments of the DC-10, able to carry 277 passengers for 6,500 nautical miles, or 331 passengers for 6,000 nautical miles, respectively, each with a choice of Pratt & Whitney PW4000 or GE CF6-80C2 turbofans.

Smallest of the projected McDonnell Douglas airliners is a 110-seater similar in size to the DC-9 Series 30 but powered by a pair of new-generation 10,000-shp propfan engines. Tests to date suggest that such powerplants, driving scimitar-blade contrarotating pusher propellers, will be the most fuel-efficient of all aircraft engines. Initial price and maintenance costs are calculated as being lower than for comparable turbofans, but, as always in engineering, advances have to be paid for.

Propfan propeller tip speeds will be subsonic during takeoff and landing, so there should be no difficulty in meeting the latest stringent FAR Pt 36 Stage III noise regulations. More difficult will be to keep noise at an acceptable level inside the cabin, as tip speeds will be supersonic in cruising flight. Rear-mounted engines will be essential. Even then, soundproofing is not likely to be easy, but the effort will be worthwhile for the operator, who can anticipate reductions of fifty-three percent in fuel burn and thirteen percent in direct operating cost over an average 350-nautical-mile stage with full passenger payload.

This is the first Airbus A310 flying in the livery of Pan American World Airways. (Michel Isaac)

Biggest surprise in the commercial airliner business in 1984 was the announcement that Pan American World Airways, the most American of all airlines, had signed a letter of intent to acquire a large fleet of European Airbus aircraft. The agreement involved the interim lease of twelve A300B4s and four A310-200s, plus the purchase of twelve A310-300s and sixteen A320s. Options on a further thirteen A310-300s and thirty-four A320s brought the total value of the deal to approximately $1 billion.

Inevitably, there were allegations that "it is the European taxpayer who is buying Pan Am's fleet for it." They were answered by Airbus Industrie's President, Bernard Lathière, with the assurance that "not one centime, not one penny, not one Deutsche mark of European taxpayers' money is involved in the deal." Little wonder that his company felt able to state in a press release issued at the 1984 Farnborough Air Show: "Having established its prowess in the marketplace, Airbus Industrie arrives at Farnborough '84 with a superb range of airliners for the 1980s and beyond. Its 267-seat A300-600 and 218-seat A310, and the 150-seat A320, launched since last Farnborough, already meet a wide range of airline needs. They will be followed by the 220/280-seat long-range TA11 and the 330-seat TA9 in the early and mid-1990s, respectively."

It all sounded a little grandiose until one was reminded a few paragraphs later that the partners in Airbus Industrie—British Aerospace, Aérospatiale, MBB, and CASA—have combined resources greater than any other airliner builder and benefit from nationally funded research by the RAE and ARA in Britain, Onera in France, DFVLR in West Germany, and NLR and DNW in the Netherlands.

Progress with one of Europe's other new transport aircraft, the small four-turbofan British Aerospace 146, seems to be dogged more by slowness of deliveries than lack of orders. In general, however, the UK industry is looking in better shape than it has for many years. The decision has been taken at last to fund development of the BAe ATP, an advanced turboprop follow-on to the popular BAe 748, with up to sixty-four seats and a pair of 2,520-ehp Pratt & Whitney Canada PW124s. First flight is scheduled for August 1986, with deliveries starting thirteen months later.

One step down in aircraft size, Shorts of Belfast can look back on a good year. This was appropriate, as the company celebrated its seventy-fifth year of aircraft series production in 1984, having received a contract from Orville and Wilbur Wright to manufacture six Flyers in 1909. As mentioned earlier, it repaid the favor by supplying USAF with the first of a fleet of Sherpa transports for its European Distribution System. The only British-built aircraft purchased by USAF since World War II, they were, of course, preceded by many Shorts 330 and 360 commuter transports delivered to US commercial operators.

When these thoroughly practical aircraft first appeared on the international market, they met with sales resistance from airline marketing personnel who felt

A major mark of approval for the BAe 146 is an order for two for the British Royal Flight.

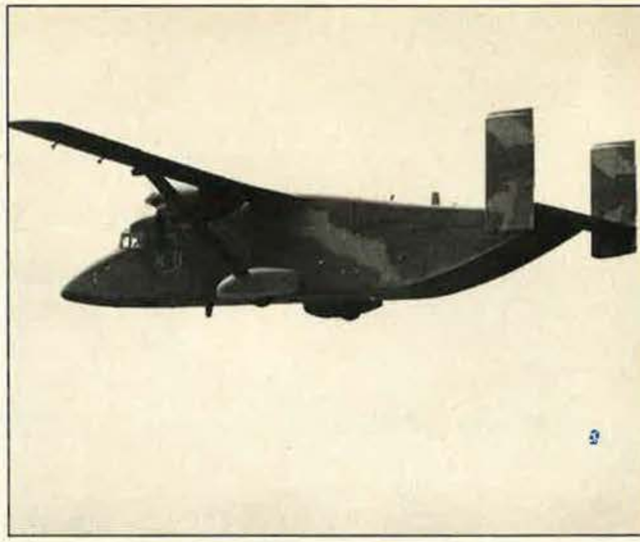
that passengers might object to flying in airliners with such a boxlike shape. However, passengers travel *inside* airplanes. Once they learned to appreciate the comfort of the 330/360's roomy six-foot-four-inch-square cabin section, they tended to feel confined in the circular or oval fuselage of other commuters.

Even the smallest UK passenger transports had a better year, helped no doubt by the pound's low exchange value on the international money market. Sales of the eighteen-passenger BAe Jetstream 31 passed the fifty mark with a four-plane order from NetherLines, a new Dutch regional operator, announced on November 1. Production will step up to thirty-six a year by 1986, which may not sound exciting by US standards, but is highly satisfactory in Europe at a time like the present.

Gloom for GAMA

Those last five words of the previous paragraph continue to provide problems for manufacturers of small civil aircraft. In France, Aérospatiale's production line of superb light and medium helicopters has slowed drastically because of reduced demand from the offshore oil and gas drilling industry and from the once eager and affluent US private and business market.

A new UK company named Trago Mills has produced the prototype of a little side-by-side two-seat fully aerobatic trainer known as the SAH-1. Those who have flown the aircraft rate it as probably the best in its class in the world, and it is now waiting only for an established manufacturer to set up a production line. Unfortunately, most of those capable of undertaking such a simple task seem to be scared away by the tale of woe spread by existing lightplane builders.



Short Brothers' first production contract, seventy-five years ago, was for six Wright biplanes. Today, their Sherpa transports are the first British-built aircraft operated by the USAF since World War II.

Lear Fan, Shorts' neighbor in Northern Ireland, closed its two plants near Belfast in mid-1984 pending full certification of its unconventional twin-turbine Model 2100. In the USA, Gates Learjet followed suit by suspending production of all its commercial aircraft and laying off about 1,000 workers at its Wichita and Tucson works in October 1984.

America's General Aviation Manufacturers Association (GAMA) had a strangely mixed story to tell in its annual report. In 1983, the ten US companies that report quarterly delivery and billing results shipped a total of 2,691 aircraft valued at nearly $1.5 billion. It was the worst year for deliveries since 1951, when 2,302 aircraft were shipped by twelve manufacturers. The 1,087 aircraft delivered in the first half of 1984 represented a further 20.5 percent drop compared with the same period of 1983, suggesting that whole-year figures could be the worst since GAMA began its records in 1946.

However, Cessna's subsequent results are not wholly discouraging. The company had its worst-ever year in 1983, recording its first loss in its history. It delivered just 1,219 aircraft of twenty-six types, compared with 8,839 shipped in 1977, its best year. The losses continued in the first half of its 1984 fiscal year. Then, in the third quarter, came a return to profitability. Sales in the period totaled only 181 aircraft, compared with 319 in the third quarter of 1983; but their value was $151.7 million, up from $98.1 million. Delivery of sixteen of the new Citation III business jets produced the turnaround.

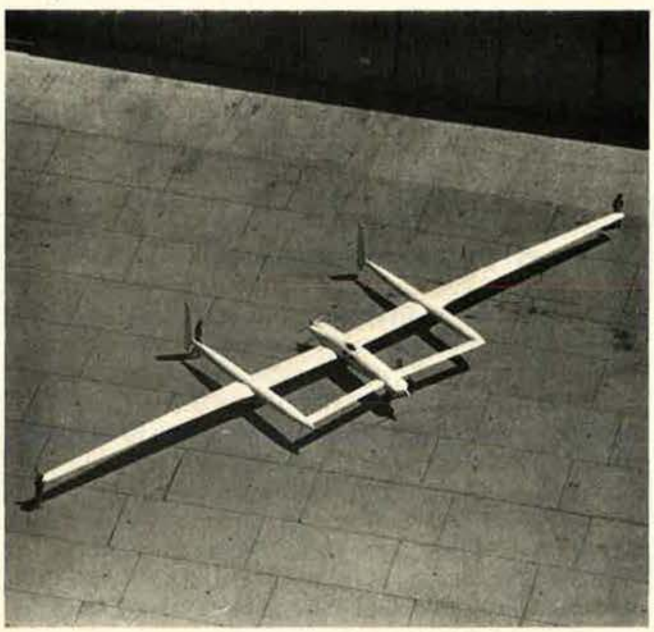
Of the other members of the US "big three" lightplane manufacturers, Beech is pinning great hopes on its unconventional Starship to bolster future sales. Piper, operating at only twenty percent capacity, has closed its Lock Haven plant after forty-seven years and consoli-

Beech is pinning great hopes on its unconventional Starship to bolster future sales. (Jay Miller/Aerofax)

dated its activities in Florida. It has been suggested that this decline of US general aviation stems in part from the expanding network of low-fare airline services that has followed deregulation. Already, private flyers—their access to busy airports increasingly restricted—foresee a parallel with rail travel, where everyone travels by train, but nobody owns the locomotive.

It is, of course, the high cost of professionally built "aerial locomotives" of every kind that has encouraged the dramatic growth of the homebuilt and microlight/ultralight aircraft movements throughout the world. In recent years, they have filled the fastest growing sections of *Jane's All the World's Aircraft,* which would certainly have surprised Fred T. Jane, founder/editor of the book seventy-five years ago.

In the preface to the 1912 edition, he wrote: "A curtailment has been made of freak machines and homemade types—interest in both of which is nowadays comparatively slight." Does this mean he would have omitted the original Wright Flyer had *Jane's* been published five years earlier? It was undoubtedly a "homemade type." And would he have shunned the Rutan Voyager of 1984 as a "freak," when it promises to be the first airplane to circumnavigate the world nonstop without refueling in flight and on the power of two lightplane engines?



Fred T. Jane would have considered Rutan's Voyager a "freak," but this strange aircraft could well be the first to circumnavigate the earth nonstop without refueling in flight.

Nor is the present editor always right. In a book published in 1967, he referred to the deaths of hang-gliding pioneers Otto Lilienthal and Percy Pilcher in the 1890s and added that the accidents happened because the aircraft "relied for control on the unsatisfactory technique of moving the pilot's body from side to side and fore and aft as he hung beneath it." Nobody expected, at that time, that hang gliding would ever return to favor; yet a precisely similar control technique is used in modern hang gliders, from which evolved the microlight movement.

We must clearly be even more cautious if we express personal views about the aerospace future when, today, transatlantic passenger travel at Mach 2 has already become day-to-day routine and when men have walked on the moon, orbited freely on a seat in space as a 15,000-mph human satellite, and are now committed to building within ten years a manned space station 400 feet long on which up to eighteen personnel will study the universe, conduct research, and operate a servicing center for satellites in need of repair.

At least, there seems little reason to fear that future Aerospace Surveys will be dull. ■

Last year, John W. R. Taylor celebrated his twenty-fifth anniversary as editor of the world-renowned Jane's All the World's Aircraft. *A regular contributor to* Air Force *Magazine through 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.*

The F-20 has almost everything except customers.

Trials of the Tigershark

BY JAMES P. COYNE, SENIOR EDITOR

NORTHROP'S new fighter, the F-20 Tigershark, looks just like its namesake—sleek, beautiful, and deadly.

But it has a lot more than good looks. This versatile little brute has demonstrated cost-effective performance and weapons employment capabilities that make it competitive with any other fighter flying today.

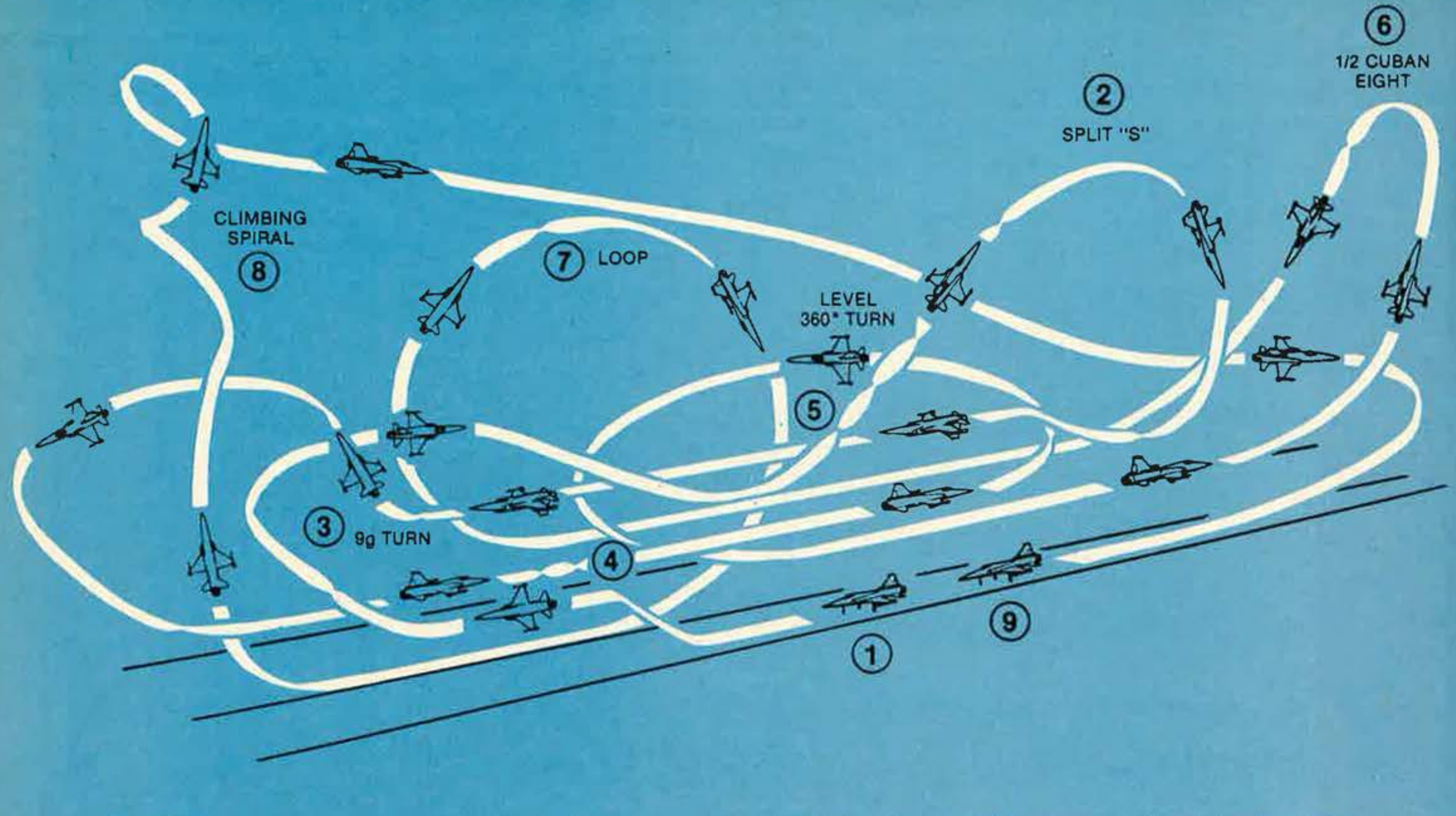
Even more important, the aircraft has established reliability and maintainability standards unmatched anywhere—they are so good that Northrop will guarantee flying hour costs in writing.

Quick Off the Mark

The Tigershark is the world's fastest-reacting interceptor. With its quick-starting engine (spool-up in eighteen seconds) and a fast-erecting ring-laser gyro (twenty-two seconds) in its inertial navigation system, an F-20 on "cold-cockpit" strip alert (no prestart electrical power to the aircraft) can be off the ground in one minute. Two and a half minutes after the pilot initiates the start sequence, the F-20 can be at 32,000 feet, using its advanced avionics and multimode radar to acquire enemy attackers more than fifty miles away. This fast-reaction capability is an important consideration for nations whose potential enemies are only minutes away or for countries that must keep slower-reacting fighters on expensive airborne alert to guard against enemy hit-and-run border incursions.

For air-to-air missions, the Tigershark carries up to six AIM-9 Sidewinder heat-seeking missiles or two Side-

A Tigershark demonstrates its superb weapons employment accuracy in tests at Edwards AFB, Calif.



The F-20 Tigershark flight demonstration included (1) maximum power takeoff; (2) the classic split S maneuver, starting with a roll at the top; (3) a nine-G turn; (4) a high-speed roll; (5) a full 360 degree turn at a high sustained turn rate; (6) the over-the-top half Cuban eight maneuver; (7) a loop with a pull-up of four Gs; (8) a climbing spiral, holding four Gs; and (9) landing.

winders and two AIM-7 Sparrow radar-guided missiles. It will also employ up to six of the new AMRAAM advanced radar-guided missile. The aircraft's two internal 20-mm cannon can be used for close-in dogfighting.

For air-to-ground missions, the Tigershark is capable of employing a wide variety of munitions. These include Mk 82 bombs, 2.75-inch rockets, laser-guided bombs, the Maverick missile, the cannon, and various other weapons, including a 30-mm gun pod that is used for antitank work.

In weapons employment tests, aircraft systems have proved extremely accurate. In one test series, twelve bombs were dropped singly, one per pass. Diving at a thirty-degree angle and using a Continuously Computed Impact Point (CCIP) delivery mode, the Tigershark achieved an average impact of twenty feet from bull's-eye—well within the 150-foot lethal radius of a 500-pound bomb.

With CCIP, the pilot places the pipper—or aiming dot—on the target, presses the bomb release button, and executes a pullout from the dive. Regardless of speed, specific dive angle, or altitude above the target, the bomb will impact on the aiming point.

The Tigershark's air-to-sea capability is just as impressive. In the air-to-sea mode, the General Electric radar can detect stationary or slow-moving targets in calm seas and targets moving at eight knots or above in rough seas at a range of up to thirty miles. The aircraft has carried the Harpoon antiship missile.

All Tigershark tests have been flown out of Edwards AFB, Calif. The US Air Force is Department of Defense executive agent for the evaluation program.

Around the World

Northrop recently sent two Tigersharks on a round-the-world trip to demonstrate the military capabilities of the aircraft to interested countries in their own environments and, further, to validate aircraft ruggedness, reliability, and ease of maintenance. The two F-20s appeared in both static displays and maximum-performance flight demonstrations in fifteen countries and in static displays in an additional two.

England's Farnborough Air Show was the starting point for the round-the-world flight. The late Darrell Cornell, Northrop's Chief Test Pilot, flew the demonstrations, which included such high-performance maneuvers as nine-G turns, a climbing spiral, a loop, inverted flight, a low-altitude split S, and a half Cuban eight *(see diagram)*.

The demonstration proved to be a show-stopper, especially at Farnborough. Noted British test pilot John Farley, the expert commentator for BBC television, said, "If I had to pick one man who has impressed me most with his outstanding professionalism, it would be Darrell Cornell in the F-20. I believe, in years to come, when pilots are sitting down talking about this year's air show, this is the man they'll remember, this is the display they'll talk about."

The two Tigersharks departed Edwards AFB on August 17, 1984, and completed the more than 6,000-mile trip to Farnborough without a single aircraft system failure.

After the Farnborough show, the two aircraft began their world tour on September 12. First, they were demonstrated in Europe, making stops at Cologne, Germany; Emmen, Switzerland; and Alverca, Portugal. The aircraft were then flown south to the coast of Africa, where they visited Rabat, Morocco; and Bizerte, Tunisia. Then it was back across the Mediterranean to Athens, Greece, and south again to the Middle East. There they landed at Cairo, Egypt; Amman, Jordan; and Dhahran, Saudi Arabia. Then, the two aircraft traveled eastward, skirting the Hindu Kush, to Pakistan, where the aircraft visited both Karachi and Islamabad. They transited India, stopping only for crew rest and refueling.

Their route then took them along the belly of Asia to Southeast Asia, where they flew into Bangkok, Thailand; Kuala Lumpur, Malaysia; Jakarta, Indonesia; Singapore; and then Manila, the Philippines, with a stop on the way at Brunei for fuel.

The two F-20s next departed for East Asia, stopping in Okinawa for fuel and landing at Suwon, Korea, for the final flight demonstration on October 10. Unfortunately, this proved to be the final flight demonstration ever for Darrell Cornell. At the conclusion of the demonstration at Suwon, at the end of the last maneuver, the aircraft crashed, killing Mr. Cornell. *(See also "Aerospace World," p. 30, December '84 issue.)* Results of the accident investigation had not been announced when AIR FORCE Magazine went to press.

Demonstrating long-range unrefueled deployability, a Tigershark departs Midway, in the middle of the Pacific, for Adak, in the Aleutians—the longest hop in the around-the-world tour. Production F-20s will have built-in in-flight refueling capability.

Through the Paces

In addition to planned demonstrations, Northrop pilots flew the Tigersharks through a number of basic fighter maneuver (BFM) demonstrations, and potential customer pilots flew the F-20 for firsthand evaluation. (Northrop spokesmen could not reveal which countries evaluated the aircraft with their own pilots.) A total of eighty-seven flights averaging 1.1 hours in duration was flown in the twenty-nine days the two aircraft traversed the world from Farnborough to Korea, supported by five maintenance technicians.

An analysis of maintenance data shows that support for the flights averaged six maintenance man-hours per flight hour. Of the six hours, less than a half-hour was for unscheduled maintenance.

After the Korean demonstration, the remaining F-20 was flown back to the United States by the planned route, which included stops for refueling and crew rest at Kagoshima, Japan; as well as stops at Saipan; Wake Island; Hickam AFB, Hawaii; Midway Island; Adak, in the Aleutians; Anchorage, Alaska; Whidbey Island, Wash.; and, finally, on October 26, Edwards AFB. The returning F-20 had flown 29,455 nautical miles.

Although the production Tigershark will have an inflight refueling capability, one trip objective was to demonstrate unrefueled deployability. One reason for this is that most prospective purchaser nations do not have or need an in-flight refueling capability. Another was to demonstrate the long-range capability of the F-20. The longest leg on the flight was 1,430 miles, from Midway to Adak. Prior to the round-the-world trip, a Tigershark was flown nonstop from Edwards AFB to Andrews AFB, Md., for an unrefueled flight of 2,007 nautical miles.

For the post-Farnborough portion of the round-the-world trip, the Tigersharks posted a departure reliability of ninety-seven percent. Departure reliability is defined as the probability of launching the aircraft as scheduled. Mission reliability was ninety-eight percent. Mission reliability is the probability of completing the mission once launched.

The mean flight hours between failures (MFHBF) rate of major components for the two Tigersharks was 9.3 hours. Northrop predicts a 4.2-hour MFHBF rate for a mature F-20 system in a combat or training environment.

High Reliability

The two Tigersharks demonstrated high reliability during the tour. On the entire trip, only eleven system components failed on the full-up avionics aircraft. Four of these components were damaged at the stop at Bangkok, where demonstrations were grounded for two days by heavy monsoon rains. The aircraft were parked in the open. A combination of moisture intrusion in the avionics compartment of one Tigershark and an overvoltage charge from a borrowed airline power unit damaged the items. Production aircraft will have a sealed avionics compartment. On the trip, only two items, a transformer rectifier and a digital display indicator, were taken out of factory supply stock. The other items were replaced from stocks carried with the aircraft supporting the Tigersharks. In an actual operational situation, these would have been available from base stocks.

At Bangkok, the demonstration was delayed two and a half hours by the maintenance actions, but the aircraft departed on schedule for Malaysia.

The exceptional mission reliability of the F-20 was demonstrated by completion of all but one of the planned missions. This happened after three external tanks were installed so that the F-20s could fly the long overwater hop from the Philippines to Korea nonstop. But one of the Tigersharks could not transfer fuel from the right external tank, so both landed at Kadena AB, Okinawa, to defuel the tanks. The aircraft arrived in Korea only thirty minutes behind schedule. It was later discovered that a fuel-tank check valve had been improperly installed.

The high level of aircraft reliability on the tour is attributable in part to the efforts of Northrop factory-trained technicians. But the generally poor facilities and the logistics environment in the countries visited did not make their job any easier. This high level of aircraft performance was remarkable, especially considering the fact that the aircraft were operating in an essentially bare-base environment.

Why No Orders?

Did Northrop garner any Tigershark orders as a result of the around-the-world demonstrations? Northrop spokesmen say "not yet." This raises the inescapable question of "why not?"

The biggest reason is probably that before the F-20, Northrop developed the single-engine F-5G, an updated version of the US standard export fighter that resulted from the competition sparked by the Carter Administration for a new export model. (Another entry in the export fighter field was the F-16 with the J79 engine, which is the engine used in the F-4 and other older fighters.) However, before the F-5G could be offered for sale to foreign nations, the Reagan Administration, reacting to the Soviet presence in Afghanistan, agreed to sell the F-16A to Pakistan. For the first time (except for Israel, which is always a special case), a first-line fighter was offered for sale overseas outside of NATO before a substantial portion of the US armed forces was equipped with it. Soon, the F-16 was sold to Venezuela. It was already being coproduced in NATO. Suddenly, foreign military assistance recipients began requesting F-15s, F-16s, and F-18s.

None of these potential purchasers wanted an "export" fighter, which they viewed as an aircraft of lesser performance than USAF and US Navy front-line fighters. And since they were actually going to *pay* for these aircraft, albeit in many cases with borrowed US money, the US did not have the leverage to persuade them to buy an export model. New fighter sales came to a virtual standstill. At the same time, competition from such foreign manufacturers as the French, British, and Soviets—who were offering better terms than US firms could offer—increased dramatically.

Foreign military sales not only proliferate US equipment around the world but spread US influence as well. The pressure was (and is) on to sell first-line fighters to foreign friends and allies.

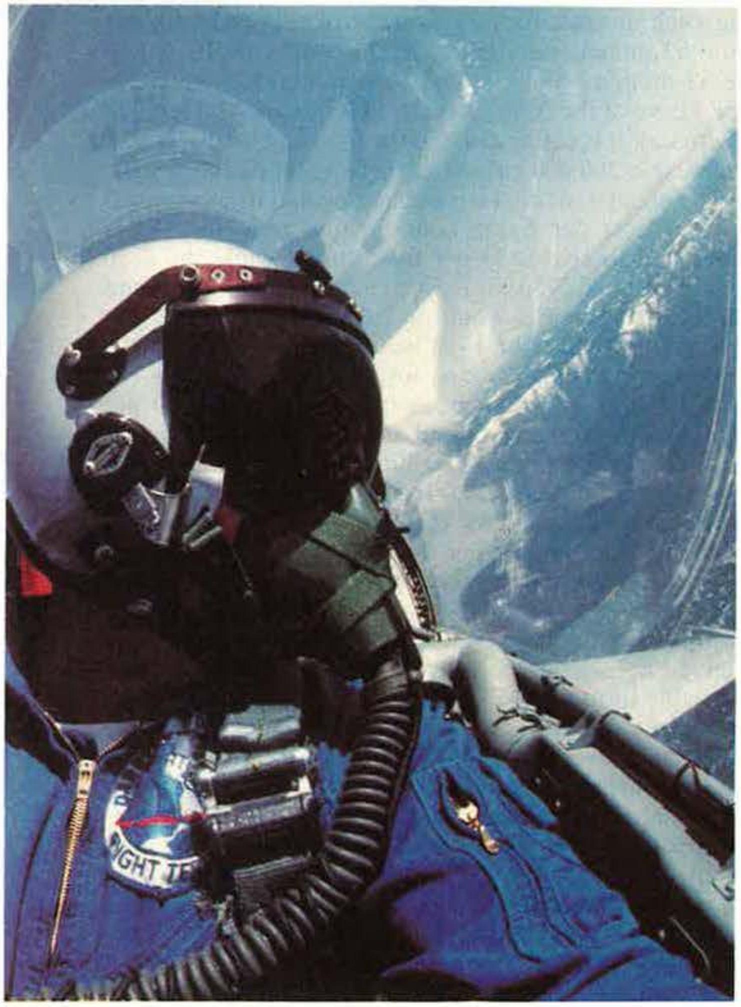
Unrestricted visibility of the Tigershark cockpit is apparent in this in-flight photo over the mountains of California. Northrop has invested more than $800 million in corporate funding to develop the F-20 as a versatile, first-line fighter.

A New First-Line Fighter

Recognizing this, Northrop developed the single-engine F-20 Tigershark. While many basic structural assemblies are compatible with the F-5, the Tigershark is a new, competitive, first-line fighter. So far, upwards of $800 million has been spent developing the F-20. The authoritative *Jane's All the World's Aircraft* sums it up: "With an empty weight increase of only fifteen percent compared with the F-5E, the Tigershark has a seventy percent increase in engine thrust and offers significant performance improvements." The percentage of thrust increase is based on a 17,000-pound-thrust General Electric F404 engine. The production aircraft will have a new version of the F404 with more than 18,000 pounds of thrust.

Specific comparisons of the F-20 with other US and foreign front-line fighters are difficult to make because the technologies involved are up to ten years or more apart. The F-4 was developed in the 1960s and 1970s and the F-15, F-16, and F-18 developed in the mid to late 1970s. The French Mirage 2000 is late 1970s. Only the F-20 started with the latest 1980s technology.

Aside from the single-engine configuration of the F-20, differences with the F-5 are immediately evident in the cockpit. It seems roomier than the F-5—or the F-16. Sitting in it, one is struck by the excellent vis-



ibility, including to the rear and downward and around the Stencil III ejection seat, which has a headrest only nine inches wide.

The Stencil III is a zero-zero seat, meaning that a pilot can eject on the ramp or runway with the aircraft at rest and be propelled high enough by the seat for his parachute to open safely. The seat has a vectored maneuverable thrust rocket system. This translates into a capability for a successful ejection at any altitude when the aircraft is erect and at an airspeed as slow as 130 knots or at an altitude as low as 300 feet with the aircraft inverted.

Immediately in front of the pilot is the wide-angle head-up display (HUD), which projects on the windscreen the symbology and information that the pilot needs for any flight condition and weapons employment mode. He can read it without having to move his eyes into the cockpit. Immediately below the HUD, well up in his field of view while looking through the windscreen, is the data entry panel. This single panel is used to set up every function performed by the aircraft's avionics systems, from changing radio frequencies to reprogramming the inertial navigation set to calling up specific systems information on the two digital display indicator screens on either side of and slightly below the data entry panel. Also, the pilot calls up radar and weapons delivery modes on the screens, or he can check weapon systems settings, ordnance stations, or aircraft systems operation by using buttons and actuators on the stick and throttle (Hands on Stick and Throttle—HOSAT—control). So the pilot can navigate, detect targets, and deliver weapons without taking his hands off the flight controls.

Computer-Controlled Engine

Enabling the pilot to perform these tasks with his fingertips while keeping his head "out of the cockpit" are twenty-one on-board computers that constantly monitor and control themselves and aircraft systems. The modular F404 engine in the Tigershark is digital computer-controlled (in the Navy's F-18, the same engine is analog). The flight control system also is digital computer-controlled, although it is not purely "fly by wire." Rather, the computerized system operates on top of and in conjunction with a mechanical control actuation system. If battle damage should knock out the double-redundant computerized system, the pilot could still control the aircraft mechanically.

The engine's own computer automatically monitors and controls the engine, notifying the pilot of performance and calling his attention to performance degradation. Using inputs from other computers, it refines engine settings constantly to reflect optimum thrust output for any combination of airspeed, altitude, and angle of attack.

The Tigershark has simple engine inlets rather than complex inlet ramp actuators. Because of computerized control, the F404 engine operates throughout the performance envelope of the aircraft, from forty knots to Mach 2+, without developing stalls, stagnations, overtemperatures, pressure spikes, or other problems experienced in some other high-performance engines. One potential customer pilot, a Northrop spokesman reported, took the aircraft to 40,000 feet, throttled back, let the airspeed decay to forty knots at a high angle of attack, moved the throttle immediately into full afterburner until the aircraft had attained more than 400 knots, and then back again to idle until airspeed had decayed to forty knots, repeating the cycle again and again with no engine problems.

The computer is so reliable in monitoring engine performance that there are no scheduled overhauls. A major component is changed only when the computer indicates that the component is nearing the end of useful service. After a component change, there is no need for maintenance personnel to "trim," or optimize, the engine—the computer trims it automatically. Northrop expresses complete confidence in the F404 engine, pointing to more than 116,000 operating hours in the F-20 and other aircraft. In the F-20, a Mean Time Between Failure (MTBF) rate for the engine of more than 190 hours has been documented—the highest in the aircraft industry.

The Main Task

The Tigershark has the fastest mission computer flying today—it can handle up to 650,000 computer operations per second. So much aircraft operation is handled by digital computerized systems that the pilot can concentrate on his main task—flying and fighting—with minimum concern over internal systems. These are handled by computers, automatically.

When something goes wrong in the F-20, the computer tries to handle it, and if it can't, it then notifies the pilot of the problem by audio or visual caution warning system. The pilot can call up enough information on one of the digital display indicator screens to determine whether or not to continue, modify, or abort the mission. Teledyne guarantees a MTBF of 2,000 operating hours, or about five years for the mission computer.

The Tigershark's General Electric multimode coherent radar, working with the Honeywell ring-laser gyro inertial navigation set, provides superb air-to-ground or air-to-air attack capability. In one of the ground mapping modes, the pilot can "freeze" the radar so it stops emanating signals and enters a memory phase. On his screen, the mapping display stays in place as the pilot descends to minimum altitude and executes whatever maneuvers he requires on ingress to the target. A moving aircraft symbol follows his movements across the map, telling him where he is in relation to the target at all times. This significantly reduces the possibility of detection by enemy electronic systems until very late in the attack and increases the element of surprise. In addition, while ingressing to the target with his radar active, the pilot can select a "Doppler beam-sharpening mode," which enhances the radar image by a factor of forty to one—almost to photographic quality. Using this feature of the radar, the pilot, from ten miles out, can "see" parked aircraft and other details before he actually enters the target area.

The best indicator of differences between the F-5 and the F-20 is performance. The F-5, with both afterburners engaged, will get off the ground in 2,200 feet. The F-20, under military power (afterburner not engaged), takes off in just under 2,200 feet—and in only 1,400 feet with afterburner. At 10,000 feet, the F-20 accelerates from 165 to more than 500 knots in twenty-seven seconds.

After a comparison demonstration in which an F-5 and F-20 started side-by-side at the same airspeed and selected full power simultaneously, the F-5 pilot said, "The Tigershark pulled ahead of me so fast, I involuntarily looked down at my instruments to be sure my burners were cooking. They were—and he still left me feeling I was standing still." The F-20 has exceeded Mach 2 at altitude and will sustain 800 knots-plus when below 5,000 feet. These dash speeds, unattainable by the F-5, are critical to high-G, low-level maneuvering and aircraft survival when departing the target area, after the enemy has been alerted to the attacker's presence.

The Tigershark has demonstrated optimum maneuverability at nine Gs. Its performance at any airspeed and altitude is significantly enhanced by fully maneuverable leading and trailing edge flaps, which are positioned automatically and optimally by a computer that senses airspeed and angle of attack changes. Finally, the F-20 can exceed Mach 1 without using afterburner; most other fighters flying today can't.

The Bottom Line

For potential foreign military sales (FMS) recipients, costs of buying and operating the F-20 are as significant as performance. USAF FMS cost projections show that the F-20 comes out ahead of the F-5E in this department as well. Because of the obvious increase in capability of the F-20, no performance comparisons were made, but for a twenty-aircraft F-20 buy, USAF estimates an FMS purchase cost of $315 million in FY '84 dollars. Assuming each aircraft flies an average of fifteen hours per month, annual operating costs for twenty F-5Es would be $3 million, compared to $2.7 million for the F-20s (exclusive of the costs of fuel and lubricants, which will fluctuate). It is estimated that the F-5s and the F-20s will each use 2,200,000 gallons of fuel and lubricants a year.

The significant cost a purchaser would use as a yardstick is cost per flying hour. In this area, the F-5 is estimated to cost $833 per flying hour, while the F-20 would cost just $750 per flying hour, exclusive of fuel and lubricants. The F-5 would use 600 gallons of fuel per flying hour, while the F-20 would use 620 gallons.

By comparison, the cost for a "first-line" single-engine US fighter would be something over $2,000 per flying hour, exclusive of fuel and lubricants. The flying hour cost of a foreign "first-line" fighter—in this case, the French Mirage 2000—is estimated at $2,885 per flying hour, plus the cost of something over 900 gallons of fuel and lubricants per flying hour.

Another important consideration for a foreign purchaser is what total force—"force presence"—he can get for his money. In tests, the Tigershark has yielded 6.2 sorties per day, while another US aircraft available through FMS yielded 4.2 per day. Assuming a twenty-five-aircraft fleet, a purchaser could have available a daily average of 155 F-20 sorties vs. 105 sorties by another airplane.

A final consideration is supportability. Northrop postulates, based on actual test data, a manpower requirement to support the F-20 only one-half that for most other first-line fighters. This, once again—depending on a purchaser's national economic conditions—translates into lower costs.

In sum, the Tigershark offers a purchasing nation the latest in American technological advancement, performance as good or better than anything else available, significantly less cost in dollars and manpower, and reliability and supportability, all adding up to higher force effectiveness—along with lower flying hour costs guaranteed in writing.

Who'll Be First?

So why hasn't anybody bought it? One answer seems to be that the US Air Force hasn't bought any, and until it does, foreign buyers are reluctant to be first. All through the fall, rumors were circulating hot and heavy in Washington that the Air Force, or the Navy—or both—would be buying the Tigershark. Neither Northrop nor the government would confirm or deny this.

The Air Force has said from the beginning that the F-20 is a fine aircraft, equal in many respects to Air Force aircraft, though it can't carry quite as much ordnance quite as far. But it was developed for sales overseas at the same time USAF was pressing ahead with its force planning with F-15s and F-16s. These two aircraft are already in hand and have significant growth potential to meet future Air Force needs (although so does the Tigershark).

The Air Force would like to have the Tigershark for a new "aggressor" training aircraft—the existing aggressor fleet is piling up flying hours. But aircraft cost money. At this writing, there's no USAF Tigershark in sight.

Yet. ■

USAF's new aeropropulsion test center is changing the whole relationship between airframe builders and engine makers.

Big Wind at Tullahoma

BY CAPT. NAPOLEON B. BYARS, USAF
CONTRIBUTING EDITOR

An engineer inspects the Aeropropulsion Systems Test Facility (ASTF) exhaust ducting as part of shakedown activities.

ALONG Interstate Highway 24 between Chattanooga and Nashville, Tenn., hills finger out from the Cumberland Mountain Range and point to a geographic area known as Middle Tennessee. It's a stretch of road where truckers talk over CB airwaves while hauling freight east and west on the Interstate. Small and sleepy farms dot the hillsides, as do billboards advertising breakfast—two eggs, bacon, and grits—for ninety-nine cents.

This is the country-western music heartland, and moonshine stills operate here and there on the ridges. You might assume, as you drive west on I-24, that this rustic setting is credible evidence that the wheels of progress passed right on by the people of Middle Tennessee.

You couldn't be more clearly wrong.

Here by the Elk River, on the border of Franklin and Coffee Counties, is Arnold Engineering Development Center (AEDC), a part of Air Force Systems Command. AEDC operates the most advanced and largest complex of aerospace flight simulation test facilities in the free world.

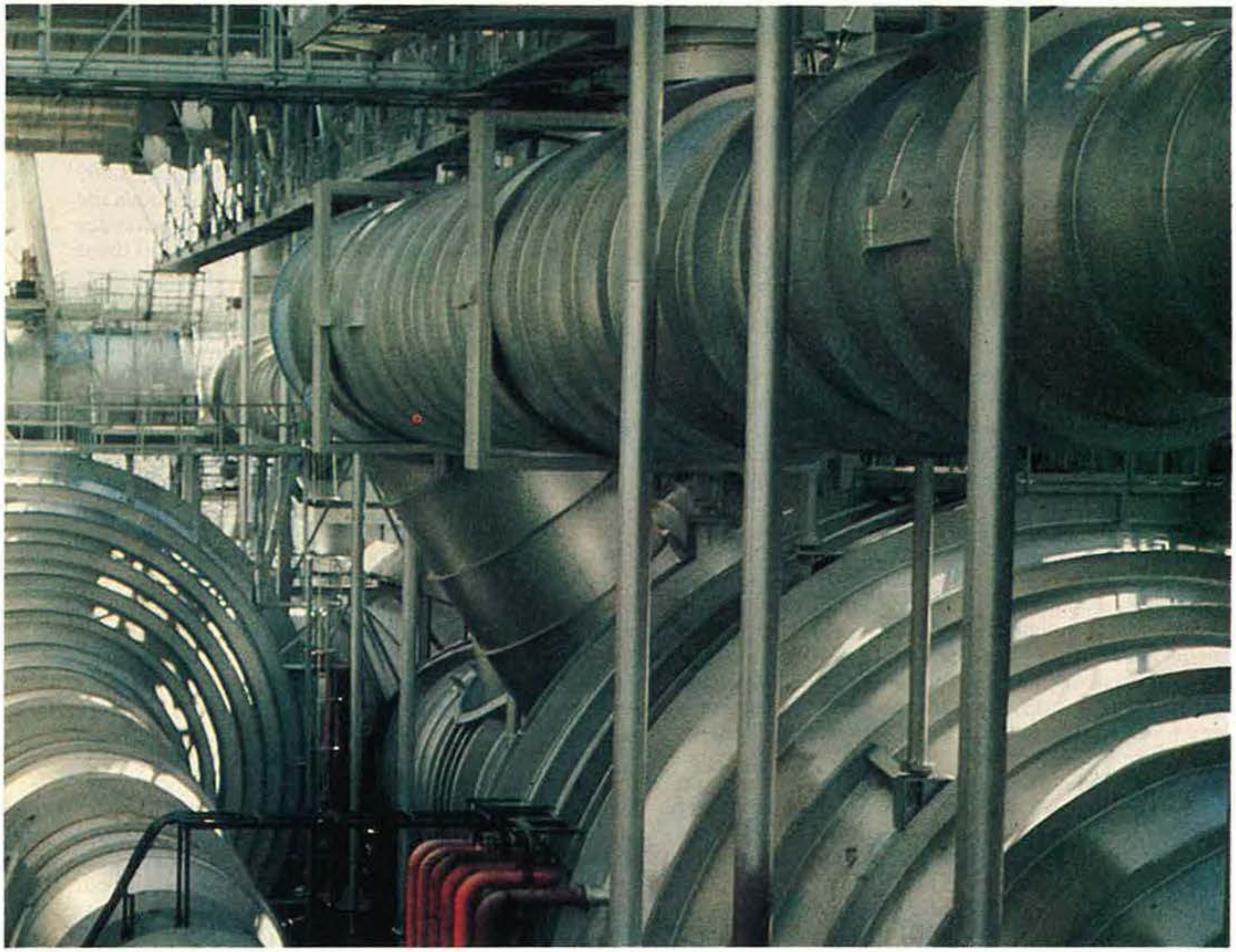
Inside Arnold's test facilities, man controls the elements. Scientists and engineers simulate altitudes, temperatures, and speeds and can even make four kinds of snow. Since the mid-1950s, AEDC has been the primary propulsion test facility for the Air Force, the Department of Defense, and aerospace industry.

With the recent dedication of the Aeropropulsion Systems Test Facility (ASTF), the people at Arnold are changing the relationship between airframe builders and the engine makers. ASTF will provide the information for the Air Force to improve the quality of future aircraft, such as the Advanced Tactical Fighter (ATF), and rein in the costly process of retrofitting weapon systems after they have already entered the inventory.

A Unique Test Facility

So what is ASTF?

ASTF is a $625 million aeropropulsion test facility with unique capabilities that will allow scientists and engineers to test for the first time the full mission profile of an air-breathing propulsion system, including the airframe inlet and exhaust—from takeoff to landing and at simulated speeds of up to Mach 3.8, at thrust levels of 75,000 pounds, and at altitudes up to 100,000 feet. In addition, ASTF will enable the Air Force to test engines two times larger than the largest of today's military and civilian aircraft engines.



The significance of ASTF becomes clear when you examine the history of engine testing in the US, beginning from World War II.

At the outset of World War II, fighters were capable of top speeds of approximately 300 miles per hour. Near the end of the war, fighter aircraft were approaching the speed of sound (about 760 mph at sea level) in dives from high altitudes. The Air Force's wind-tunnel facilities located at Wright-Patterson AFB, Ohio, and tailored to testing subsonic systems were proving inadequate as technology pushed flight toward transonic and supersonic speeds.

To Gen. H. H. "Hap" Arnold, Commanding General of the Army Air Forces (AAF) and the man in whose honor AEDC is named, the inadequacy of US propulsion test facilities was painfully clear. He had been stunned by the rapid advances made by the Germans in aeronautical research and development, leading them to the V-1 buzz bomb, V-2 liquid-fuel rocket, and the Messerschmitt Me 262—the world's first operational jet fighter. In November 1944, he asked the renowned aeronautical scientist and Director of the newly formed AAF Scientific Advisory Group, Dr. Theodore von Kármán, to look ahead twenty years in aviation and determine what would be required to put AAF research and development on a sound footing.

From the efforts of Dr. von Kármán and the AAF Scientific Advisory Group came the idea to build AEDC. In June 1950, after congressional approval and site selection, construction began. President Harry S. Truman dedicated the Center a year later.

The city of Tullahoma, Tenn., was chosen as the site for AEDC because of the availability of land, water, and power. The forested landscape helps to muffle facility noise, the Elk River feeds into a reservoir that supplies the water for AEDC's cooling systems, and the Tennessee Valley Authority provides electricity to power huge motor drive systems.

With its forty aerodynamic and propulsion wind tunnels, engine- and rocket-test cells, space chambers, and ballistic ranges, AEDC served for the next three decades as the proving ground for propulsion systems and airframe models designed and produced by industry for DoD and NASA. Airframe builders tested their scale models in Arnold's wind tunnels. Engine companies tested their full-scale engines in Arnold's engine-test cells. At a later point in the acquisition process, sometimes well into the production cycle for each, the engine and airframe were "married together," as the people at Arnold like to say.

The Marriage of Engine and Airframe

Those marriages of engine and airframe have sometimes been unhappy ones, costing the Air Force millions of dollars.

The most publicized and serious case of airframe and engine incompatibility surfaced with the F-111 in the 1960s. The F-111 suffered from inlet distortion and engine stalls that occurred whenever the aircraft maneuvered and turned. The propulsion integration problem was eventually ironed out, but only after a costly program of retrofitting.

Still, AEDC engineers will tell you—and rightfully so—that the F-111 was truly a remarkable advance over previous aircraft technology, such as that in the F-106. The F-111 was the first Air Force aircraft to sport both integrated air inlets and exhausts that blended somewhat into its airframe.

When the Air Force F-15 and Navy F-14 were first introduced into operation, some of their highly publicized operating problems were also traced to the less than total compatibility of engine and airframe. Airframe builders pointed to problems with the engine. Engine manufacturers suspected that inlet airflow problems caused poor engine performance. In addition to the money spent in correcting the problem, the services were forced to hedge their use of both weapon systems until the bugs were worked out.

The real challenge of airframe and engine mating on the F-111 and F-15 had more to do with the state of propulsion system testing technology and shortcomings in the aircraft acquisition process than with the weapon systems themselves.

Prior to ASTF, which is undergoing activation testing and is scheduled to achieve initial operational capability (IOC) in September 1985, the state of the art in engine testing at AEDC relied heavily on German equipment brought over following the Allied victory in World War II.

Using advanced testing techniques and computers, Arnold's engineers and scientists have worked diligently with this equipment to keep up with the rapidly increasing pace of propulsion testing technology.

The billions of dollars saved by trouble-shooting propulsion systems at AEDC don't make nearly as many headlines as do the problems that occasionally surface after systems are fielded. Still, the increasing limitations of aging engine-test facilities handicapped engineers in their fight to solve the costly propulsion system integration problem.

The way AEDC tests turbine engines is simple: They push a large quantity of air in one end of the engine and pull it out the other end. At Arnold's Aeropropulsion Systems Test Facility, the air supply to the front of the engine is first generated by six giant compressors driven by a 215,000-horsepower system. The air is then directed through driers to remove any moisture, which could damage the engine, and then into heaters (to simulate high-speed and low-altitude temperatures) or refrigeration turbine units (to simulate low-speed and high-altitude temperatures). Next, the air is directed through the test cell and then pulled out to create a pressure differential across the engine that simulates flight speed and altitude.

"The secret is to trick the engine into thinking that it's really flying," said Lt. Col. Doug Ridings, Director of ASTF Integration and Operations.

Once the air has been put through the engine, it exits the engine at temperatures sometimes as high as 3,500 degrees Fahrenheit. Before the hot air is run through the compressors that push out the air, it is cooled with water to a temperature of approximately 100 degrees, is dried again, and then released back into the atmosphere as clean air. The water used to cool the air flows back into AEDC's water system. ASTF's exhaust cooling and auxiliary systems can use up to 387,000 gallons of water per minute.

The Advantages of Free-Jet Testing

Since the mid-1950s, turbine engines have been tested in Arnold's Engine Test Facility (ETF) only by direct-connect testing, as opposed to free-jet testing. In a direct-connect test, the bare engine, without its airframe inlet or exhaust, is placed in the test cell, and air is force-fed directly into the engine. In a free-jet test, a nozzle blows air across the whole propulsion system—the engine, the front of the aircraft, inlets, and in some cases the aft end of the aircraft. This gives engineers a much truer representation of how the entire aircraft goes through the atmosphere.

A key advantage with ASTF is the capability to do free-jet testing as well as direct-connect testing.

"Free-jet testing allows us to marry the aircraft inlet or exhaust configurations and the engine a lot sooner than we can now," Col. Casper Klucas, ASTF Program Manager, said. "Now that's done by first testing an engine, which is later married to the airplane and put into flight test at Edwards Air Force Base," he explained.

Since the late 1960s, England, France, and the Soviet Union have made large investments in engine-test facilities and have been using improved technology to advance engine development. The Soviet Union has operated a facility similar to ASTF for quite some time. But some AEDC engineers boast that their aeropropulsion facility, with its 2,170 instrumentation channels for data collection on engine performance, leapfrogs existing technology.

In addition to being limited primarily to direct-connect testing of turbine engines, ETF can presently conduct only a limited test of a mission profile. Once the engine is in the test cell and instrumented for data collection, precise points in the mission profile are simulated in a number of tests. The data are then collected, and engineers use the data to interpolate a graph to approximate how the engine would perform during the entire mission profile or envelope. The operation is manual and not programmable, since the ETF equipment does not allow for rapid changes in test conditions to simulate a complete mission.

To get an accurate, complete picture of how a turbine engine will perform—by using data from a limited test of a mission profile—a sufficient number of such data points have to be collected. The cost of slow point-by-point testing helps to make engine development a multimillion-dollar undertaking.

With ASTF, however, engine developers can do transient testing of the mission profile. In transient testing, engineers manipulate the engine's power setting, flight velocity, altitude, and attitude during simulated aircraft maneuvers. That means the engine will be put through the paces of an actual mission—takeoff, climb, maneuvering, descent, and landing—just as if a pilot were flying it. There will be no need to interpolate the graph to calculate how a turbine engine will perform during an actual mission. More importantly, by combining free-jet and transient testing, the likelihood of propulsion integration problems surfacing after production has already begun will be greatly reduced.

Saving Time and Increasing Capability

Col. Philip J. Conran, AEDC Commander, said that "ASTF will encourage engine developers in industry to take the necessary technical risk, without undue penalty if their initial designs are faulty. Now, under realistic flight conditions, they'll be able to wring out their engine designs and refine them earlier in the development cycle. It's far cheaper to fix one qualification model than it is to find and fix the same problem later on in 100 production engines."

Another big advantage of ASTF is its real-time, simultaneous data collection and display feature. Engineers will be able to react to data coming from the engine and to manipulate the parameters of the test during flight simulation. Currently, with ETF, the engine test is conducted, and the data are collected, crunched into a usable format, and given to engineers for evaluation. The entire process can take anywhere from two minutes to two days.

One goal of turbine engine testing is to validate the mathematical model, or computer code, of the engine. This allows engineers to predict how the engine might perform under a given set of conditions.

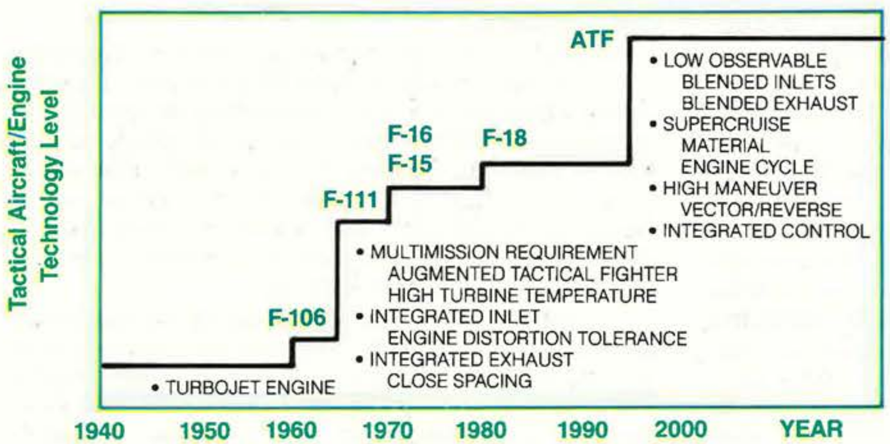
As the ability to match mathematical model predictions to actual engine performance becomes more exact, the time required to ground-test and flight-test engine models will be shortened significantly. A parallel savings in the cost of testing engines might also be realized. ASTF will allow engineers to validate an engine's computer code for the complete mission profile.

Another goal of engine testing is to advance the capability of propulsion systems. "We're tailoring our testing techniques to the next generation of engines," said R. E. Smith, Chief Scientist for Sverdrup Technology Inc. Sverdrup is the aeropropulsion contractor at AEDC.

"Unlike the operational tactical fighter engines we have today, the engine for the Advanced Tactical Fighter will be totally controlled by digital computers. It will not require the use of cams and levers. The kinds of things that the Advanced Tactical Fighter will do represent an incredible technology step over the F-15, F-16, and F-18," Mr. Smith said.

Mr. Smith is confident that, with ASTF for a laboratory, the ATF could well be an affordable and reliable aircraft from the outset. Taking into account the requirements of the ATF—stealthy, low-observable features; supersonic cruise capability; high maneuvering capability; and integrated controls—that's a real bargain.

Step Changes in Propulsion System Technology Increase Development Risks



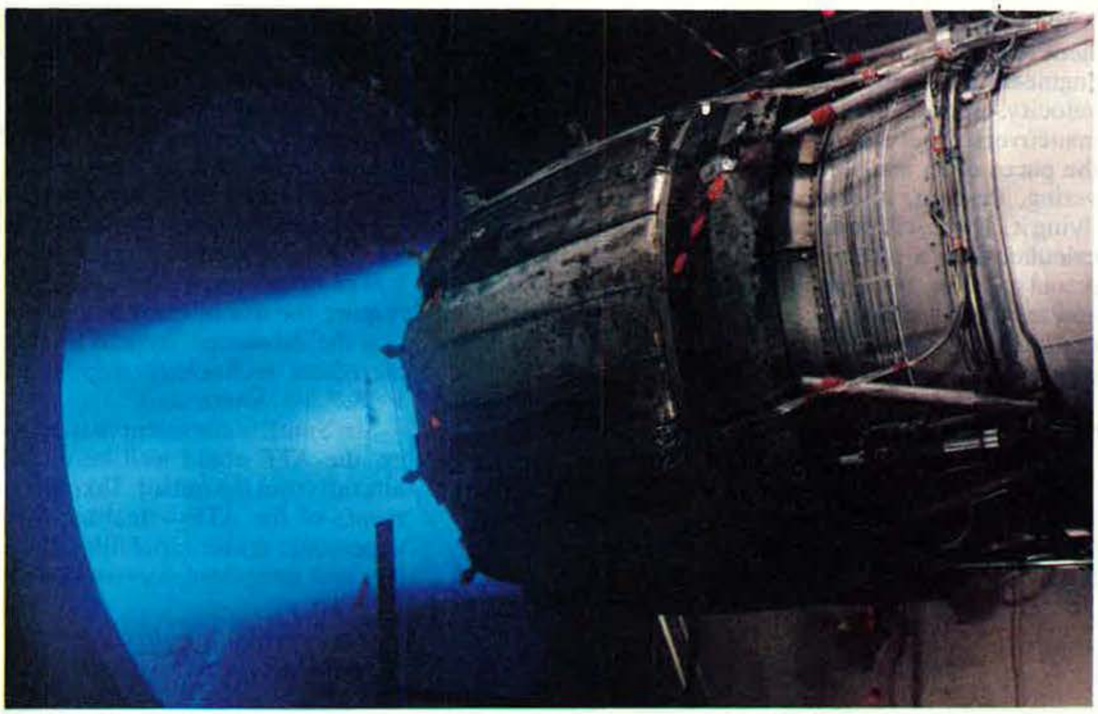
The Advanced Tactical Fighter's low-observable, supersonic cruise, and high maneuverability features require a marked technological step increase over previous fighter aircraft.

The Advanced Fighter Engine

Pratt & Whitney and General Electric are competing for the Joint Advanced Fighter Engine (JAFE) contract. Unlike past engine wars, this one promises to be a head-to-head competition. "ASTF was designed to handle this very situation," said Dr. Bill Kimzey, Director of the Aeropropulsion Programs Department for Sverdrup. ASTF has two engine-test cells and a data control set-up to handle competitive engine testing. While one engine is undergoing testing, another engine can be set up and calibrated.

"We use our big wind to simulate the real mission environment in hopes of working out the kinks in full-scale turbine engine models before they're bought by the Air Force," Dr. Kimzey said. "That way, we help ensure that engine models meet operational expectations in terms of performance, reliability, and maintainability. In a real way, AEDC is just a large air-conditioning company selling insurance," he said.

Even after ASTF comes on line, older engine-test facilities at Arnold will continue to be used for propulsion testing.



A gas turbine engine undergoes testing at Arnold's older Engine Test Facility (ETF).

Presently, ETF is involved in Component Improvement Program (CIP) testing of the F100 engine and in production verification testing of the F110 engine. The F100 and F110 are powerplants for the F-15 and F-16 fighters. The F109 engine destined for the T-46, the Next-Generation Trainer (NGT), is also in testing. In fact, almost all new propulsion systems for major Air Force weapon systems will be tested at AEDC.

As preparations get under way for the JAFE competition, test engineers from AEDC's engine-test facilities and propulsion wind tunnels caution that the traditional practice of choosing an engine model somewhat independently of its airframe design will no longer work.

"With the Advanced Tactical Fighter and beyond, what we're really talking about, in addition to other benefits, is an all-weather Air Force," said Lt. Col. Lowell Keel, Director of Aerospace Flight Dynamics Testing at AEDC. "The problems associated with the engines and airframes for these aircraft will be interrelated. Thrust vectoring and reversing will enable the airplane to be extremely maneuverable and capable of landing on a 1,000-foot runway, even in marginal weather. But this will have an effect on the airframe. Among other things, we have to look at what that hot air flowing back over the airframe will do to the airplane's control characteristics," he added.

Engineers are also discussing a variable cycle engine that will enable an aircraft to fly very slow or fast by varying its bypass ratio to achieve desired speeds. It will literally be two engines in one and so mission-flexible that it is called the "rubber engine."

An increasing number of engineers on both sides of the engine-airframe equation agree that with "stealthing" aircraft, which will in part involve the complete integration of engine inlets and exhaust, the testing of engine and airframe designs becomes inseparable. Once this happens, test techniques will have to be restructured to achieve simultaneous testing of engine models and airframe designs. ASTF is a step in that direction.

Looking Ahead

The engine and airframe marriage will continue to be a critical design consideration for future aircraft. Looking ahead, engineers are busy anticipating the propulsion integration problems with the Transatmospheric Vehicle (TAV). They are studying the flow fields that would come into an inlet if a second, alternate power source were an air-breathing system. Scientists are also considering ways to put nozzles on rocket engines so that the nozzles don't burn off during use.

Changes will also have to be made in the acquisition process. Congress and the Air Force will have to rethink the way both do business with industry. More money will have to be appropriated up front to encourage companies to do the necessary testing in order to identify design compatibility problems and to solve them in the early development phase. The cost of increasing funding for development is small when compared to the millions of dollars that are now spent in retrofitting propulsion systems.

"There are a lot of people who look at how much it costs to do the testing, without an appreciation of what it could potentially save," Colonel Conran said. "You never really know when you've done enough or too much testing. You learn very quickly when you've done too little, but then it's too late."

Even with a rethinking of the aircraft acquisition process and even with ASTF and the whole AEDC complement of engine-test facilities, wind tunnels, and high speed ranges, the most important factor in turbine engine testing remains people.

The people at Arnold take their charge seriously. As one engineer commented: "Our war here is to test in such a way as to put the best weapon systems into the field."

With the addition of the ASTF making possible the early marriage of turbine engines and airframes, the Air Force will be reaping a lot more than just a big wind at Tullahoma. ■

Winning in The Turns

Sixty years ago, Jimmy Doolittle used his aeronautical insight and superb flying skills to capture the Schneider Trophy. Here's how he did it.

BY TERRY GWYNN-JONES

US Army Lt. Jimmy Doolittle won the 1925 Schneider Cup in his Curtiss R3C-2 biplane, beating Italy, Great Britain, and the US Navy at Baltimore, Md., with a record speed of more than 232 mph.

FOR more than half a century she has lived in London in peaceful retirement, remote from those heady days when she cast her spell over racing pilots from half a dozen nations. She's still known as the "Flying Flirt," and, in her prime, young men gave their lives and governments spent fortunes to win her. But for a magnanimous sporting gesture, she would have fallen to her American suitors and would have settled permanently in the United States.

Sixty years have passed since her last great American romance. It took place in Baltimore on a windy October day in 1925. Dying gales still ruffled the waters of Chesapeake Bay as a young US Air Service pilot, Lt. James H. Doolittle, prepared his Curtiss R3C-2 for the 350-kilometer (217.5 miles) race for the Schneider Trophy—aviation's most famous prize.

The trophy was instituted by Jacques Schneider in 1913 to stimulate the design of seaplanes. The son of a wealthy French arms manufacturer, and an avid sportsman, Schneider was never happier than when racing *canots automobiles* (unlimited powerboats) on the placid Mediterranean. Following a racing accident that left him with a crippled arm, the young engineer turned his attention to flying. He saw the earth's surface—seventy percent of which is water—as a huge landing field for flying boats, which would one day link the continents.

As early as 1914, it became obvious that the Schneider Trophy was destined to symbolize speed and would have little bearing on the production of commercial seaplanes. That year it was won by a little Sopwith biplane that became the progenitor of a family of superb British World War I fighters—the Pup, the Triplane, and the immortal Camel.

Postwar Progress

In the early years following the war, England and Italy battled over the Flying Flirt in a series of unimpressive races. The postwar series had done little to stimulate aviation progress. European designers remained hidebound by wartime concepts, and their Schneider racers were basically reworked World War I designs. By 1923, however, a design revolution had taken place in the United States that was to turn the Schneider Trophy into the true "blue ribbon" of international speed racing.

Since the end of the war, American military aviation had struggled under the yoke of saddle-bound generals and battleship admirals. Army pilots had already been assigned the demanding task of flying the nation's airmail. Equipped with outdated aircraft and facing decreasing budgets, farsighted Army officers like Gens. Billy Mitchell and Mason Patrick sought ways to promote the cause of aviation. Meanwhile, Adm. William A. Moffett, despite his violent opposition to Mitchell's flamboyant tactics, worked tirelessly to bolster naval airpower.

Against this background, military airmen undertook record-setting flights to draw attention to the reliability and flexibility of the military air services. In particular, they hoped to attract the attention of President Calvin Coolidge.

In 1919, Navy Curtiss flying boats made the first crossing of the Atlantic. In 1922, Lt. Jimmy Doolittle, fast gaining a reputation as a leading Army pilot, made aviation headlines with the first one-day flight across North America. The following year, Lts. Oakley Kelly and John Macready made the crossing nonstop. Then, in 1924, the Army, flying the Douglas World Cruisers, made history with the first aerial circumnavigation.

With only meager funds available to develop new aircraft, both the Navy and Army turned to air racing as a legitimate (and low-cost) means of stimulating the design of new pursuit fighters. Their prototype racing machines were test-beds for new engines, propellers, radiators, and aerodynamic techniques. The Pulitzer Trophy Races, established in 1920, became their test arena and the scene of interservice rivalry.

Thus, it was only natural that they should seek international honors; in September 1923, the Navy's Pulitzer-bred Curtiss CR-3 racing biplane scored a sensational win in the Schneider Trophy Race held at Cowes, England. Pilot Lt. David Rittenhouse, USN, averaged 177 mph over the five-lap, 215-mile course—twenty mph faster than England's defending Supermarine Sea Lion III.

The American victory stunned the British aviation fraternity. For some years they had rather superciliously pointed out that the "Yanks" had made no significant aeronautical contribution to the winning machinery of World War I. The British had tended to rest on their aviation laurels and to adapt wartime designs to the needs of peace, whereas American designers, less bound by past glories, had looked and leaped ahead. Curtiss, with its low frontal area D-12 engine, low-drag skin radiator, Reed metal propeller, and exquisitely streamlined airframe, now led the world in high-speed technology.

The 1924 Schneider Trophy Race was canceled when the lone British challenger crashed during trial flights and the Italians were unable to complete their new racer in time. Faced with no competition, America decided to cancel the race rather than fly around the circuit unopposed to claim the trophy—as Italy had done in 1921. It would prove to be a fateful decision.

The Europeans Regroup

Italy and England had taken full advantage of the two-year break in the series to build new aircraft, and both announced they would be at Baltimore for the 1925 race. Three pilots were chosen for America's defense of the Flying Flirt: Navy Lts. Ralph Ofstie and George Cuddihy and Army Lt. Jimmy Doolittle. All three were to fly Curtiss R3C-2 biplanes—improved versions of the 1923 Schneider winner that sported new low-drag wings and an improved engine. Two weeks earlier, Doolittle's aircraft—in landplane configuration—had been flown to victory in the Pulitzer Trophy Race by Air Service Lt. Cyrus Bettis. On that occasion, Doolittle had been a reserve pilot, but during practice he had achieved a record speed of 254 mph—exceeding Bettis's winning performance by five mph.

In June 1925, Doolittle, already holding a bachelor's degree in aeronautical engineering, had been awarded his doctorate after two years of study at the Massachusetts Institute of Technology. As a part of his thesis, Doolittle had made a practical study of the little-known effects of in-flight acceleration on pilots and aircraft structures. He put this experience to good use in planning how best to achieve a minimum speed loss in the acute pylon cornering associated with Pulitzer and Schneider racing.

The brilliantly analytical Doolittle was aware that turning too tightly killed speed and turning too widely added time. He perfected a method of flying the exact arc of a circle joining the legs of the circuit without throttling back, as was customary. By commencing the turn just before reaching the pylons and passing hair-raisingly close to the structures while at the same time diving to between fifty and 100 feet, Doolittle found he lost very little speed in the turns. Furthermore, he studied the effect of wind on his performance and discovered that, by flying low into wind and high downwind, his average speed improved by as much as eight mph.

Following their crushing defeat in 1923, the British had realized that their best chance of overcoming America's biplane superiority lay with monoplanes. In 1924, Supermarine's innovative young designer, R. J. Mitchell, displaying the brilliance that a decade later would give birth to his famed Spitfire, sketched a bold new shape on his drawing board.

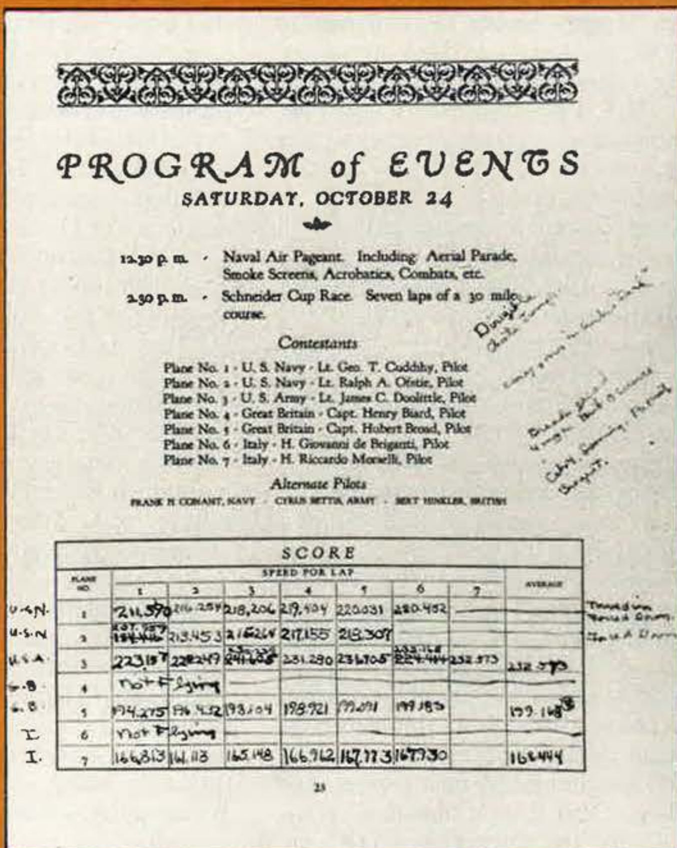
A year later, Mitchell's design had been transformed into the Supermarine S.4—an exquisitely streamlined floatplane. With its cantilever wings requiring no drag-producing bracing wires and powered by an all-new 680-horsepower Napier Lion engine, the S.4 posted a new world floatplane record of 226.7 mph during its early flight trials. However, its pilot, Henri Biard, felt uncomfortable with its handling in turns, sensing an unexplainable vibration through the control column. Nevertheless, the S.4 seemed to behave perfectly. Being a pragmatist, Biard dismissed the vibration as a figment of an overworked imagination.

Italy's Mario Castoldi, chief designer at Aeronautica Macchi, had followed a similar path. However, his M.33 monoplane was a flying boat with its engine mounted on a pod high above the wings. This arrangement generated significant drag.

Playing it safe, the British team included two beautiful little Gloster IIIA biplanes to back up their untried S.4. The Gloster, like the S.4, had been funded by the Air Ministry in an effort to regain lost prestige. Since the 1923 British defeat, intense press and public criticism had finally forced a reluctant government to give financial assistance to Britain's Schneider challenge.

Setbacks and Postponements

"Never in the history of aviation have we tackled an international speed race in so thorough a manner," *Flight* magazine told its readers as the British team sailed for Baltimore. But British hopes were to take a severe setback three days before the race got under way.



PROGRAM of EVENTS
SATURDAY, OCTOBER 24

12.30 p. m. - Naval Air Pageant. Including Aerial Parade, Smoke Screens, Acrobatics, Combats, etc.

2.30 p. m. - Schneider Cup Race. Seven laps of a 30 mile course.

Contestants

Plane No. 1 - U. S. Navy - Lt. Geo. T. Cuddihy, Pilot
Plane No. 2 - U. S. Navy - Lt. Ralph A. Ofstie, Pilot
Plane No. 3 - U. S. Army - Lt. James C. Doolittle, Pilot
Plane No. 4 - Great Britain - Capt. Henry Biard, Pilot
Plane No. 5 - Great Britain - Capt. Hubert Broad, Pilot
Plane No. 6 - Italy - H. Giovanni de Briganti, Pilot
Plane No. 7 - Italy - H. Riccardo Morselli, Pilot

Alternate Pilots

FRANK H. CONANT, NAVY - CYRUS BETTIS, ARMY - BERT HINKLER, BRITISH

SCORE

	Plane No.	Lap 1	Lap 2	Lap 3	Lap 4	Lap 5	Lap 6	Lap 7	Average
U.S.N.	1	211.590	216.254	218.206	219.404	220.031	220.452	—	—
U.S.N.	2	[illegible]	213.453	216.264	217.155	218.307			
U.S.A.	3	223.157	228.249	[illegible]	231.280	[illegible]	[illegible]	232.573	232.573
G.B.	4	Not Flying							
G.B.	5	194.275	196.452	198.104	198.921	199.091	199.185		199.168
I.	6	Not Flying							
I.	7	166.813	[illegible]	165.148	166.962	167.773	167.730		[illegible]

This program of events for the 1925 Schneider Trophy Race shows Jimmy Doolittle's winning times. He's No. 3 on the list. He won in the turns by applying principles for rounding pylons he developed in his doctoral thesis in aeronautical engineering.

During a prerace test of the S.4, Biard was turning above the pier when the aircraft appeared to roll violently in the other direction. Then followed a series of flicking, rolling oscillations as the aircraft rapidly lost height. It seemed to sideslip and then flatten out as it hit the water and virtually disintegrated in a sheet of spray. Miraculously, Biard survived. The Air Ministry later blamed the crash on Biard for allowing the aircraft to stall in a turn. But with the hindsight of today's knowledge, it is clear that the luckless airman had experienced the then little-understood problem of wing flutter.

The competition was postponed for two days by gales that whipped up Chesapeake Bay. On October 26, conditions improved and racing got under way. England suffered a further setback prior to the race when, during the seaworthiness trials required by the Schneider competition rules, the Gloster III racer flown by Australian-born H. J. "Bert" Hinkler burst a float when landing on the choppy water. The British challenge depended on the remaining Gloster racer.

Five aircraft prepared to race—the trio of Curtiss R3C-2s, the Italian M.33, and the lone Gloster III. The Schneider Race began with each aircraft being flagged off a few minutes apart to race against the clock.

Doolittle's Daring

Doolittle was first away, his black Army racer momentarily disappearing in a cloud of spray as he accelerated across the choppy bay. Despite a lack of experience with seaplanes, he made a superb takeoff and headed into the first of the seven fifty-kilometer laps. Hubert Broad was next in the Gloster, followed by Cuddihy, Ofstie, and, finally, Giovanni de Briganti in the Macchi.

By the end of the first lap, the crowd was wildly cheering Doolittle's flying. As he had meticulously planned and practiced, the inimitable airman was cutting to within a few feet of the pylons in a series of nearly vertical banked turns. With the throttle firewalled, he appeared to lose no speed during the turns and recorded an astonishing 223 mph for the first lap.

Broad set out in pursuit in the Gloster, which had a maximum level-flight speed of 225 mph. It quickly became apparent that he was having difficulty with the acute turns. Due to inherent directional instability, the Gloster sideslipped badly during the turns, forcing the Englishman to take a wide, slower path around the pylons.

The two Navy Curtiss pilots were performing well but were noticeably slower than Doolittle. It was clear that the difference lay mainly with the Army pilot's fearless cornering. Experts were concerned that he might black out during his incredibly fast turns. But this was where Doolittle's high-G flight-testing experience gave him the competitive edge. Whereas most pilots tended to black out above five Gs, Doolittle had trained himself to withstand forces as high as eight Gs for short periods.

Despite a superb display of cornering by de Briganti, the M.33 was averaging only about 170 mph and was clearly out of contention unless the other aircrafts' engines failed under the stress—a common occurrence during the Schneider races.

Halfway around the sixth lap, the first engine failure occurred. Ofstie's Curtiss suffered a sheared magneto shaft, and the naval pilot made a forced landing in the middle of the bay. Cuddihy, in the second Navy racer, was also experiencing problems with the new V-1400 engine. For several laps he had noticed the engine temperature climbing ominously, but he had grimly held on in second place. But on the seventh lap, his engine, which had been leaking oil, suddenly seized up and caught fire. Cuddihy doused the fire with an extinguisher and made a hasty landing.

The Gloster was now in second place and, with its Napier Lion engine noted for reliability, was virtually assured of finishing. On the American side, there was concern that Doolittle's engine might not last the race. But Doolittle had already commenced his last lap. Minutes later he crossed the finish line and zoomed high in a victory climb before landing close to the pier.

America's Final Victory

His official speed of 232.57 mph shattered every existing seaplane record—not only for closed-circuit racing but also for all-out straight-line speed. Broad finished second, thirty-three mph slower, and de Briganti came in third, averaging only 168 mph.

Doolittle was elevated to the status of national hero. He had saved face for the Navy in a thrilling fashion. The Navy's chagrin at being beaten by the Army in their traditional preserve was no doubt tempered by the knowledge that the British had placed second.

Only when viewed in light of Doolittle's victory does America's sporting decision to cancel the 1924 competition become fully apparent. Had they simply overflown the course at a safe speed they would have achieved three successive victories. Under the rules of the trophy, Doolittle's 1925 win would have given America permanent possession of Schneider's exotic winged woman of speed.

Nevertheless, there was still 1926. However, with no funds for new racing aircraft, and with the government decreeing that 1926 would be the last year of Schneider involvement, this was to be America's final chance to retire the Flying Flirt. Italy's new dictator, Benito Mussolini—keen to advance Fascist prestige, and his own—ordered the race won regardless of cost.

In November 1926, Mario Castoldi's classic M.39 monoplane broke both the Curtiss biplane domination and the American Schneider team's heart. It won the race, averaging 246 mph—fifteen mph faster than the tiring and outdated Curtiss racer that managed to come in in second place.

Italy and England battled for the trophy over the last three races. The great Schneider series finally came to an end in 1931 when a British Supermarine S.6—developed from the 1925 S.4—overflew the course, unchallenged, to give Great Britain three consecutive wins.

High Achievements

Doolittle's flying career became a series of escalating achievements. In 1929, he made what was probably his greatest contribution to the advancement of flying when, as head of the Full Flight Laboratory, he completed the world's first true "blind flight." Frustrated with poor pay and lack of promotion, he resigned from the Army in 1930 and joined the Shell Oil Co. to manage its new Aviation Division. In 1931, he won the Bendix Trophy. The following year, he flew the "killer ship" Gee Bee racer to a world speed record and then blithely flew it round the pylons to win the Thompson Trophy. When asked why he chose to risk his life in the notoriously unstable Gee Bee, Doolittle characteristically replied: "Because it was the fastest thing going."

During World War II, he rose to the rank of lieutenant general, battling—with his legendary determination—both the Axis and General Eisenhower's efforts to keep him out of the air. He finally retired from active service in 1944, returning to Shell as a vice president and director. In 1946, he became the first National President of the newly formed Air Force Association.

In 1975, when asked about America's decision not to hold a 1924 Schneider Trophy Race, General Doolittle pointed out that the subsequent races produced the Rolls-Royce Merlin-powered Supermarine racers that were the forerunners of the Spitfire and Hurricane fighters that won the Battle of Britain. He concluded philosophically:

"Had the Schneider Trophy Races gone out of existence in 1925 by our having won it in 1924 by just flying the course, there would have been no incentive to continue the development of racing planes in England. That is hypothetical, but the fact that there was an incentive had a profound effect on the Battle of Britain, which was won by the superb courage and skill of the RAF flyers and the excellence of their fighters."

Today, in the aviation hall of London's Science Museum, a Spitfire and a Hurricane remind visitors of England's "finest hour." Nearby stands the Supermarine S.6 that gave them life, and between its floats is Jacques Schneider's evocative trophy. The years have not dulled the silver, winged woman as she kisses a zephyr rising from a breaking wave. Sixty years on, she remains the Flying Flirt. America so nearly captured her, but when one sees her surrounded by the machines she inspired, the acuity of Jimmy Doolittle's observation becomes plain.

She could, indeed, have no better home. ■

Terry Gwynn-Jones has served as a fighter pilot with the RAF, the Royal Canadian Air Force, and the Royal Australian Air Force. He is now an Examiner of Airmen in Australia's Department of Transport Aviation. A regular contributor to aviation and travel publications, in 1976 he set a round-the-world speed record for piston-engine aircraft.

MX must overcome perceptions that the concept has changed too often to be credible.

Peacekeeper and the Public

BY JOHN T. CORRELL
EDITOR IN CHIEF

THE MX Peacekeeper program is in trouble, Dr. Albert C. Pierce contends, mainly because the American public perceives it to be a weapon in search of a rationale. Over the course of ten years and four different Presidential administrations, the concept has changed too often to be credible, says Dr. Pierce, NBC News Pentagon correspondent and leadoff panelist at the Aerospace Education Center's Roundtable on MX in late October 1984.

MX, Dr. Pierce said in his opening assessment, "could be a classic example of a failure to articulate over time a clear and consistent rationale for a public policy program." Blame for the woes of MX cannot be heaped on the press and Congress alone. A parade of basing proposals—multiple protective shelters, then "Dense Pack," and now deployment in improved Minuteman silos—led to skepticism, he said. And after years of hearing about the vulnerability of Minuteman in silos, the public doesn't understand why, all at once, silo-based MX is okay.

A Problem of Perceptions

Senior Air Force officers on the panel pointed to the logic of teaming MX with the forthcoming small ICBM in response to two strategic modernization needs: effectiveness against hardened Soviet military assets and survivability of the US ICBM force. Vacillation in strategic modernization objectives, they contend, is more apparent than real.

Maj. Gen. James P. McCarthy, DCS/Plans at Strategic Air Command, acknowledged that, in the days of the mobile MX concept, program advocates talked mostly about survivability—but even then, he said, military effectiveness of the missile was of equal concern. Each year, superhardening of silos puts additional Soviet missiles into the "sanctuary," he said. Minuteman will not be good enough to attack them successfully; MX will be. *(See chart on p. 90.)*

The Reagan Administration ruled out mobile basing of MX in the western United States, investigated closely spaced basing, or Dense Pack, then moved away from that for several reasons—including questions about whether or not US silos could be hardened adequately for it to work—and settled finally on the Scowcroft Commission proposal for a mix of MX and the small ICBM. The small missile will probably be deployed in a mobile mode, which would add to the survivability of the ICBM force. In the short period since Dense Pack was under consideration, dramatic advances have been made in silo-hardening technology, said Maj. Gen. Aloysius G. Casey, Commander of USAF's Ballistic Missile Office.

Congressional staff members on the panel recognized the arguments in favor of MX but reported that the program has several problems, including one of credibility, on Capitol Hill.

The Ninety-eighth Congress left MX in a precarious position. Production of the first twenty-one missiles (out of a planned total of 100) had been approved the previous year, but in 1984 MX ran into strong opposition.

With the debating hard and the voting close, Congress decided to defer its decision on continued MX production until April 1985. MX narrowly escaped outright defeat in the House of Representatives, which made its stand on further production contingent on perceived progress in arms-control negotiations. An unusual stipulation requires that two affirmative votes be cast in each House of Congress, one for authorization and the other for appropriation of funds, and that the

The MX Roundtable was the first program in a new series to be presented by the Aerospace Education Center. Each roundtable will analyze a different aerospace issue of national or international significance.

votes of the two Houses be separated by no more than a day. The number of additional missiles in question—twenty-one—is only half as many as the Administration asked for originally.

The overall impression that emerged from the Roundtable debate is that the future of Peacekeeper depends on public and political opinion and that MX advocates will have an uphill job to convince doubters that the system is needed and strategically viable.

Slippage in Congress

"There was a deterioration of support for the MX missile from the first session of the Ninety-eighth Congress to the second session," said Roundtable participant Alan C. Chase, senior professional staff member of the House Armed Services Committee. Part of the reason, he said, is purely political.

MX is the centerpiece of the President's defense program and a chosen target of the Democratic leadership. Opinions are formed along party lines. The Watergate generation of Democratic congressmen is at the core of opposition to MX, and, in the past ten years, these congressmen have moved into positions of power.

Mr. Chase said that he believes that MX is needed, and so do most members of the House Armed Services Committee, regardless of party. Some congressmen, however, honestly believe that MX would destabilize the world power balance, others doubt that the United States has an urgent need to upgrade its ICBMs, and still others have trouble with the shift in basing modes.

"Consider the plight of the poor congressman who was told, just two years ago when Dense Pack was touted, that we can never harden enough to protect against the incoming missiles, so we've got to place them in a unique scheme to protect them," Mr. Chase said. That congressman will need a lot of convincing between now and April, he said.

Brig. Gen. Gordon E. Fornell, USAF's Special Assistant for ICBM Modernization in the Pentagon, agreed that the MX has taken on a political identity. "Once a program becomes politicized," he said, "it becomes very difficult to draw it back from the political fighting." He had hoped that the Scowcroft Commission report would lead to a consensus and a political normalcy for MX but has now concluded that, once politicization of a program occurs, that will be its lot, unfortunately, for the course of its development and acquisition.

Robert F. Bott, a staff member of the Strategic and Theater Nuclear Forces Subcommittee, Senate Armed Services Committee, said that partisanship has been less of a factor in the Senate—but that the switch-around in basing modes has had a big impact on MX supporters there.

"It really made a profound difference with them," said Mr. Bott, who worked for the Defense Department for eight years before going to the Senate staff. "I think we [in the Pentagon] had done such a good job [of] convincing people that we had a survivability problem and that one of these basing modes would solve it that we completely lost credibility when we got to the point where we were going to put [Peacekeeper] in those silos that we had been downgrading all those years."

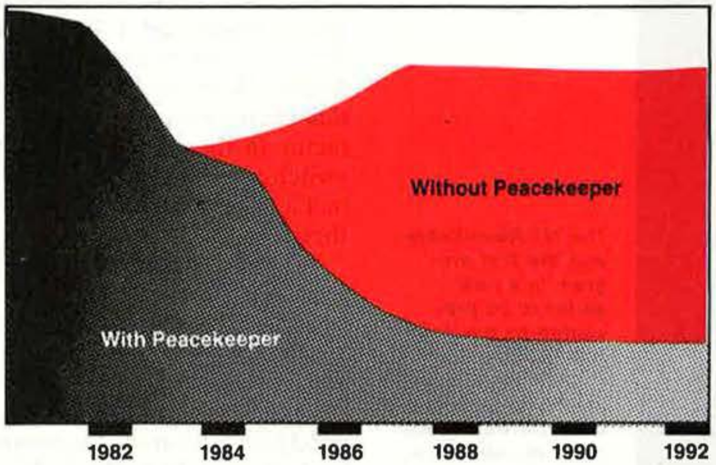
Frustration with lack of progress in arms control—the MX silo option having been depicted as an incentive to bring the Soviets to the bargaining table—is also of considerable importance in the Senate's view of the program, he said.

Progress and Improvements

If MX can clear its congressional hurdles in April, the strategic modernization program will be in good shape, despite the cutbacks. "Eighty-seven percent of the ICBM modernization money we asked for in FY '85 was approved by Congress," General Fornell said. "The fenced money is in procurement only. The research and development activities are on track. Procurement of the first twenty-one missiles is holding our contractual team together, our industrial base for long-lead items, spare parts, and those things necessary for the deployment. We have very high confidence in meeting our initial operating capability in December of 1986."

Six flight tests out of twenty have been completed. "The results are superb—superb accuracy," General Casey said. Preparations are under way for the basing of the first MX missiles in Minuteman III silos at Francis E. Warren AFB, Wyo. And, General Fornell said, the Air

Soviet ICBMs in Sanctuary



The number of Soviet ICBMs based in superhardened silos is increasing, and Minuteman—even with improved accuracy—will not be effective against them. Unless Peacekeeper is fielded to put these hardened silos at risk, the sites become an unassailable sanctuary. This would give the Soviet Union a strategic advantage and the leverage that goes with it.

Force is moving ahead with accelerated development of the small, single-warhead ICBM.

The most telling progress, however, seems to have been in silo-hardening technology.

"We have been pursuing programs with the Defense Nuclear Agency for some time now to determine how hard you can make a structure," General Casey said. "We have found some dramatic things. Structures that are essentially steel with concrete used as interleaving—as opposed to concrete structures knitted together by steel, as you normally see in buildings—have great resiliency. They can take some elastic deformation and still preserve enough of their basic shape to function well for what they're intended to do. . . . I'd be the first to admit that if [warhead] accuracy improves and improves and improves, ultimately the structure loses to the warhead coming in. But with the superhardening technology that we have demonstrated in subscale, we have been able to show that there are structures that could withstand the capability of the Soviet forces today and those projected in the near time."

Mr. Chase predicted that some congressmen will see the hardening advances as relevant news, whereas others will interpret this as still more dithering.

"They've been told in the past that it's almost impossible to harden something enough to make it survive," Mr. Chase said, "that the incoming missile will hit so close that the crater will encompass the silo, and the silo will either be destroyed or tip over to the extent that the missile cannot be launched out of it." Dr. Pierce added that the public probably won't understand the hardness development—and may not readily take the Air Force's word for it, either.

"On technical matters, I think the public is willing to defer to technical experts," Dr. Pierce said. "They are willing to listen to the expert community so long as the expert community doesn't all of a sudden take gigantic leaps which seem to contradict what they have been saying for long periods of time. People's minds aren't that agile—I know mine isn't."

Pressed by others on the panel, Dr. Pierce said that people do not require absolute consistency on every detail forever. They do understand that the world and technology change. But, he said, the jump from "ten years of argumentation saying that fixed silos are vulnerable to all of a sudden saying, 'Let's put this new, powerful missile in fixed silos; we don't have to worry about that so much, at least for several years'—that takes a flexibility that maybe Mary Lou Retton has—but I don't."

Why Not Minuteman?

In response to a question from the audience, General Casey said that an improved Minuteman missile would not be a worthwhile alternative to MX.

"In fact, you could improve the accuracy of Minuteman," he said. "We looked at installing the advanced inertial reference sphere, which is the heart of MX accuracy, in Minuteman. It turns out that it is quite expensive to do that. Today, we are recycling the third-stage rocket motor in Minuteman III and have plans to do the same with the second stage. You're talking about a booster that's already seen its service. Were you to put this magnificent, accurate, inertial reference sphere in Minuteman, it would cost you a lot of money and you'd end up with, essentially, an out-of-date booster and still not have done the first thing about all the other associated electronics."

General McCarthy said that, while there may be some justice in the criticism that the Air Force seemed to be changing its mind as it went along, there has been absolute consistency in the position that a new ICBM is needed.

Over the years, the United States has not hardened its silos, and it has not kept pace with the Soviet Union on new ICBMs. The result is that Soviet silos have gotten harder, making older US missiles less effective against them. At the same time, Soviet missiles have become more accurate, posing a greater risk to unimproved US silos.

The result, if the balance is not corrected, will be that the Soviet Union will eventually have a commanding advantage and the strategic leverage that goes with it.

"By knowing that we have little capability against them while they have great capability against us, they are deterred the less," General McCarthy said. "In the future, they must see that their attack on our silos will result in an attack on their silos that is equal, if not greater, in its effectiveness." ■

The Military Imperatives In Space

Increasing militarization of space seems inevitable, although the US wants to avoid an arms race in that medium.

BY EDGAR ULSAMER
SENIOR EDITOR (POLICY & TECHNOLOGY)

THE central importance of military space systems is their unique ability to help aircraft, missiles, and "the troops in the trenches" put the "right amount of firepower in the right place at the right time," Gen. Robert T. Herres, Commander of the Air Force Space Command, stressed in his keynote address at the Air Force Association's national symposium on "The Military Imperatives in Space."

The country's national security, he stressed before the AFA meeting held in Colorado Springs, Colo., on November 1–2, 1984, "depends on the high-tech edge of our space systems" to such an extent that adversaries soon won't be able to contemplate engaging US military forces without "holding at risk" this nation's space assets. This "sobering" logic makes increasing militarization of space inevitable, even though the US wants to avoid an arms race in this medium.

Air Force Under Secretary Edward C. Aldridge struck a similar chord when he rejected the notion of a "sinister" Pentagon plot to step up the militarization of space, asking rhetorically, "Should we give up our capability to verify arms treaties? Should we do away with our ability to gain early warning and thus greatly increase the risk of being surprised in any future conflict?"

Similarly, the US can no more afford to give up the command control and communications capabilities derived from military space systems than it can the weather-forecasting capabilities derived from such systems, Secretary Aldridge suggested. Nor—in the absence of countervailing capabilities—can the US allow the Soviets to maintain ASAT weapons capable of eliminating this country's military space systems. "Can we really do away with our ability to negate enemy satellites used in the support of targeting our forces?" he asked.

The myths about the military in space are more damaging than the realities of military space activities, he stressed, adding that "the military has used space, and will continue to use space, to prevent future conflict. But if a conflict occurs, we can use our space systems to multiply the effectiveness of all of our forces. We can use space to offset the advantage of a numerically superior enemy." To curtail the benefits national security derives from space systems, he stressed, "would be a truly sinister act against our country."

Two national security imperatives ensue from the vast and growing importance of US military space assets, according to General Herres. The country's technological edge in space must be maintained, and the employment of space assets must be streamlined.

Exploiting Technological Opportunities

Assistant Secretary of Defense (Research and Technology) and Director of the Defense Advanced Research Projects Agency (DARPA) Dr. Robert S. Cooper cited an array of near-term technological opportunities potentially capable of revolutionizing military space capabilities but kept in limbo or stymied by the Pentagon's tendency to deal with advanced technology in a "piecemeal" and ultraconservative fashion. US space capabilities, as a result, he charged, are shortchanged at times by the use of "retarded technologies" and constrained

VIEWPOINT

From Potsdam to Geneva

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

We Americans are no longer the innocents abroad we were in 1945—but neither do we have the immense power advantage we had in those days.

It is more difficult to visit Potsdam than the sham tourist trap of East Berlin, but the visit is more rewarding. The gray old city, for all its Communist shabbiness, has a certain style. Best of all, there is Sans Souci, Frederick the Great's jewel of a summer palace. Meanwhile, a visitor is constantly reminded of the Russians. Potsdam, unlike East Berlin, is a garrison town with Soviet tanks, Soviet trucks, and sleazy-looking barracks, all as evidence of the Red Army's presence.

A good place for lunch is the Cecilienhof, a latter-day Hohenzollern dwelling. It was the scene of the 1945 Potsdam Conference, and the rooms used by the various delegations—Soviet, British, and US—have been preserved as they were for that occasion. Americans were innocents abroad in 1945, and the events that took place at the Cecilienhof during those few weeks in July were shaped by that innocence.

Harry Truman, with scarcely three months of on-the-job training as President, came to Potsdam with a self-confidence befitting the leader of the new, and unravaged, world power. Besides, the first nuclear bomb was about to go off in the New Mexican desert, which would make Truman, indisputably, the world's most powerful figure. Nevertheless, there was a certain innocence in Truman's and, for that matter, in Churchill's attitude toward Stalin. Good old Uncle Joe had not yet been unmasked as a monster, and the public, like its leaders, looked on him as a crafty but genial ally. We can only guess at what a humiliation Stalin would have made of the Potsdam Agreement had that July nuclear explosion taken place in Siberia instead of in New Mexico.

As an insight into the USSR's regard for its allies, as well as for the truth, there is a corridor in that Cecilienhof that tells the story of World War II, Moscow version. The United States, it appears, had little to do with the outcome of that war, other than to inflict indiscriminate bomb damage on German cities. The ruins of Dresden are pictured without an explanation that the attack, however misguided, was carried out with great reluctance and only at Russian insistence.

Even though it took awhile before it sank in, the Potsdam meeting was a grand disillusionment, the first real indication that the Soviets were not only strange allies but a potential future enemy. The gathering at the Cecilienhof was simply a brief interlude between World War II and the Cold War. The agreements reached during those few weeks in July were systematically broken or ignored in the years that followed, except for some of those having to do with seemingly unimportant military arrangements. Thanks to them, the air corridors to Berlin exist to this day, and so does West Berlin.

Security precautions along the frontier defining the "Soviet sphere of influence"—a Potsdam conference phrase—are those of a maximum security prison. The guard towers, barriers, gunboats, and other such paraphernalia are, as at any prison, for the purpose of keeping people in, not to repel intruders. It is a strange world behind those barricades, a world of inmates and their keepers. The inmates, to be sure, have certain privileges so long as they don't try to escape.

These are the people—the keepers, that is—who will once again sit down with our side to debate the business of arms control. While we are no longer the ingenuous provincials who turned up at Potsdam, neither do we have the immense power advantage the United States had in those days. Even though the US was demobilized and essentially defenseless from a conventional standpoint, President Truman had the unanswerable threat of a B-29 with a nuclear weapon aboard to warn off interference with the Berlin Airlift.

Today, the issues to be faced in Geneva are infinitely more complex. Pershing IIs are deployed in Germany, the cruise missiles to Greenham Common and Sicily. Diehard protest movements, like that of the grubby females outside Greenham Common, still carry on, but their clamor has subsided. NATO's nuclear modernization is a fact. So is the Soviet answer, a threat to deploy SS-20s to Czechoslovakia and Hungary in addition to those already aimed at Western Europe.

When the arms-control talks get under way, there will doubtless be strong pressures and much talk about removing the missiles from Europe, especially the Pershing IIs, in return for some Soviet concession. This nuclear modernization has apparently stirred the Soviets more than anything NATO has done in all its thirty-five years. But short of a Soviet agreement to meaningful on-the-spot verification, it is hard to see how our side could accept a NATO missile cutback.

From a purely military standpoint, the Pershing and cruise missiles make no particular sense, any more than do nuclear weapons in general. It is unlikely, for instance, that NATO-based missiles could be used without engaging the whole nuclear arsenal on both sides. However, these weapons based in Europe, American-owned and -manned, are visible evidence that we consider European and American security inextricably linked.

Lord Carrington, NATO Secretary General and a man with no illusions about the Soviets, has dismissed the idea of a nonnuclear strategy, saying there is no earthly reason to believe the Soviets would give up nuclear weapons. "We would be left," he said, "without the means to deter a nuclear attack or to counter nuclear blackmail."

That is a good thing to remember in Geneva. ■

by the deleterious influences of the "bean-counters."

Space-based radar, Dr. Cooper told the meeting, is a prime example of this technological retardation: "Over the past fifteen years, we have tried to define the role of space radar in fits and starts [and have] used every imaginable reason that we can think of to avoid prosecuting radar in space to its logical conclusion." This technology has come to a point where the resultant capabilities "will be startling and unavoidable in terms of military utility." The utility encompasses a "variety of applications that could multiply the capabilities of our military forces throughout the world."

Expressing amazement that "this technology is as far along as it is without ever having been tested in space," he pointed out that "if the Soviet Union is pursuing low-observable, 'Stealth' technology as rapidly as we are," the value of space-based radar for some key missions may well be lost before a US system can be deployed. The Soviets, Dr. Cooper pointed out, seem to be able to infuse such new technologies into their forces "more rapidly than we can, although they are not able to bring

atives

to readiness new technology as fast as we are. They wait until we apply and confirm [new technologies] and then infuse them very fast."

DARPA, Dr. Cooper said, in concert with the military services, pioneered "monolithic microwave transmitter/receiver modules [with the dimensions] of a large postage stamp" that generate about ten watts each and incorporate the phase shifters required for the transmitter modules. These integrated circuits can be made either from silicon or gallium arsenide materials and provide the basis for very large power aperture phased-array radar systems. Over the past few years, the US has not only developed the capability to build gallium arsenide integrated circuits that withstand nuclear weapons effects to an unprecedented degree but has also started up pilot lines in a number of places "that could produce the material and the monolithic circuits in large quantities," according to the DARPA head. A moderately sized space-based radar system, he told the AFA meeting, would require about 10,000 elements, each radiating about ten watts, for a peak power of 100 kilowatts, or about fifteen kilowatts of average sustained power.

The technology to array these modules in large space structures—about forty meters in overall dimension—is in hand, according to Dr. Cooper. The beam width of such a space-based radar will be about five milliradians, or about one-third of a degree. The power requirement of such a system, assuming a conversion efficiency of thirty percent, the DARPA Director suggested, would be about fifty kilowatts. If, in turn, a power source with such an output is available, "it would mean we could operate [the system] in low orbit" on an around-the-clock basis and without regard to weather conditions. The SP-100 Nuclear Power Generator Program assigned to the Strategic Defense Initiative Organization (SDIO), Dr. Cooper said, can be expected to "produce a space-qualifiable 100-kilowatt output by about 1989." This program, he stressed, is well funded and progressing on schedule.

Combined with MHD (magnetohydrodynamics, an

DARPA's Cooper says the Pentagon has been ultraconservative in its application of advanced space technology.

advanced technology that transmutes energy into usable power with little waste), a space-qualifiable nuclear power generator with a nominal output of about one thermal megawatt should provide several hundred kilowatts of steady power. Several companies are working "diligently" on SP-100, he said, adding that "next summer we plan to pick a winner [from among the competing aerospace companies who then] will build a prototype system that will be space-qualified—but operated on the ground—with an electric output from between 100 to 300 kilowatts." Beyond this program—which SDIO manages for the Defense Department, the Department of Energy, and NASA—there are tentative plans to move toward space-qualified nuclear power generators with an output of tens or even hundreds of megawatts of usable power, Dr. Cooper told the AFA symposium.

Two specific problems affect development of such large nuclear power generators. For one, such systems don't lend themselves to straightforward scale-up and require separate designs for various power levels. Even more importantly, nuclear power in space poses political and sociological problems. Even the relatively low-powered SP-100 program is burdened by the incubus of a technical failure that might cause radioactive materials to shower down on earth. In recognition of public apprehension, the SP-100 uses a nuclear reactor rather than radioisotope technology. There is no way to "turn off a radioisotope because it is hot all the time. Also, it is hard to handle on the ground, during the system's transition to space, and in space," according to Dr. Cooper.

Large nuclear generators in space might put out hundreds of megawatts of usable power.

Turned On at Orbital Altitude

Reactors, on the other hand, can be kept at an inert status until they are fully assembled. The SP-100 reactor, therefore, will be kept disassembled until it gets into space. The nuclear powerplant would be assembled and made to go "critical," meaning turned on, only after the system has reached a safe orbital altitude well outside the earth's atmosphere, "without the chance of accidental reentry," according to Dr. Cooper.

Space-based nuclear power sources, he pointed out, are essential for a number of applications beyond space-based radar. NASA's manned, permanent space station, scheduled for deployment in the 1990s, as well as such space-based directed-energy weapons as lasers and neutral particle beam devices appear to be dependent on nuclear generators.

Space-based radar and complementary infrared detection technology could lead to advanced standoff systems.

Another major challenge associated with building a space-based radar system ensues from the fact that such a system has to look down on the earth and the various forms of natural and man-made energy emissions known as clutter. As Dr. Cooper pointed out, "Every range gate [of the system] has some earth return in it, albeit at a different Doppler [shift, a function of relative speed between the observed object and the sensor] from the target." The critical technical problem, then, is to filter out by computational means the clutter that is stationary and thereby "enable a space-based radar to see the Backfires, the Blackjacks, and, yes, the cruise missiles, and, yes, even the stealthy cruise missiles that don't have cross sections lower than minus thirty-five dB/sm [decibels per square meter]."

Acknowledging that attaining such high resolution is a "tough job," he expressed confidence, nevertheless, that this requirement can be met with technologies now in hand or under development. Two relevant multiprocessor architecture programs are under way—one under Air Force and the other under DARPA aegis.

The program handled by his agency, Dr. Cooper said, is called Advanced Onboard Signal Processing and aims at an all-gallium arsenide multiprocessor system that "will run in the 300-mega-operations-per-second range with a thirty-two-bit word." Terming this design a fantastic computer dramatically beyond anything the US has put into space so far, he said the system, by dint of its gallium arsenide technology, is about one hundred times more resistant to nuclear effects than silicon-based designs.

A Host of Applications

As the Defense Science Board pointed out in a recent study, development of a space-based radar system—because of the pervasive military utility of such a system—should proceed on a step-by-step basis in spite of technical and political pitfalls. Potential applications include augmentation of existing or planned ballistic missile warning and attack assessment systems, such as the BMEWS (Ballistic Missile Early Warning System) North Warning Upgrade, and naval battle group defense, ocean surveillance, and over-the-horizon targeting of various advanced standoff weapons.

Without derogating its potential, another speaker at the AFA symposium, Air Force Systems Command (AFSC) Commander Gen. Lawrence A. Skantze, cautioned against impetuous pursuit of space-based radar. Not only might the cost of putting three or four of these systems into space reach $15 billion, but, because they will by necessity be very large, the enemy will be able to find and presumably destroy them easily. Also, if the Air Force and the Navy were to invest in such a space-based radar network, they would probably have to give up a number of existing programs, such as, in the case of the Air Force, the ground-based OTH-B warning system and the North Warning Upgrade.

"We always tend to be forced toward single point solutions," General Skantze suggested. Commodore Richard L. Truly, the Commander of the Naval Space Command, told the AFA meeting that space-based radar is essential for ocean surveillance, but acknowledged that even though the Navy, about twenty years ago, tried to build such a system then "known as Clipper Bow, interservice fights, disagreements over technical directions, and cost" caused this and other subsequent efforts to be scuttled.

Dr. Cooper treated space-based radar and complementary infrared detection technologies as steppingstones for advanced standoff systems: "Long-range smart standoff missilery will be coming on the scene with a vengeance over the next ten years. The single Achilles' heel [of such comprehensive systems or concepts as 'Assault Breaker,' 'Counter Air '90,' and 'Deep Strike'] has been the absence of targeting systems." The US, he emphasized, lacks adequate over-the-horizon targeting systems, and "we have an inadequate effort to redress this problem. We might wind up with long-range standoff systems without any ability to acquire" essential targets in real time.

Even though the Air Force and the Navy, through their respective Secretaries, proposed formally last year a joint development program for a space-based radar system—and even volunteered a specific funding approach—the Defense Resources Board subsequently turned thumbs down on this joint proposal, Dr. Cooper told the AFA meeting. The judgment of the Board, the senior decision-making body of the Defense Department, was that the proposal by the two services centered on the use of older, established technologies—which meant that the system would have had "difficulty seeing advanced, mainly small targets"—and that, therefore, more advanced technologies should be brought into play.

At the same time, the Board felt that some of these advanced technologies required further study and effort, with the result that the "bean-counters" cut the program's funding. Dr. Cooper predicted that some reprogramming of funds would occur this year to supplement DARPA's "substantial" investments in this area.

He and other speakers at the AFA symposium predicted that the R&D effort on space-based radar would be continued to support a decision on full-scale development in about two years.

The Challenge of Teal Ruby

Sometime next year, the Space Shuttle, flying from Vandenberg AFB, Calif., will put into orbit the Teal Ruby "staring" infrared experimental satellite that is expected to usher in a new era in space-based target detection and tracking. Teal Ruby, Dr. Cooper explained, is a staring array that has more than 350,000 elements in its focal plane and that differs dramatically from the currently used "scanning" sensors, such as those on the Defense Support Program's Early Warning Satellites. The latter technology has trouble looking at the earth's natural clutter and various reflections and telling them apart from real targets, or, as he put it, "figuring out which twin has the Toni." Staring arrays of the Teal Ruby type, he said, "overcome this problem and give us the opportunity to [develop] low earth-orbiting systems that can actually search for, detect, and track" other satellites, objects in the atmosphere (including cruise missiles), ships at sea, and "hot objects" on the battlefield.

Teal Ruby "staring" arrays may bring a new era in target detection and tracking.

The Teal Ruby technology, the DARPA Director said, is maturing to a point where in about two or three years "we should be able to design [operational systems] and peg their costs with an error range of no more than twenty percent." This technology is becoming "manufacturable" so that the staring array elements could be produced on an economical basis in the 1,000,000 to 10,000,000 range. In the case of a 1,000,000-element array, it would be possible to search an area of fifty square kilometers in a second with a "resolution of about seven linear meters. This [in turn] allows [it] to search an area of about 180,000 square kilometers per hour, which represents a substantial fraction of the ground track observable from a satellite orbiting around the earth at an altitude of between 500 and 700 kilometers."

In a step beyond the Teal Ruby technology, which relies on silicon arrays and, hence, requires cryogenic cooling systems that are long-lived, DARPA is exploring new materials, such as mercury-cadmium-telluride, that are easier to manufacture and that require less cooling. A technical challenge associated with such advanced staring infrared detection systems is the computational capacity to deal with all the information that is being produced by the million-plus elements of the system. In spite of the technical challenges associated with building an operational staring IR satellite, he predicted that, "within the next two years, we expect to have mastered all the uncertainties so that we can apply this technology."

Tactical ballistic missile warning and attack assessment capabilities would gain vastly from large-scale staring array technology, as compared with the capabilities of the present generation of DSP satellites, Dr. Cooper pointed out. So, of course, would CONUS and theater air defense.

The funding approach to the $450 million-plus Teal Ruby program epitomized the services' "technological conservatism" that, although "bad elsewhere, is most pronounced" with regard to space systems, Dr. Cooper complained. "It was wrong," he stressed, that DARPA had to fund the entire program as an applied research—defined in Pentagonese as a 6.2—project, "without any service money."

The Prospects for Space Laser Weapons

About five years ago, a blue-ribbon panel of experts conducted an in-depth Defense Science Board status study of space-based laser weapons and "concluded that IR [infrared] lasers were probably not in the cards for [ballistic missile defense] applications." That conclusion, Dr. Cooper told the AFA meeting, "continues to be relevant." But the same panel also concluded that a space-based laser weapon operating with an output of ten megawatts and an aperture of ten meters, combined with a jitter stability of about thirty nanoradians, has the potential to serve as "an ideal system for attacking high-flying aircraft from space. As a matter of fact, long-range aircraft could be placed at risk virtually anywhere above the surface of the earth if you knew where they were and could target them with other systems from space," such as radar and Teal Ruby-type staring arrays. DARPA and other elements of the Defense Department have been working this technology vigorously over the past few years. Oversight of this technology has now been assigned to SDIO.

Laser technology of this type, Dr. Cooper suggested, probably could be ready for operational application in about ten years. Such capabilities would automatically make possible a "devastating ASAT weapon in space" and have a substantial, ancillary role in strategic and theater air defense, according to the DARPA Director.

Dr. Angelo Codevilla, a senior professional staff member of the Senate Select Committee on Intelligence, told the AFA symposium that the Soviet Union plans to launch a "probe to Mars that will carry a laser device—not a weapon, as they say—with [a power output of] between 100 kilowatts and one megawatt. Five will get you ten that it will not get out of earth orbit and that it will turn out to be a very potent laser weapon."

The Defense Department, on the other hand, he charged, has seen fit to reduce drastically its level of effort in space-based laser R&D by sharply curtailing the so-called laser triad that consisted of three interrelated programs called Alpha, Talon Gold, and Lode. The Alpha laser, he said, was scaled down to a two-megawatt device from the originally scheduled level of five to ten megawatts, and Talon Gold, the steering and tracking experiment, was truncated by dropping one of the two telescopes—the one operating in the infrared regime—scheduled to be carried forward by the experiment.

While the view is widely held that space-based laser weaponry should only be thought of in relation to strategic defense, Dr. Cooper pointed at the "interesting fact that virtually none of the technologies being worked in our research program is clearly applicable to ballistic missile defense." The US laser weapon effort has so far focused mainly on chemical IR lasers operating in the three-micron band and is "almost surely not applicable to ABM in its most difficult incarnation—that is, [intercepting from several thousand kilometers away] ICBMs rising from the USSR." This fact notwithstanding, "there is in my view a place for IR lasers—in defense of the CONUS [against air-breathing threats] and of naval battle groups," two missions that are not being met well because they require either forces so massive that present budget levels can't support them or "wild infusions of advanced technologies of the kind foreseen for strategic defense. There is a real opportunity to press forward with [IR laser] technology and to prove it out through feasibility demonstrations in either one or both of these areas," according to the DARPA Director.

The Survivability Challenge

The potential threat of Soviet laser weapons to US satellites has caused DARPA and other Pentagon elements to launch a major initiative aimed at hardening spacecraft against attack and interference by directed-energy weapons. Overall direction over this hardening effort has been assigned to SDIO, according to Dr. Cooper. DARPA, specifically, has pursued "this subject as a basic research [effort], looking at what it takes to hurt material with lasers and what can be done to harden against laser fluences [fluences are the impact of radiant energy over a given unit of time on a given unit of area, usually a square centimeter]." This research showed that, up to certain fixed physical limits, hardening efforts pay off handsomely because the coupling of the laser energy with the target can be "driven down by a substantial degree by certain engineering techniques. There may be energy fluences of tens or hundreds of kilojoules that the material can be made to reject."

Tackling the problem of spacecraft survivability in a broad, generic sense, General Skantze stressed that "space assets have become part of the force structure, just like fighter wings and naval battle groups. If the current focus on a unified Space Command does no more than help us take a cohesive look at the imperative of survivable space assets, it would be worthwhile. We need to come up with an investment strategy to make our space assets survivable, [even though] it's expensive."

Three basic routes toward enhanced spacecraft survivability should be taken, according to the AFSC Commander. For one, passive protection by means of maneuverability, hardening against laser and nuclear effects, and dispensing of decoys must be explored and exploited with greater vigor. Secondly, there is the potential for "active protection, but this entails high costs and conceptually never got off the ground." Lastly, there is the option to put up more robust constellations, including a proliferation of satellites. Such an approach, he explained, involves keeping satellites as "spares" and deploying them in such a way that they can't be taken out easily in a systemic sense, meaning that if the enemy succeeds in destroying some of them, the remaining elements of the space system will continue to function.

The potential Soviet laser threat has led to a major US initiative to harden spacecraft.

By the 1990s, space-based laser communications will be an integral element of military command and control.

One of the principal obstacles to the creation of robust constellations is the high cost of individual satellites: "If there is one thing in space systems development that we are not good at, it's our ability to get costs down." The current philosophy pivots on building satellites one at a time, in handcrafted "Skunk Works" fashion, which tends to drive up both costs and complexity, General Skantze complained.

Some progress is being made in cutting the cost of space systems, General Skantze said, citing specifically the Navstar GPS program. Here the Air Force scored what he called a real breakthrough by changing to a multiyear program arrangement. This, in turn, enabled the contractors to invest in cost-effective modern production technologies. The net result, he said, "was that we were able to bring down the price and thereby put up a more robust constellation." Another important step toward reducing the cost of military spacecraft is to reduce launch cost: "We need to cut the cost of [delivering payloads to geosynchronous orbit] from $20,000 to $5,000 [a pound]. That would be a key to robustness."

Another means to boost the survivability and endurance of space-based communications functions, according to Dr. Cooper, entails the use of low-data-rate digital satellites incorporating DARPA's "packet-switching" technique. Such systems would lead to "literally hundreds of communications nodes in space." By switching data "packets" over multiple paths within ground-based networks, DARPA has already demonstrated the extreme resilience of this approach. The time is here, Dr. Cooper suggested, to take packet switching into space "with inexpensive low-altitude proliferated satellites [to] create hundreds or even thousands of communications nodes that, [by self-organizing] tasking, would be able to move data at low rates with high reliability in a way that is almost impossible to attack and [that is] highly resistant" to electronic countermeasures.

The first operational system to use proliferated satellites as a means to increase survivability is Milstar (Military Strategic and Tactical Relay system), which, according to Dr. Cooper, is proving that such an approach—even at this early developmental state—"makes good sense."

The Promise of Laser Communications

In the summer of 1984, the Defense Department conducted a series of experiments involving the propagation of laser beams generated aboard high-flying aircraft through clouds and through ocean water down to submarines "operating at great depth," Dr. Cooper told the AFA symposium. The power level of these communications lasers was in the eighty-watt range. In the view of the DARPA Director, these experiments validated a technology that is ready for operational application—except for the long lifetimes that such systems require. The laser's longevity must match the lifetime of its space platform, which is about seven years. This equates to about 100 billion pulses over the life of the orbiting laser and "represents a real challenge that [we, however,] believe can be met within two years."

The payoff, he stressed, is that such systems "would give us a virtually foolproof capability to communicate with our submarines anywhere in the world in any kind of water [and] at [a] substantial data rate. Application of this technology to the task of communicating with submerged missile-launching and attack submarines [SSBNs and SSNs, respectively,]" he predicted, will "tip the balance so that people will seriously consider the use of lasers for space communications" for a variety of military missions. Key among these, he suggested, ought to be communication with high-flying reconnaissance aircraft, which is also a mission that "until now has been avoided." He predicted that space-based laser communications will become an integral element of military command and communications by the 1990s.

Artificial intelligence (AI), meaning computational processes that incorporate associative reasoning to resemble the thought processes of the human mind, could have revolutionary impact on future military space operations, according to Dr. Cooper: "AI might make possible satellites that can function for months and years without human intervention. This concept is so daring that it would probably eliminate all those big ground stations and the thousands of people who monitor them." Such an approach, he said, means that "we put the equivalent of a little astronaut [on board the satellite] who can solve and fix problems" on the spot. Complaining that the Pentagon shows little inclination to "move in this direction," he said the tendency is to do "the exact opposite" and rely more and more on vulnerable data links.

Streamlining Space Operations

The common denominator underscored by almost all speakers at the AFA meeting was the need to manage and plan military space functions in a more coherent fashion than is the case now. There was agreement that creation of a unified Space Command—promulgated since then—would further this end. Conversely, the speakers tended to reject the notion of creating an autonomous space force because, as General Herres put it, "It is not easy to draw a dividing line between the atmosphere and space. It is even harder to draw dividing lines between the missions in air and space." Further, "specific military missions don't reside in any specific service but rather in unified or specified commands that answer to the Secretary of Defense and the Joint Chiefs of Staff," he said.

By its very nature, the military space mission tends to be global in scope and predominantly oriented toward the strategic sector. It would be, he stressed, "quite duplicative to form another department [with the responsibility] to organize, train, equip, and provide forces for our CINCs to operate in space." Terming creation of a Department of Space unnecessary and a potential cause of "agonizing overlaps," he stressed that "you would still need a unified command."

The unified Space Command will manage and plan military space functions in a more coherent fashion than is now the case.

Seconding these points, Commodore Truly suggested that a unified Space Command, as supported by the JCS, "will make a major contribution to the structure and effectiveness of joint" space operations and planning and, at the same time, "help in the advocacy of joint space systems."

The Need for a Unified Space Command

In underscoring the need for a unified Space Command, General Herres suggested that "we have to consider the consequences of a great many military space platforms and assets important to the operation of our forces being managed, operated, and deployed by a wide variety of departments and agencies—without single operational direction or focus on their relationship with the operating forces, without a single-threaded operational chain of command running from the Secretary of Defense through the Joint Chiefs of Staff to the operators."

In addition, he warned, "there is no doubt that there will be more [space] systems, their operations will become more complicated, and the interrelationship between these systems, the protection of these systems, and their effect on the combat forces will become more critical and demanding. Perhaps all of this will become a discipline by itself, if it isn't already."

Dr. Cooper predicted that, in addition to a unified Space Command, a special high-powered office for space matters will be set up within OSD, in part because the Joint Chiefs of Staff "show every sign of being interested in a cohesive space approach."

General Skantze pointed out that space operations "are subsumed in other programs, mainly strategic offense and defense, [with the result that their] advocacy is diffused." Stressing that space needs a stronger focus, he said that as yet "the fabric is not in place."

Maj. Gen. John H. Storrie, Director of Space on the Air Staff, told the symposium that a unified Space Com-

US monitoring requirements, for the most part, can be met only with space-based sensor systems.

mand, in peacetime, could "develop plans to support all of the other unified and specified commands [and] ensure [that] their communications, weather, and navigation requirements are met." In wartime, on the other hand, such a unified command "would employ its assigned forces upon direction of the President and National Command Authorities. The unified Space Commander could be responsible for prioritizing operational requirements and resolving conflicts involving space systems. The primary mission during conflict would be to support other warfighting commanders."

All services would contribute to a unified Space Command, he suggested:

- An air component would be responsible for Air Force satellites and Spacetrack sensors and would launch DoD satellites.
- A naval component could be responsible for Navy satellites and the NAVSPASUR tracking system.
- The land component could be responsible for Army test ranges and ground radars and the development of ballistic missile defense.

Intelligence Operations in Space

Although contending that the basic role of intelligence has not changed much in forty centuries of recorded history, there has been an explosive increase in the past few years in the need "to know what the other side is doing," Lt. Gen. Lincoln D. Faurer, Director of the National Security Agency (NSA), told the AFA symposium. Fortunately, this dramatic increase in needed information is being matched by enormous gains in data processing and data transfer. This meteoric rise in processing power—from computer memory chips limited to a few kilobits early in the past decade to the prospect of megabit chips clearly on the horizon—points the way to massive data-processing capabilities on board spacecraft in direct support of the National Command Authorities.

Hand in glove with the explosive growth in processing and transferring data are advances in AI. General Faurer singled out knowledge-based systems, a subset of artificial intelligence, that "appear to offer the capability to provide a uniform base of experience and background information that can be used to rapidly interpret and manage huge quantities of data."

Knowledge-based systems, he suggested, could "assimilate larger and larger volumes of raw, uncorrelated data to enable timely detection and reporting of key events and indicators." In the case of a rapidly evolving crisis situation, for instance, "we cannot afford to have critical indicators overlooked simply because they were hidden in a mass of data, or because a particular duty officer was inexperienced, or because there was no way to quickly infer a sequence of activities when key events in that sequence had been missed by external sensors." Recent work by the intelligence community, he pointed out, demonstrated that AI technology can be brought to bear on the problem of processing, analyzing, and interpreting vast volumes of data in near real time. Attaining such capabilities is crucial, he stressed, because "decision windows in today's world can be measured in minutes and seconds, and we clearly must use all available technology to keep the windows as wide as possible."

Assessment of new strategic weapons is becoming more difficult and expensive and puts extreme pressure "on our capability to devise new ways to monitor Soviet weapons testing," according to the NSA Director. Also, "future weapons may have various basing modes, making it extremely difficult for our monitors to locate all potential launching points and provide timely characterization of their status." With tactical weapons R&D showing a similar fecundity, US monitoring requirements, for the most part, can be met only with space-based sensor systems. Exacerbating the monitoring problem is the seeming inevitability of Third World, possibly unstable, countries entering the ranks of nuclear powers: "If unstable governments and their leaders ever gain access to the incredible weaponry of the twentieth century, then even a good monitoring capability may be inadequate to deal with the threat posed."

Stressing that the Soviets demonstrate through their increasing level of effort that a major part of their military doctrine is to take the high ground of space, General Faurer said that their new space launch boosters are tailored to match and surpass "our Shuttle and manned space program." Warning against underselling their potential to "create their own systems or to mimic whatever we come up with," he pointed out that, in this decade alone, "we have seen them working on a duplicate of the Space Shuttle, and we have read their announcements of what appear to be carbon copies of the Navstar Global Positioning System and our TDRSS data relay satellites."

In a related vein, the NSA Director said that the Soviets will stress antisatellite concepts that hold some promise of countering SDI. They will also emphasize research and development "in the area of cruise missiles, depressed trajectory weapons, or other weapons that might lower the effectiveness of SDI." These developments will further stress the intelligence monitoring mission, even though the intelligence community will probably derive some spinoff advantages from the sensor technology that is being developed for SDI. There is no doubt, General Faurer said, that US monitoring requirements in the future will not only have to focus on Soviet violations of current agreements but will have to be greatly expanded to monitor Soviet efforts to counter the new initiatives in space.

The Soviets, he warned, "have dedicated thousands of their best scientists and engineers to develop what some in the Western world have chosen to call fantasy weapons, the directed-energy weapons that are the foundation of the Strategic Defense Initiative. It may be that, with regard to the SDI weapons technology, it is we, not the Soviets, who have joined the race late." He added that "time and a great deal of collection and analysis stand between us and the answer." ■

VALOR

The Battle of Bunker Hill 10

A veteran Security Police sergeant took over when the officer in charge at the point of attack was killed defending Bien Hoa.

BY JOHN L. FRISBEE

FOR most of 1967, North Vietnam held its—and the Viet Cong's—military operations in the South at a low level in order to accumulate supplies for the massive Tet offensive that was to begin the night of January 30–31, 1968. The goal of the offensive was as much political as military: to shatter the confidence of South Vietnam's citizens in their government and to fuel the fires of antiwar sentiment that burned with increasing intensity in the United States.

A hundred cities and more than twenty air bases were attacked simultaneously by some 84,000 enemy troops in violation of a thirty-six-hour truce for celebration of the Vietnamese New Year. Saigon, the capital of South Vietnam, was a prime target. To capture it, enemy forces had to neutralize the two great air bases—Bien Hoa and Tan Son Nhut—near the city. Two infantry battalions and a reinforced infantry company were assigned the task of penetrating Bien Hoa's defenses and destroying US and VNAF aircraft and facilities. Their carefully planned surprise attack was to follow a heavy barrage of rocket and mortar fire. But surprise was not to be. Gen. William Momyer, Commander of Seventh Air Force, doubted that North Vietnam would honor the truce. All his units were on alert, with outposts reinforced, when the attack on Bien Hoa came.

At 0300 hours on January 31, rockets and mortar shells began to fall on the flight line. SSgt. William Piazza, a member of the 3d Security Police Squadron serving his second volunteer tour in Vietnam, was leader of a resupply team on the north side of the base. As the barrage lifted, the command center radioed a team (Def 6) responsible for the east end of the base, where the infantry attack was concentrated, to reinforce Bunker Hill 10, a large concrete bunker at the east end of the runway. About thirty men commanded by a captain were under attack there and would soon run short of ammunition. The team was stopped by sniper fire before it could reach the bunker.

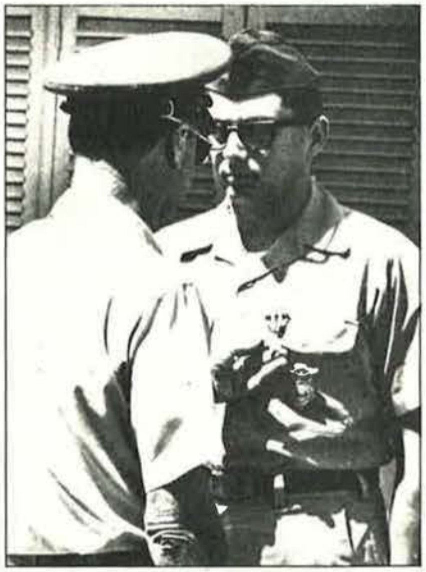
Sergeant Piazza immediately ordered his men to fall back to a safe position. He then picked up the leader of Def 6 and drove his truck, loaded with ammunition, through a curtain of enemy fire to the bunker. A few minutes after he arrived, the enemy again attacked the bunker from three sides with rockets, automatic weapons, and small arms. Piazza climbed out of the bunker and returned fire with a 40-mm grenade launcher until very close support fire from a helicopter gunship forced him back inside. There he discovered that the captain in command had been killed. Piazza assumed command of the defending force as "all hell broke loose, and Control could not get anyone on the radio."

As the night wore on, a C-47 Spooky gunship that had lighted the area, enabling Piazza to direct fire from the bunker, apparently ran out of flares. Sergeant Piazza again left the shelter of the bunker to light the area with hand flares. He continued to direct the defense until Army reinforcements arrived after daylight. Then, after the wounded had been evacuated from the bunker, Piazza and four other men remained until evening without food, water, or reinforcements, spotting targets for the Army troops and providing supporting fire. When the east end of the base had been cleared, 139 enemy lay dead and twenty-five had been captured.

Although several aircraft were destroyed or damaged by rockets, enemy infantry and sappers never penetrated the base beyond Bunker Hill 10. The citation for the Silver Star presented to Sergeant Piazza by General Momyer summed it up: "An untold number of lives and literally hundreds of millions of dollars of aircraft and other materiel had been saved" through the gallant defense of the base, led at Bunker Hill 10 by Sergeant Piazza.

The Tet offensive was soundly defeated at Bien Hoa and throughout South Vietnam. Of the 84,000 enemy troops thrown into that failed gamble, some 45,000 are believed to have been killed and another 24,000 wounded. It was not, as some journalists of that day reported, a military defeat for the US and South Vietnam. The negative political repercussion of those reports in this country is another story.

SSgt. William Piazza, one of the heroes of Tet, volunteered for a third tour of duty in Vietnam. Today he is a master sergeant stationed at Robins AFB, Ga. ■



Seventh Air Force Commander Gen. William Momyer pins on the Silver Star awarded to SSgt. William Piazza.

THE BULLETIN BOARD

By James A. McDonnell, Jr., MILITARY RELATIONS EDITOR

Recruiting Goals Met

Whatever success the Air Force Recruiting Service enjoys in 1985, it will be tough to beat the year just past.

Brig. Gen. Robert L. Rutherford, Recruiting Service Commander, put it this way: "Fiscal Year 1984 was the best Air Force Recruiting Service has had in its thirty-year history. Not only did we make all our enlisted and officer program goals, but we achieved them with the highest quality ever."

How good was it? All seventeen "people category" programs exceeded or met a hundred percent fulfillment rate, including—for only the second time in Recruiting Service history—the extremely difficult-to-attain physician goal.

In the nonprior-service category, almost 60,000 people took the oath of enlistment, and about 1,000 prior-service veterans returned. Officer Training School attracted 2,686 college graduates, and 1,013 health-care professionals received direct commissions in the Medical Service. Another 346 potential officers received health professions scholarships.

The quality of the new entrants was, by any standard, excellent. OTS arrivals came with an average GPA of 3.12 and scored in the upper thirty percent on their Officer Qualifying Tests. Almost ninety-nine percent of the nonprior-service enlistees were high-school graduates.

Who signed them up? People like the recently-recognized "best recruiters" for 1984. People like TSgt. Arthur Baca, for one, who was named the Top Air Force Recruiter. Working out of his home town of Albuquerque, N. M., Sergeant Baca's productivity zoomed off the charts. For example, tasked with signing up forty-nine nonprior-service recruits, he enlisted an even 100, for a whopping 204 percent. Likewise, he brought on board 600 percent of his goal for prior-service people and 350 percent of the OTS objective. As a Recruiting Service spokesman told AIR FORCE Magazine in enumerating the 12,000 pieces of mail sent out, forty-two speeches delivered, and 212 school visits made, Sergeant Baca "is exactly the type of person who makes the Recruiting Service go."

Then, there's the Top Rookie Recruiter. The 1984 honors went to SSgt. Kathryn Rath, who's stationed in Milwaukee, Wis. She also racked up more than 200 percent of her nonprior-service objective and 300 percent of the prior-service goal. The Brooklyn native is the first woman recruiter to win one of these annual awards. She serves eight Milwaukee high schools and says, "I have great rapport with the counselors, and quite often I'm asked by teachers to visit classes and talk about Air Force opportunities. Interest in the Air Force here is high."

Sergeants Baca and Rath, along with the other twenty individual and group winners of "top" awards, certainly hope the interest continues. This year's goals get tougher. During 1985, recruiters must find about 71,200 people in all programs as volunteers for today's high-technology Air Force.

Jobs for Veterans Stressed

AFA, along with other veterans groups, was on hand as the Washington, D. C., ceremonies surrounding Veterans Day kicked off with the Third Annual Salute to All American Veterans, hosted by the US Department of Labor.

Sen. Strom Thurmond (R-S. C.), a combat veteran of the World War II Normandy invasion, was the featured speaker. Senator Thurmond, Under Secretary of Labor Ford B. Ford, and other speakers emphasized that an important way of acknowledging veterans is to ensure that they have the opportunity to return to meaningful civilian employment.

Mr. Ford told the audience, which included members of Congress, federal officials, and leaders of national veterans organizations, that veterans "deserve the best that the employment and training community can provide them." He announced the details of a new Labor Department initiative to seek a dramatic ten-percent increase in the number of veterans placed in jobs during the next six months as compared with a similar six-month period last year.

The goal of this new "Jobs for Veterans" plan is to achieve almost a quarter of a million individual veteran job placements. The Department has asked each of the states to establish a similar initiative in the hope that these tandem efforts will be mutually reinforcing.

Dr. Lenora Cole Alexander, Director of the Labor Department's Women's Bureau, delivered a special salute to the nation's women veterans. "Women enter military service for the same reason men do . . . to protect the lives and the way of life that we enjoy as Americans." She noted that a new project at the Labor Department will examine the types of employment and training services needed specifically by women veterans and how well their military skills transfer to the civilian economy.

In closing, she praised the recent Congressional Resolution, signed by President Reagan, that had declared November 11–17, 1984, as "National Women Veterans Recognition Week."

Bernice Haydu, a former member of the World War II Women's Airforce Service Pilots (WASP), spoke briefly about the service of the WASP in ferrying aircraft and towing target sleeves. *(For more on the WASP, see the April '77 issue of* AIR FORCE *Magazine, pp. 76, 78, and 144.)*

New CHAMPUS Boss True Blue

Teresa Hawkes has been named Director of DoD's CHAMPUS program, replacing Dr. Theodore D. Wood, who moves up to become DoD's Deputy Assistant Secretary for Medical Program Management.

The new CHAMPUS leader is an Air Force fledgling. She calls California home and brings to the job a wide range of health and human services experience on both federal and state government levels. She is a former Acting Assistant Secretary for Legislation at the US Department of Health and Human Services, and she also served as Chief of Residential Care Policy for California.

A former high-school teacher, Ms.

Hawkes holds both a B.A. and M.A. in anthropology from California State University in Sacramento.

Change in Former Military Spouse Benefits

Beginning this month, a new slate of benefits for former military spouses will go into effect. Existing laws and effective dates of benefits have changed in a manner that has generally been hailed by spouse groups but sometimes roundly condemned by active and retired military members.

The total package can be confusing. Recognizing this, Rep. Les Aspin (D-Wis.) recently prepared an outline of these benefits for his colleagues in the House. Also, in a rare presentation, he offered some insight into the background and philosophy that prompted the congressional lawmakers to consider and pass the changes.

From his perspective as Chairman of the House Subcommittee on Military Personnel and Compensation, Mr. Aspin explained that "for some years we have struggled with the question of what military benefits should appropriately be given to the spouses of military careerists if they are divorced. . . . I had been concerned for some time that we were being asked to react in a philosophical vacuum. Bills to provide benefits to former spouses were gaining cosponsors rapidly because of natural sympathy, but little thought had been given to the military's proper responsibility to the former spouses of its members."

He went on to sketch some of the difficulties involved in trying to balance the rights of spouses with the rights of the military members. He commented that, "for the service member, the key to gaining lifetime rights to military health care and commissaries is completion of twenty years of active-duty service. If that twenty-year barrier was broken, as proposed by the Trible Amendment, we could see no rationale for any other time period. Although fifteen years was the period in the amendment, an earlier draft had spoken of ten years. Why not eight, or five? We felt the twenty-year requirement for access to lifetime benefits was an important one to keep."

USAF TSgt. Kenneth C. Westmoreland, Carney Park Golf Course Manager at Hq. Allied Forces Southern Europe, Naples, Italy, recently won the 1984 Worldwide Interservice Golf Tournament, held in Hawaii, with rounds of 72, 72, 73, and 75 on four different courses.

In the final passage, of course, the legislators did "break the twenty-year barrier" and set fifteen years as the threshold in some cases. As Representative Aspin put it, "The time of divorce is trying, and the military community unique. We felt the institution that fosters an element of dependence owed a helping hand to spouses departing the military family." This especially explains, he said, why the final law offers two transitional years of military medical benefits for those long-term spouses who do not qualify for lifetime benefits.

Additionally, the new legislation recognized that people departing the military face a unique medical insurance problem since the military, unlike civilian employers, provides nonconvertible actual medical care, rather than a convertible insurance policy. This led to the provision requiring DoD to come up with some future program that provides guaranteed insurability for everyone leaving the military community and finds a way for them to convert to a paid civilian health-care plan—including spouses divorced with "far less than fifteen years in the community."

DoD is still studying ways of meeting this health-care requirement.

The military benefits table is below.

Vet Compensation Checks Raised

Effective this month, VA compensation checks to disabled veterans and dependents will include a 3.2 percent boost. This is a result of the package called the Veterans Benefits Improvements Act of 1984 that was signed into law by President Reagan at the tag end of last year.

This means that, for example, a veteran with 100 percent rated disability will see benefits rise from $1,255 to $1,295 per month. Veterans with a fifty percent disability will receive $376 a month, up from $364. In addition, the bill provides the same percentage increase to surviving spouses and children of veterans who died in service or as a result of service-connected causes.

Other provisions of the bill raise housing assistance and automobile assistance grants, hike Vietnam-era GI Bill benefits by ten percent, and extend the preference in federal hiring now offered to certain Vietnam-era and disabled veterans. An unusual and significant feature of the

October 12, 1984 **CONGRESSIONAL RECORD — *Extensions of Remarks*** **E 4543**

MILITARY BENEFITS FOR DIVORCED SPOUSES OF SERVICE PERSONNEL

	Current law [1]	Defense Authorization Act of 1985 [2]			Future law [3]
Applied to those divorced	After Jan. 31, 1983	Anytime	Before April 1, 1985	From April 1, 1985 til new program.	After new program starts up.
Commissary and Exchange	Yes	Yes	No	No	No.
Military medical care and CHAMPUS	Yes	Yes	Yes	Yes	No (guaranteed insurability instead).
Length of coverage	Lifetime	Lifetime after Jan. 1, 1985	Lifetime after Jan. 1, 1985	Two years from date of divorce	Lifetime.
Loss of benefits on remarriage or under employer medical coverage.	Yes	Yes	Yes	Yes	Subject to policy terms.
Notes	This law was prospective only	We made program retroactive	We picked up spouses already divorced with 15–20 years overlap.	We addressed future divorced spouses with 15 to 20 years overlap.	We address future divorced spouses with less than 15 years overlap and develop a universal conversion opportunity.

[1] Qualifications: 20 years service in military, 20 years of marriage, 20 years overlap of military service and marriage.
[2] Qualifications: 20 years service in military, 20 years of marriage, 15 years overlap of military service and marriage.
[3] Qualification: Any brief period.

bill calls for a four-year trial program, beginning next month, during which the VA will test whether vocational rehabilitation training and other techniques can be useful in helping vets now considered unemployable to become better prospective employees.

DoD Improves Homeless Help

Stressing his desire to do more toward aiding the homeless, Secretary of Defense Caspar W. Weinberger announced new measures to beef up DoD's Shelters for the Homeless Program this year. *(For more on DoD's shelter program, see "The Bulletin Board," p. 85, July 1983.)*

Secretary Weinberger has consolidated responsibility for the program with Assistant Secretary of Defense for Manpower, Installations, and Logistics Lawrence J. Korb and has authorized him to send representatives to meet with city officials requesting DoD assistance. "By managing the program this way, I hope to expedite agreements between local officials and base commanders," said Secretary Weinberger.

DoD will also work closely with the Health and Human Services Federal Task Force on the Homeless and the National Citizens' Committee for Food and Shelter. Liaison will be maintained with elected officials and religious and charitable organizations working in this field. Model leases have been provided to local commanders to help them negotiate the sometimes-sticky legal problems involved.

Last year, DoD was given a congressional charter to provide shelters and incidental services for the homeless on its installations. About six shelters were operational by the end of the year. However, some organizations complained that red tape made dealing with the military a tough row to hoe.

Noting that, in his opinion, DoD made a major contribution in 1984, Secretary Weinberger added, "I am hopeful that with the changes we have made, we can accomplish much more."

Religious or charitable organizations that want more information are invited to contact the Federal Task Force at (202) 254-6004.

Short Bursts

Super Bowl XIX viewers will see the Air Force's **"Tops in Blue" show at halftime.** The fifty active-duty participants are the 1984 finalists from the annual worldwide talent competition. The NFL will pay production expenses for the show, the first ever "Tops in Blue" Super Bowl performance. Kickoff is on January 20 at Palo Alto, Calif.

Michael D. Tomsey, a VA vocational counselor in Baltimore, Md., has been named **one of the Ten Outstanding Handicapped Federal Employees of 1984.** A disabled Vietnam combat veteran, he was cited specifically for his active role in assisting hearing-impaired veterans. Mr. Tomsey was AFA's VA Employee of the Year and honored at AFA's National Convention in 1982.

A recent birthday ended the reign of **2d Lt. LaRhonda "Ronnie" Smith** as the **only teen-age Air Force officer.** A project officer at AFSC's Ballistic Missile Office, Norton AFB, Calif., Lieutenant Smith, now twenty, is still **nine months younger than any other officer,** according to Air Force Manpower and Personnel Center officials. A 1984 AFROTC graduate from the University of Miami, which she entered at age fifteen, she earned an electrical engineering degree and dean's list honors.

Named as **best commissaries in the Air Force** for 1984 are those at **England AFB, La.** (best CONUS facility), and **Elmendorf AFB, Alaska** (best overseas).

Twenty-seven **senior Air Force NCOs** have been selected **to attend Army and Navy senior-level professional education courses** this year. Six will train at the Army's Fort Bliss, Tex., Sergeants Major Academy, and twenty-one will sample the "salty" menu at the Navy's Senior Enlisted Academy at Newport, R. I. Ten Army and fifteen Navy top-stripers will attend the Air Force Senior NCO Academy at Gunter AFS, Ala., through the training cycle, which ends in early 1986.

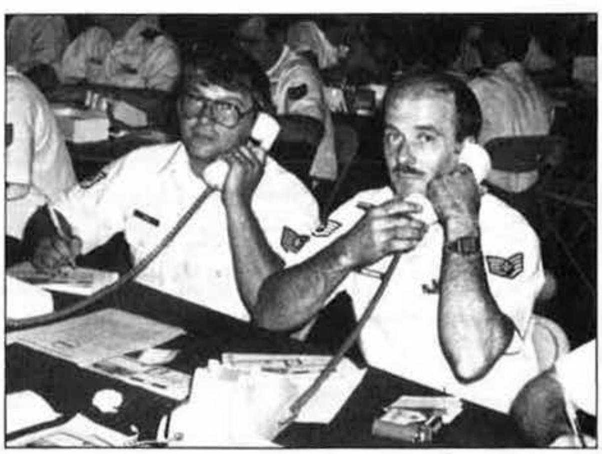
Civil Air Patrol cadets are cheering. New legislation allows the Air Force to furnish **blue uniforms** to the cadets at no charge—a move long sought by CAP to bolster its junior program.

In the past four years, there has been a net increase of about 23,000 full-time federal employees. While many departments took cuts, President Reagan added **some 61,000 civilians to DoD.** Under President Carter, DoD had lost 48,000 civilian positions.

Purple Heart wearers, change your ribbons! Recent legislation has changed the precedence of the award so that it now ranks **immediately below awards for valor.** Sen. John Warner (R-Va.) is credited as the principal legislative sponsor of the action.

Dr. John W. Ditzler, most recently Director of the San Diego VA Medical Center, has been named **Chief Medical Director of the VA.** A board-certified anesthesiologist, Dr. Ditzler has VA experience both in the field and at its headquarters. He's a US Army Medical Corps veteran of both World War II and Korea, has written extensively on his specialty, and has served as president of the American Society of Anesthesiology.

Attention, retirees! Let someone know if you're planning to be out of touch for an extended period. New legislation allows service Secretaries to declare a retiree dead **when missing for at least thirty days.** The purpose is to **expedite Survivor Benefits Program payments.**



Forty-five Air National Guardsmen from the 105th Military Airlift Group, Stewart IAP, Newburgh, N. Y., recently volunteered their off-duty time to answer telephone pledges in support of the Jerry Lewis Muscular Dystrophy Telethon. The fund-raising effort resulted in the largest amount ever pledged to the Telethon in this region.

Senior Staff Changes

PROMOTION: To be **General:** Robert W. **Bazley.**

SENIOR ENLISTED ADVISOR CHANGE: CMSgt. Arthur C. Shelton, to SEA, Hq. AFMPC, Randolph AFB, Tex., replacing retired CMSgt. W. D. "Bud" Humphries. ■

AFA INTERCOM

By Robin L. Whittle, AFA DIRECTOR OF COMMUNICATIONS

Message from the President

Key indicators for the year just concluded point to AFA as a strong, vital organization that is becoming more accomplished in its articulation of national defense concerns and the role aerospace plays in the maintenance of this nation's deterrent posture. You—the volunteer leaders and members in all fifty states and in Europe and the Far East—are working the issues in the grass roots of America and in the foreign capitals of allied nations in positive, innovative ways that are having an impact in communities around the globe.

While Americans have refreshingly waxed patriotic—flushed with pride at our Olympic accomplishments and our victory in Grenada—public support for key strategic modernization programs remains uncertain. We simply must convince more American citizens of the perils we face if we are unprepared.

As this century draws to a close, preparedness will entail an increasingly complex array of emerging technologies—none of which can be made operationally reliable overnight. Their effectiveness in deterring war in the twenty-first century depends on our commitment to develop them today. That commitment must be nurtured and sustained over time by the American people.

Thus, one of my overriding goals for 1985 is the bolstering of our civilian membership base so that our message, our hard work, and our effectiveness make a difference in our defense posture.

As you will see from the staff-written reports that follow, AFA membership is increasing. Our energies must turn to retaining the thousands we've welcomed into our ranks in 1984. Our work in recruiting Life Members has been spectacular. And our efforts in other key areas have been noteworthy.

I am continually amazed by the competence and unswerving dedication of the men and women who proudly wear the AFA pin. They represent the selfless service ethic once thought dead by proponents of the "me generation" philosophy. Quite simply, our Association is blessed with vigorous state and chapter leaders who can attract the future leaders so necessary for AFA's continued growth and prosperity. Our National Vice Presidents and National Directors can be credited with marshaling the talent that is surfacing from our grass-roots structure.

AFA's Aerospace Education Foundation has undergone a metamorphosis that will further the overriding mission of this Association—to educate.

Finally, our beautiful new headquarters building is proof positive of our increasing vitality. We occupy it mindful of all who have gone before and who have contributed just as keenly to our Association's success.

I look forward to working with you in the challenging months ahead.

Martin H. Harris
National President

AFA's Achievements In 1984

Membership

AFA's tremendous growth in membership continued during 1984. Net growth for the year was more than 20,000 members, increasing AFA's total membership to 218,000. All segments of membership (active duty, civilian, Reserve, Guard, and retired) shared in this growth.

Growth in Life Membership over the last several years has been particularly spectacular. This trend continued during 1984 with the addition of nearly 4,500 Life Members.

Geographically, the largest concentrations of members are in California and Texas, which together account for twenty-five percent of total membership. Aside from these two states and Florida and Virginia, no other single state accounts for more than four percent of AFA's total membership. The remaining seventy-five percent of the membership is spread relatively evenly throughout the country.

Field Organizations

As AFA membership increased in 1984, so did the number of field units, now counted, with the addition of Minnesota, at forty-two state organizations and 307 chapters. Most states conducted conventions during the year, ranging in depth from an afternoon session to a three-day meeting with a symposium.

A clear indication of increasingly effective chapter programs in 1984 is the more than 150,000 AFA members who are affiliated with a local unit—the largest number of affiliated members ever. Some of the more creative programs included symposia, effective community/business and internal awards programs, speakers bureaus, and joint meetings with other local groups. Five AFA regions, with national staff support, conducted intensive workshops on internal operations.

Another indicator of increased involvement was the record-breaking delegate turnout at the 1984 National Convention. A total of 417 delegates representing forty-two states and the District of Columbia attended. This momentum was maintained at the Orientation for State Presidents and new Board members held in October at AFA's new National Headquarters building. While in Washington, AFA field leaders were invited to participate in the Aerospace Education Center's roundtable, "Focus on MX Peacekeeper: Key to Strategic Force Modernization." This was in addition to formal staff briefings and the release of two publications by the Field Organizations Department designed to enhance chapter operational effectiveness: a revised *Field Operations Guidebook* and a new *Chapter Operations Guidebook*.

A look ahead shows great promise for an even better 1985. Seven AFA regions (Far West, Midwest, Rocky Mountain, Great Lakes, Northwest, Northeast, and Southwest) have scheduled workshops, and two additional workshops are in the planning stages for the North Central and South Central regions. These intensive training sessions have proven to be measurably successful. Emphasis in the year ahead will be on community outreach, and, in this regard, the Community Partner program has been computerized for better service and utilization. Also, a new promotional brochure has been produced. More AFA gift items for award presentations and personal use will be included in a new catalog to be released in 1985. Gift items will continue to be featured in AIR FORCE Magazine as well.

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On Capitol Hill

AFA provided up-to-the-minute congressional reports to AFA field leaders on the status of key national defense issues on Capitol Hill, particularly in the areas of procurement, defense manpower, and research, development, and acquisition. Liaison with House, Senate, Defense Department, White House, and government agency staffers was maintained and expanded in order to analyze, track, and affect legislative outcomes on critical defense issues in concert with the policy positions adopted by delegates to the AFA National Convention. AFA staff members spent more than eighty days on the Hill monitoring hearings and providing information. As a result, AFA realized forty-two of its personnel policy goals during the second session of the Ninety-eighth Congress.

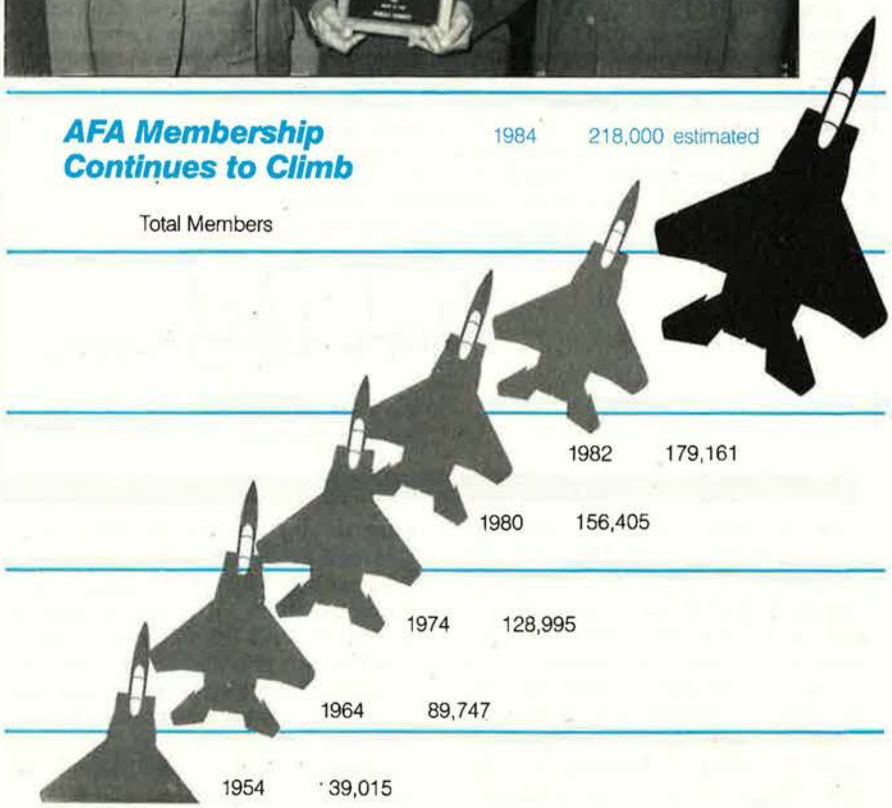
AFA's Salute to Congress, held during the National Convention, attracted 118 congressmen (103 from the House and fifteen from the Senate), ninety-one key staffers, and senior Air Force and DoD officials.

Association Events

In 1984, AFA conducted three national symposia that provided authoritative information on pressing Air Force and national security requirements to AFA members, defense leaders, industry executives, the media, and the general public. Audience reaction and media coverage were strong and positive. AFA maintained an active news room at each event, and the staff arranged interviews to provide even greater exposure. Two of these events were videotaped under AFA auspices, and cassettes were sold to interested participants and marketed to AFA's Industrial Associates and interested contractors.

In addition to the annual symposium in Los Angeles, Calif.—held in November under the title: "The US Air Force Today and Tomorrow"—AFA, for the third consecutive year, sponsored a symposium on "Electronics and the Air Force" in cooperation with Air Force Systems Command's Electronic Systems Division. The symposium was held in April in Boston, Mass. New in 1984 was the addition of a national symposium in Colorado Springs on "The Military Imperatives in Space." This event attracted a sellout crowd and generated extensive publicity for the topic and for AFA. (See also p. 92.)

During the California State AFA Convention in August, David Graham, left, was reelected State President, and Donald F. Flaherty, center, was presented the California AFA "Man of the Year" Award by Convention keynote speaker Philip Merrill, counselor to the Under Secretary of Defense for Policy. A majority of AFA's forty-two state organizations held conventions during 1984.



Air Force Secretary Verne Orr makes a stop at Fairchild Republic Co.'s T-46 display at the 1984 AFA Convention. The first T-46 will be rolled out in February at Fairchild's Long Island, N. Y., plant. More than 7,800 people attended this year's Briefings and Displays program.

AFA National Director and former Chief Master Sergeant of the Air Force James M. McCoy autographs a copy of the Aerospace Education Foundation publication** The Chiefs. **The magazine-style booklet, which recounts the stories of the eight CMSAFs, is the first volume of AEF's "Aerospace Heritage" series.

The schedule for 1985 includes national symposia on tactical air warfare in Orlando, Fla., in January, electronics in Boston in April, strategic airpower in Omaha, Neb., in June, and another status report on the Air Force in Los Angeles in October.

Other notable events during 1984 included the world premiere of *Call to Glory*, hosted by AFA and the USO in Washington *(see October '84 issue "Intercom");* sponsorship for the fifth consecutive year of AFA's "Team of the Year" program, which honored five enlisted AWACS crew members and their spouses (for 1985, the program will honor enlisted GLCM crew members); an air attaché reception hosted by AIR FORCE Magazine; and AFA's annual salute to the Air Force Academy's Outstanding Squadron.

Communications

Communications programs were stronger than ever in 1984 as chapter, state, and national leaders seized opportunities to place editorials and letters to the editor in their media outlets by using materials furnished by the Communications Department. Field leaders used timely Field Service Reports and special editions of "Crossfeed" on US attitudes toward a nuclear freeze and on public opinion on key defense issues to generate local coverage of AFA concerns. Innovative approaches were taken to penetrate typically "tough markets"—among the more imaginative of these were the Defense Education Committees organized in Eugene and Portland by the Oregon State AFA in an endeavor to better communicate national defense issues to local citizens.

An increasing number of AFA leaders as well as national staff appeared on television and radio interview shows to address pressing national security issues as they surfaced in the news. AFA's ninety state and chapter communications directors, many of whom contribute to unit newsletters, used staff-supplied information to better inform AFA members and community leaders on a continuing basis.

AFA's active film/videotape lending library was expanded in 1984. Fourteen films and 100 videotapes are now available to units for community events and regular meetings. Four films and twenty-five videotapes were added last year, including the popular AFA-produced videotape "Around the World in Sixty Years," which commemorates the nine round-the-world aviators honored at the 1984 National Convention.

Research into the feasibility of producing a film documentary was conducted by the national Communications Committee, chaired by Jon Donnelly. Work continued on this project throughout the year.

AFA's national symposia generated outstanding media coverage, as did numerous state and local programs—from chapter-sponsored air shows to state-sponsored symposia.

An updated on-base membership slide show was purchased and used by more than sixty field leaders and project officers in support of the on-base drive. The production was analyzed by AFA's Junior Officer Advisory and Enlisted Councils, and eighty percent of the Councils' members said they would join AFA after seeing it.

Aerospace Education Foundation

Early in 1984, the Foundation's Executive Committee approved a number of new policy directions and the appointment of an Ad Hoc Committee to study the purpose, objectives, and structure of the Foundation. Cochaired by former AFA President and Board Chairman John R. Alison and former AFA Treasurer Jack B. Gross, both of whom are Foundation Trustees, the Committee made a number of recommendations that were approved and implemented during the year. The number of active Trustees was set at fifteen, with the accession of other Trustees to emeritus status. Also, a Foundation Advisory Council, a nominating committee, and a position of vice president were established.

One of the key new directions during the year was the establishment of the Foundation's Aerospace Education Center, which conducted two roundtables as the year drew to a close. One was entitled "Focus on MX Peacekeeper: Key to Strategic Force Modernization" and featured prominent panelists from the Air Force, Congress, and the media who probed the theme in a two-hour evening session that was audio- and videotaped and summarized in written form for

An Air Force Association National Symposium

January 17–18, 1985
The Buena Vista Palace Hotel
Orlando, Fla.

You won't want to miss this one! AFA, in conjunction with the Tactical Air Command, is arranging this timely program to illuminate the host of issues that drive and shape the requirements of tactical air warfare. Major emphasis will be on such issues as theater air defense, USAF's interaction with ground and naval forces, and related tactical support functions performed by space-based assets.

The tentative lineup of distinguished speakers includes:

Gen. Jerome F. O'Malley
Commander
Tactical Air Command

Gen. Charles L. Donnelly, Jr.
Commander in Chief
US Air Forces in Europe

Gen. Robert Kingston, USA
Commander in Chief
US Central Command

Gen. William Richardson, USA
Commanding General
Training & Doctrine Command

Gen. Wallace Nutting, USA
Commander in Chief
US Readiness Command

Gen. Earl T. O'Loughlin
Commander
Air Force Logistics Command

Lt. Gen. Robert D. Russ
Deputy Chief of Staff
Research, Development & Acquisition

Maj. Gen. John Marks, Jr.
Commander
Electronic Security Command

Maj. Gen. Thomas S. Swalm
Commander
USAF Tactical Air Warfare Center

The event includes a Thursday evening dinner. Former Secretary of State and former SACEUR Alexander M. Haig, Jr., will speak.

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 $175 ($200 for non-AFA members).

For information and registration, call Jim McDonnell, Dottie Flanagan, or Sara Ciccoli at (703) 247-5800.

Special Note: AFA's Florida State organization is sponsoring the first annual "Florida Salute to the Tactical Air Forces." This black-tie dinner dance will be held Friday evening, January 18. For information, call Mr. Norman Abramson at (305) 356-6560 or Mr. John Combs at (305) 869-8134.

Mark Your Calendar: AFA's popular Electronics Symposium, held near Boston, Mass., is scheduled again this year on April 25–26, 1985.

further distribution. The other was titled "Strategic Defense Initiative: Opening a New Era of Deterrence?" and took place on December 4. The Center's purpose is to probe significant aerospace issues and to distribute information throughout AFA and other organizations. Planned for 1985 are monthly roundtables.

The Foundation's new directions also involve two follow-on projects under the Center's auspices—"Forum for the Future" and an "Aerospace Education Resource Office." The goal for the Forum is to provide AFA field units with detailed information and expert opinion on the full range of AFA policy concerns. The Resource Office will generate, interpret, and provide information to educators, scholars, and the media on key aerospace topics in order to clarify the role of aerospace power in American society.

Another initiative approved in principle is the "Partners in Education" program. The primary goal of this program is to help AFA field units in garnering corporate assistance in terms of resources and expertise to improve local public-school education.

The Foundation's Executive Committee approved the phase-out of the nonprofit sale and distribution of Air Force technical courses, based on a detailed economic study that argued against continuation of the program. Foundation course materials were provided to the Department of Labor, at its request, for use in underdeveloped countries.

Further Executive Committee actions included adoption of a precise definition of aerospace education and approval of continued joint efforts in book publishing with the Air Force Historical Foundation. In this regard, the Committee directed the Foundation staff to study the feasibility of producing a second publication in the "Aerospace Heritage" series that will be titled "Valor." It will contain stories first published in AIR FORCE Magazine that recount acts of valor by Air Force personnel over the years. The first publication in the series was released during AFA's National Convention. Entitled "The Chiefs," the magazine-style booklet tells the dramatic, personal stories of the eight Chief Master Sergeants of the Air Force. Sponsored by United Technologies Corp. and presented by AFA's Enlisted Council, the booklet was well received, and some 75,000 copies were distributed throughout the Air Force.

Elected at the annual Foundation Board of Trustees meeting in September to serve in the year ahead were Sen. Barry M. Goldwater (R-Ariz.), Chairman of the Board; George D. Hardy, President; Eleanor P. Wynne, M.D., Vice President; Alton G. Hudson, Secretary; and Jack B. Gross, Treasurer.

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Councils/Task Forces

AFA's Enlisted and Junior Officer Advisory Councils continue to represent their peers effectively in AFA's advisory structure *(see July '84 issue "Intercom").* The Councils, representing every Air Force major command, separate operating agency, and direct reporting unit, are among AFA's most active and productive advisory groups. Last year, they met three times—twice in Washington, D. C., and once in San Antonio, Tex. In addition to furnishing significant recommendations on key personnel issues that were reflected in AFA's 1984–85 policy paper on Defense Manpower Issues, each Council provided input for a career pamphlet aimed at new junior officers and NCOs. Further, the Enlisted Council helped develop "The Chiefs," the first publication in the Aerospace Education Foundation's "Aerospace Heritage" series.

During the National Convention, senior enlisted advisors from throughout the Air Force met in the eighth worldwide conference to share ideas and discuss issues. Under the leadership of CMSAF Sam E. Parish, the group spent several days probing concerns important to the Air Force and AFA.

Also during the year, the AFA/AFROTC Task Force, chaired by former AFA Board Chairman Judge John Brosky, and the AFA/CAP Task Force, under the leadership of AFA National Director Dan Callahan, completed their respective two-year evaluations of how AFA can work more effectively with these two key groups. Task Force reports were submitted to AFA's elected leadership for evaluation.

Insurance

AFA's CHAM*PLUS*® program, providing CHAMPUS Supplement coverage to retirees and their dependents as well as to dependents of active-duty personnel, continued its strong growth during 1984, as did participation in AFA's Medicare Supplement program. Together, these two plans now provide coverage to more than 9,000 AFA families; 4,000 claim payments were made during the year in an aggregate amount that exceeded $850,000.

AFA's Life Insurance program also continued to grow during 1984, stimulated by an across-the-board increase in coverage for all participants under age sixty-five and a twenty percent premium dividend. This marked the eleventh consecutive year in which a substantial year-end premium refund (dividend) had been paid. Taken together with the benefit increase, the dividend has produced

AFA's Junior Officer Advisory and Enlisted Councils, plus an assembly of senior enlisted advisors from throughout the Air Force, held a series of working sessions during the 1984 AFA National Convention to discuss issues affecting USAF and AFA.

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the lowest net cost for this insurance in the program's twenty-four-year history.

Servicing policyholders continues to be a major activity of the Association. During 1984, more than 18,000 requests for policy information were answered (exclusive of claim payments), and new policies were issued to nearly 4,500 AFA members.

Then National President and current Board Chairman David Blankenship presented an AFA tie to Col. Dale W. Thompson, Jr., 20th Tactical Fighter Wing Commander and AFA member, during ceremonies last year marking the chartering of a new AFA chapter at RAF Upper Heyford, UK.

Briefings and Displays

The Aerospace Development Briefings and Displays program during the AFA National Convention was once again very successful. More than 7,800 people attended, making for the largest attendance in the more than twenty years that AFA has been staging this event.

The exhibit hall at the Sheraton Washington Hotel was packed. More than 100 companies or divisions of companies participated, and fifty-five conducted formal briefings on the latest developments in USAF systems and equipment.

AFA provided bus service from the Pentagon, Andrews AFB, Md., and Bolling AFB, D. C., to facilitate Air Force attendance.

Industrial Associates

As of this writing, 249 companies are affiliated with AFA's Industrial Associates program. Through this affiliation, these companies support the objectives of AFA as they relate to the responsible use of aerospace technology for the betterment of society and the maintenance of adequate aerospace power as a requisite of national security and international amity. At this time last year, 223 companies were affiliated with the program.

UNIT REUNIONS

Bombardiers

Bombardiers will hold a reunion in Midland, Tex., on April 12–14, 1985. **Contact:** Ned Humphreys, Box 254, Eagle Harbor, Mich. 49951. Phone: (906) 289-4440.

Combat Pilots Ass'n

The Combat Pilots Association, assisted by the American Fighter Aces and members of the Eagle Squadron, will hold a reunion on April 13, 1985, aboard the *Queen Mary* at Long Beach, Calif. **Contact:** Orange County Squadron, Combat Pilots Association, P. O. Box 6360, Anaheim, Calif. 92806. Phone: (714) 632-6340.

Foster AFB, Tex.
A reunion will be held on May 31–June 2, 1985, for all military and civilian personnel who were assigned to Foster AFB, Tex., during the 1940s and 1950s. **Contact:** Paul Kneblick, Rte. 6, 601 Cambridge, Victoria, Tex. 77901. Phone: (512) 575-5840. Frances Mozisek, Box 12, Telferner, Tex. 77988. Phone: (512) 578-5878.

Iceland Veterans Ass'n
Members of the Iceland Veterans Association will hold a reunion on June 23–27, 1985, at the Kutshers Country Club in Monticello, N. Y. **Contact:** Dave Zinkoff, 2101 Walnut St., Philadelphia, Pa. 19103. Phone: (215) 568-1234.

9th Troop Carrier Squadron
Veterans of the 9th Troop Carrier Squadron will hold a reunion on April 18–20, 1985, at the Sheraton New Orleans Hotel in New Orleans, La. **Contact:** Reginald T. Badeaux, Jr., 234 Loyola Bldg., New Orleans, La. 70112.

11th Service Squadron
The 11th Service Squadron, 482d Service Squadron, the Headquarters Squadron, and the 8th Service Group will hold a reunion on May 3–5, 1985. **Contact:** John J. "Jack" Heckler, 76 East Harbor Drive, Teaticket, Mass. 02536. Phone: (617) 540-1303.

B-17 Veterans Composite Wing
Many B-17 groups that served throughout the world in World War II will gather in Seattle, Wash., on July 25–28, 1985, to celebrate the fiftieth anniversary of the B-17. **Contact:** B-17 Veterans Composite Wing, P. O. Box 326, King of Prussia, Pa. 19406. Phone: (215) 265-2778.

31st Air Depot Group
Members of the 31st Air Depot Group who were stationed at Hill Field, Utah, during the years 1942–43 will hold a reunion on July 18–20, 1985, in Salt Lake City, Utah. **Contact:** W. S. Noble, 7266 Goodwood Ave., Baton Rouge, La. 70806. Phone: (504) 925-8454.

47th/479th Service Squadron
Veterans of the 47th/479th Service Squadron (formerly the 28th Service Squadron) will hold a reunion on May 3–4, 1985, at the Flagship Inn in Arlington, Tex. **Contact:** Ben Dickson, 2606 Oak Cliff Lane, Arlington, Tex. 76012.

60th Troop Carrier Group
The 60th Troop Carrier Group will hold its reunion on June 5–8, 1985, in King of Prussia, Pa. **Contact:** John Diamantakos, 7216 Pine Tree Lane, Fairfield, Ala. 35064. Phone: (205) 923-2323.

73d Bomb Wing Ass'n
The 73d Bomb Wing, including the 497th, 498th, 499th, and 500th Bomb Groups, the 65th, 91st, 303d, and 330th Service Groups, plus all attached and assigned units on Saipan during World War II, will hold a reunion on May 2–5, 1985, at the Ramada Inn in Tucson, Ariz. **Contact:** 73d Bomb Wing Association, 105 Circle Dr., Universal City, Tex. 78148.

80th Fighter Squadron
Members of the 80th Fighter Squadron "Headhunters" will hold their reunion on June 20–23, 1985, in Colorado Springs, Colo. **Contact:** Don McGee, 135 Clare Rd., Mansfield, Ohio 44906. Phone: (419) 529-4945.

97th Bomb Group Ass'n
Members of the 97th Bomb Group who served in England, North Africa, and Italy during 1942–45 will hold a reunion on July 25–27, 1985, in Seattle, Wash. **Contact:** Clarence Hammes, 15 Avilla Heights S., Alexander, Ark. 72002. Phone: (501) 794-2615.

100th Bomb Group
The "Bloody 100th" and supporting units will hold a reunion on July 25–28, 1985, at the Stouffer Dayton Plaza Hotel in Dayton, Ohio. **Contact:** Ray E. Miller, 1619 E. Siebenthaler Ave., Dayton, Ohio 45414.

313th Bomb Wing (VH)
A reunion is planned for veterans of the 6th and 505th Bomb Groups, 313th Bomb Wing, for August 28–September 1, 1985, in Colorado Springs, Colo. **Contact:** K. H. Gibson, 1400 E. Indian Wells Rd., Tucson, Ariz. 85718. Phone: (602) 297-2619.

388th Bomb Group (H) Ass'n
The 388th Bomb Group (H) will hold its thirty-sixth annual reunion on July 26–28, 1985, at the Madison Hotel in Seattle, Wash. The reunion will be held in conjunction with the celebration of the fiftieth anniversary of the Boeing B-17 Flying Fortress. **Contact:** Ed J. Huntzinger, 1925 S. E. 37th St., Cape Coral, Fla. 33904.

442d Troop Carrier Group
Members of the 442d Troop Carrier Group, including the 303d, 304th, 305th, and 306th Troop Carrier Squadrons and all assigned and attached units, will hold a reunion on May 17–19, 1985, in Dayton, Ohio. **Contact:** Reunion Committee, 442d Troop Carrier Group, 1135 Trentwood Rd., Columbus, Ohio. 43221.

Class 41-C
I would like to hear from members of Flying Class 41-C (Randolph and Kelly Fields) for the purpose of planning a forty-fifth-anniversary reunion.

Please contact the address below.

Col. Otto C. Ledford, USAF (Ret.)
541 St. Andrews Way
Lompoc, Calif. 93436
Phone: (805) 733-1969

514th Strategic Recon Squadron
I would like to hear from former members of the the 514th Strategic Reconnaissance Squadron (VLR) and the 54th Reconnaissance Squadron (M) who are interested in a reunion.

Please contact me at the address below.

Robert Mann
1971 Briscoe Terrace
Fremont, Calif. 94538

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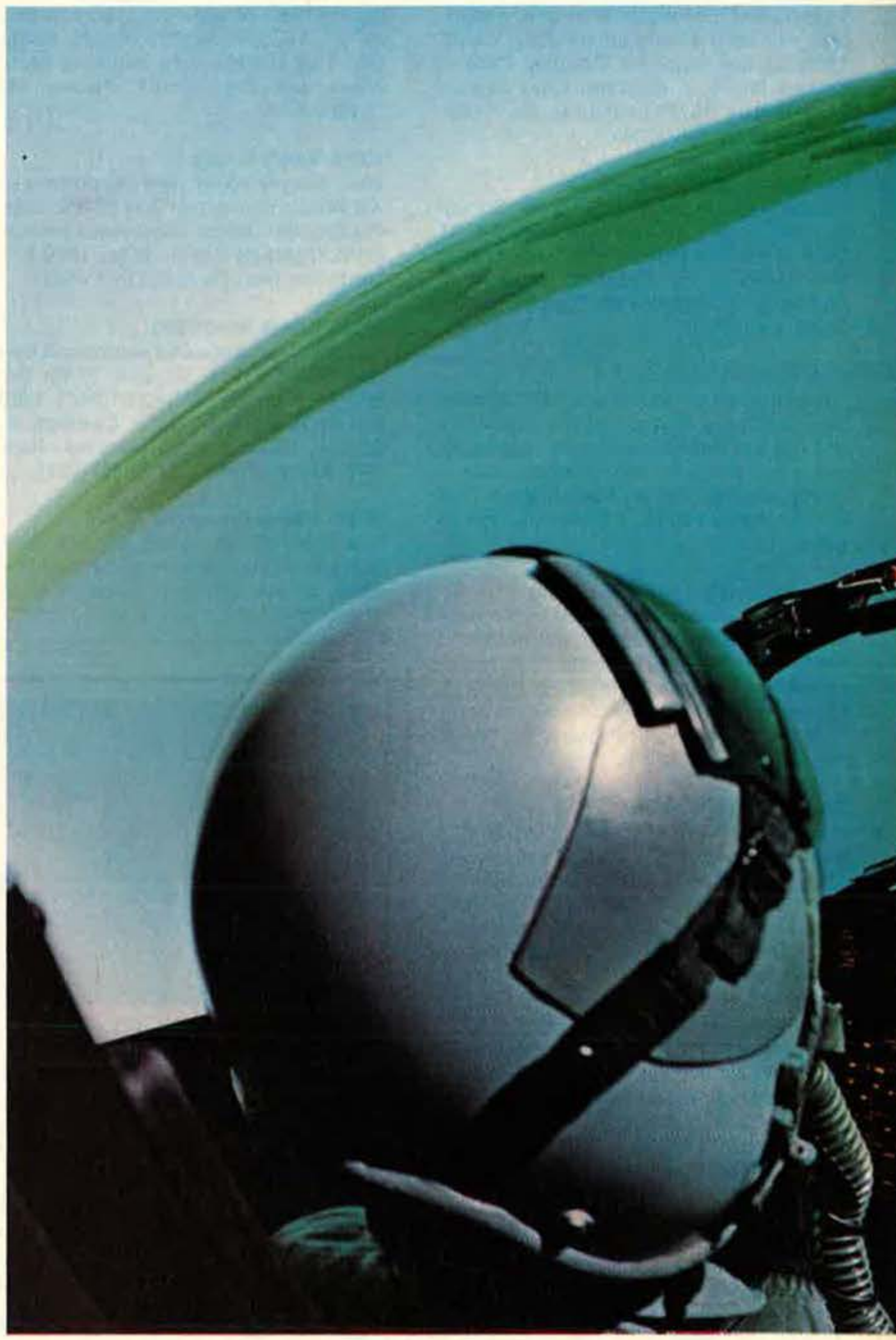

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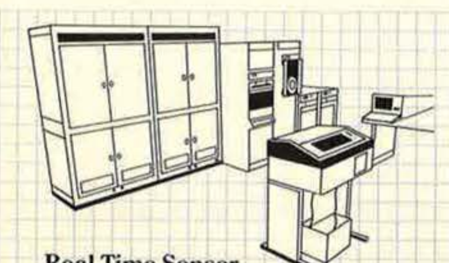

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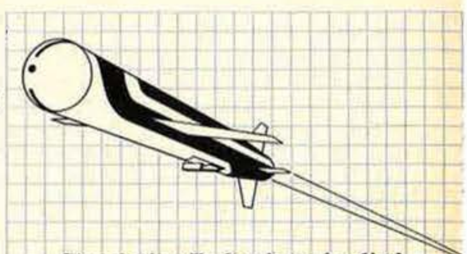

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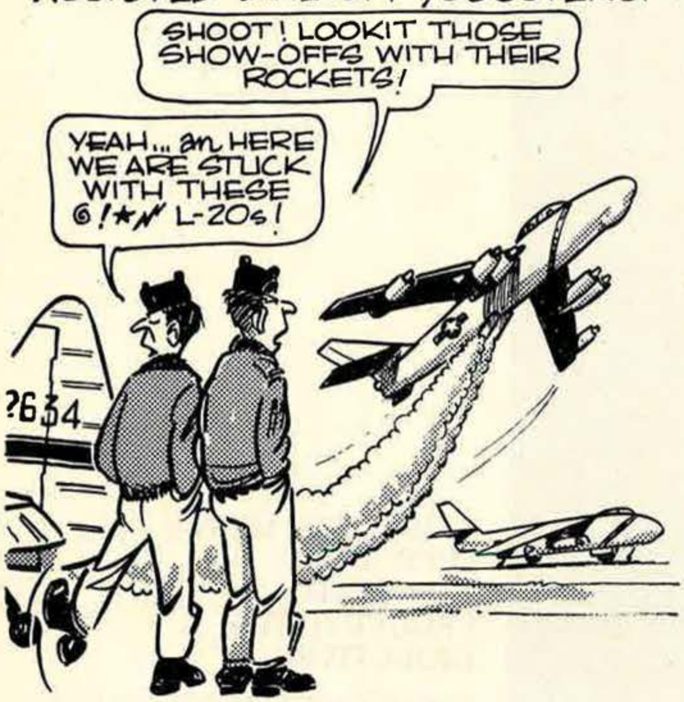
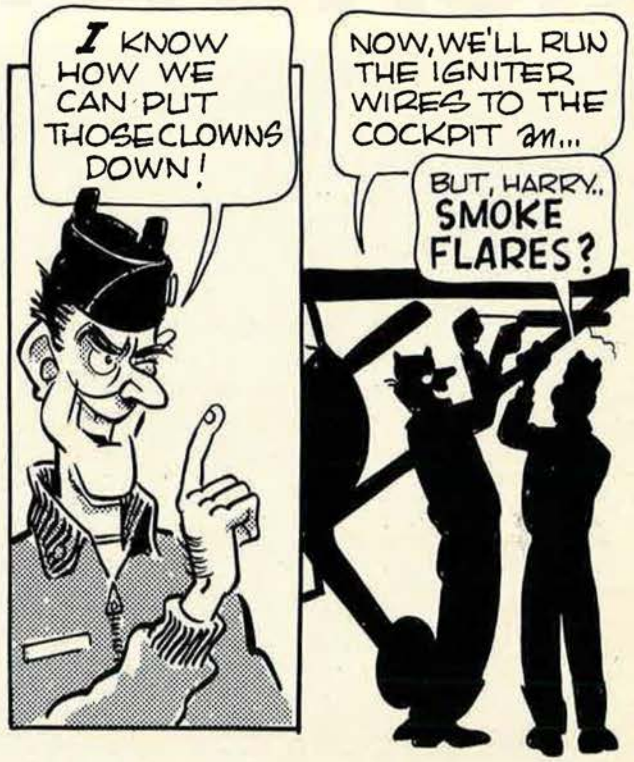
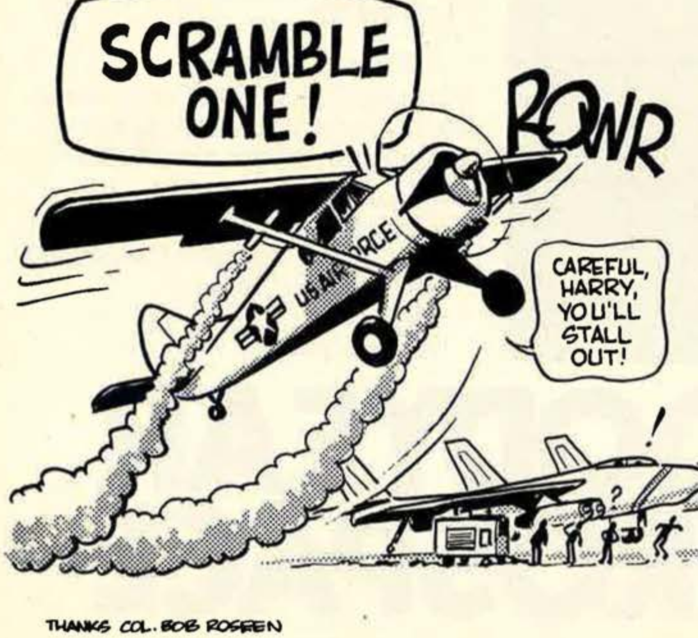
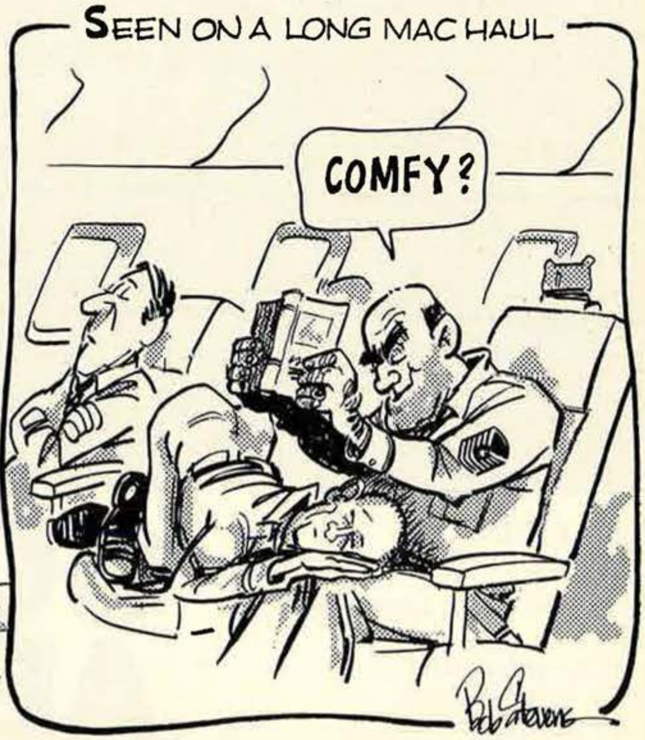




THEN, ON A DAY WHEN THE B-47 WING WAS IN FULL ARRAY ON THE RAMP, "RED DOG LEADER" LEAPED OFF!





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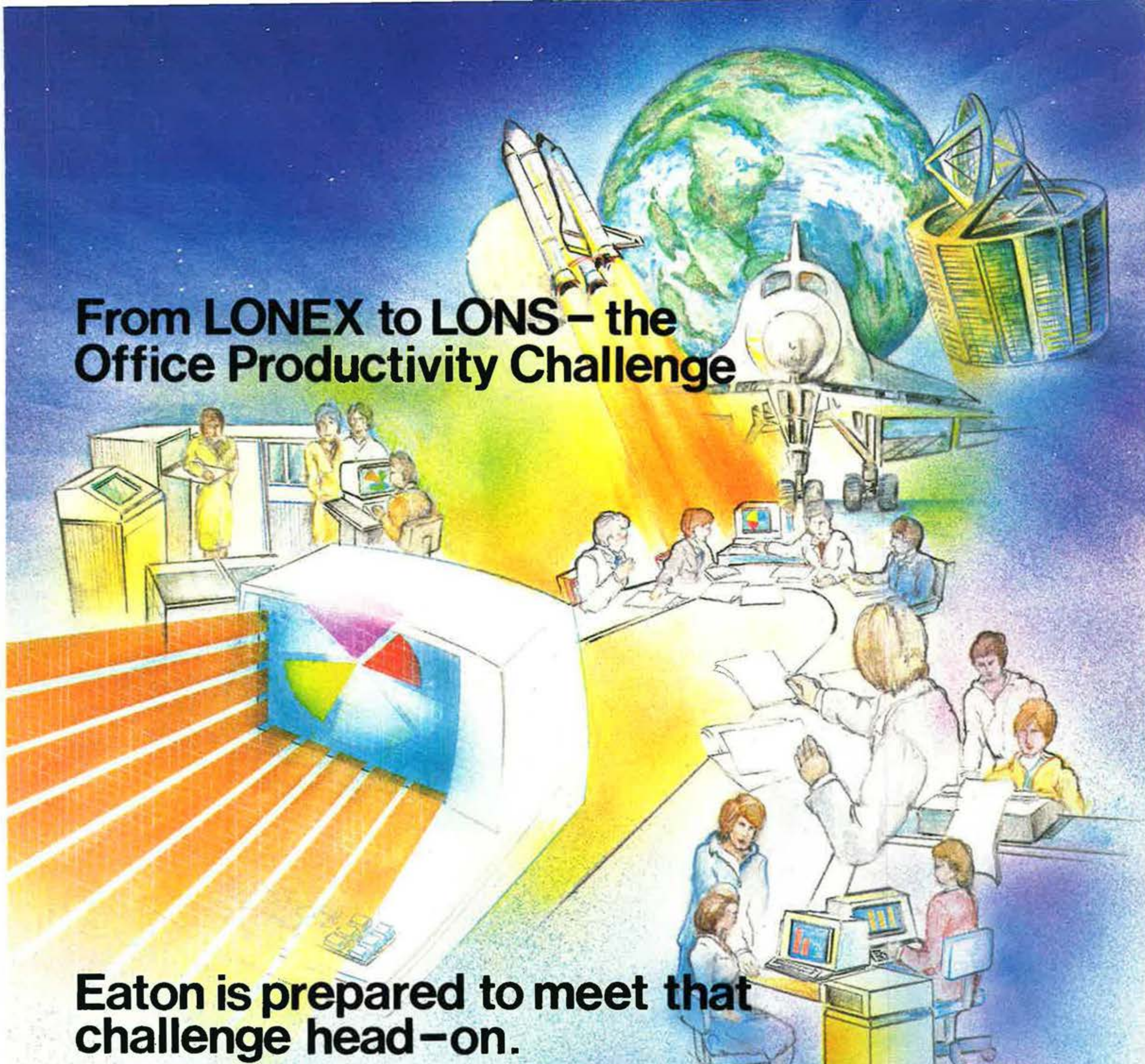


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