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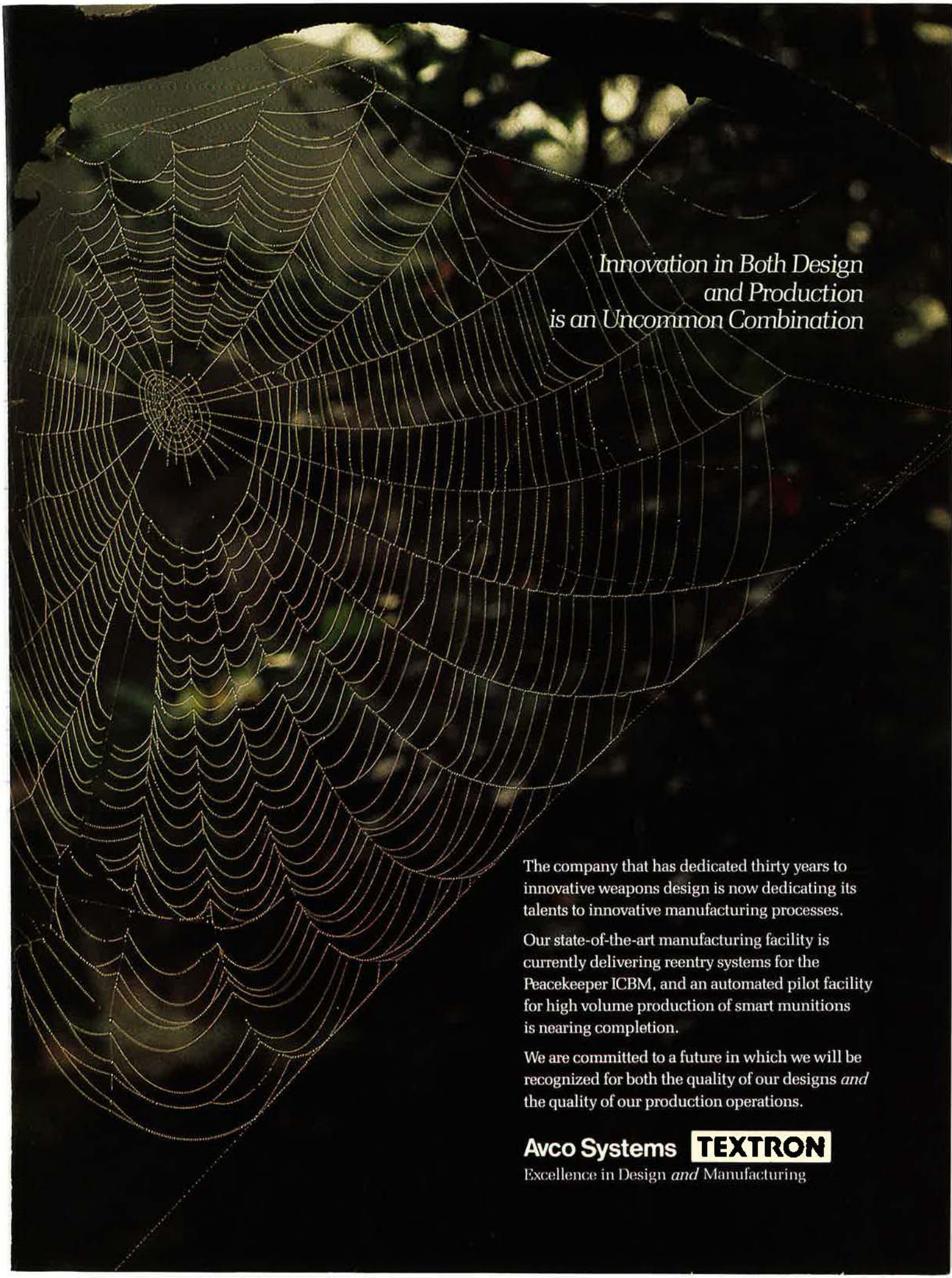
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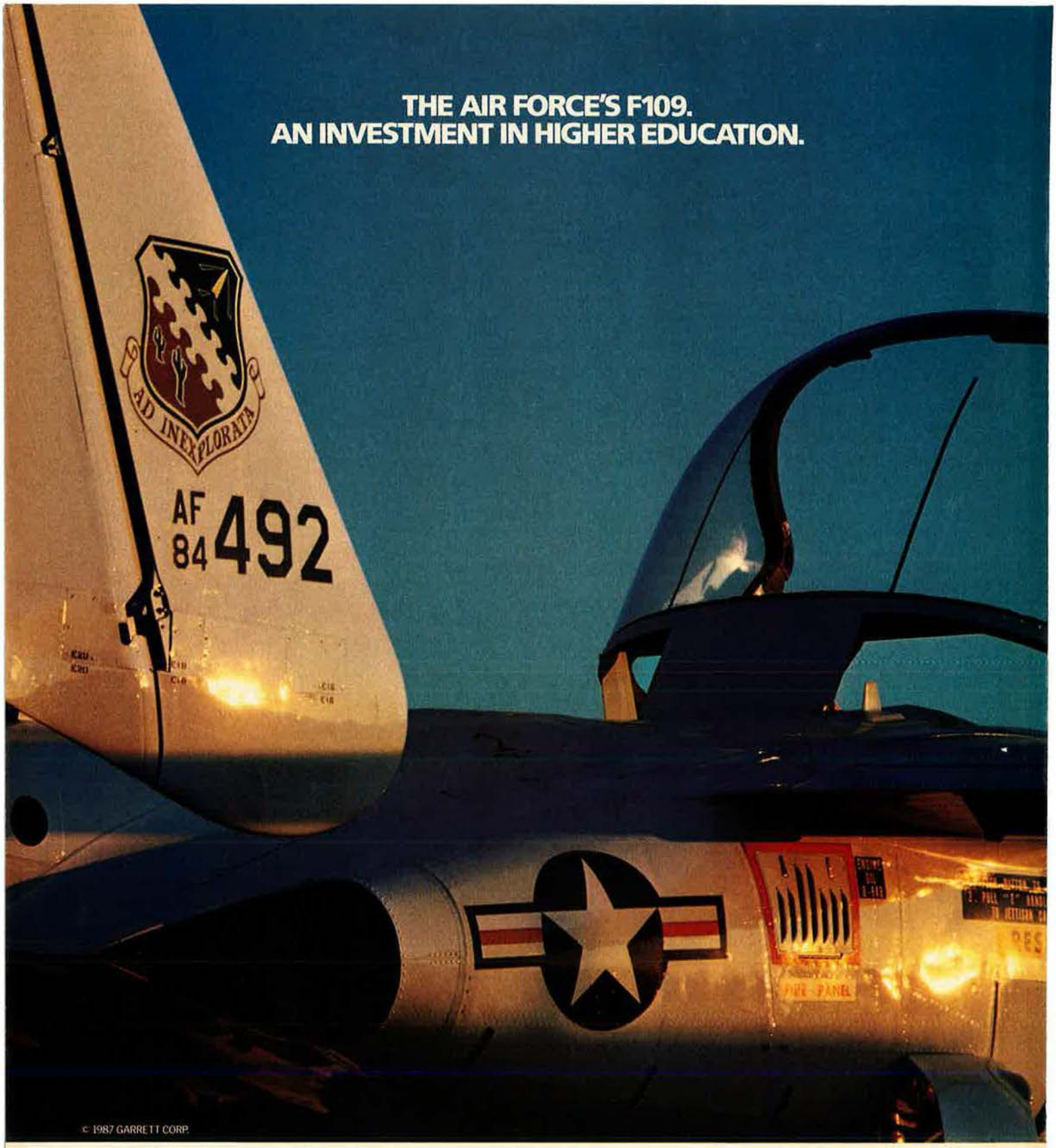

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Page 84

About the cover: Martin Marietta is refurbishing these launchers to help boost the US along the comeback trail in space. A special section on "Aerospace Technology" begins on p. 44.

Special Section: Aerospace Technology

Features

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AN EDITORIAL

The Worst Money We Could Save

By John T. Correll, EDITOR IN CHIEF

THE armed services, their wounds barely healed from the recruiting and retention disasters that gutted their ranks in the late 1970s and early 1980s, may be headed for another military manpower crisis. That, anyway, is the opinion of Secretary of the Air Force Edward C. Aldridge, Jr. "I see a crisis in a continuing expansion of collateral missions—that is, missions outside our basic charter—without additional manpower authorizations," he says. "I also see a crisis in a growing force of technologically sophisticated systems without enough quality men and women to operate them."

For some time now, Congress has been unwilling to authorize the Air Force the full number of additional people it has needed to assume new missions, such as interdiction of drug traffic, and to field new systems, such as the Ground-Launched Cruise Missile, the B-1B bomber, and the Peacekeeper ICBM. At public and congressional insistence, all of the services have diverted manpower to more intense management of spare parts and to the conduct of a campaign against waste, fraud, and abuse. For the most part, the services have been left to satisfy these manpower needs by internal realignment of personnel. In FY '87, for example, USAF got 350 additional military manpower authorizations, but met another 9,100 new requirements "from within the existing baseline."

The services have drawn down some functions to man others of higher priority, transferred missions to the Guard and Reserve, and assigned civilian employees and contractors to do jobs once performed by military personnel. For many men and women in uniform, unpaid overtime has become a part of the daily routine.

The manpower gap is widening steadily, but it is only one part of the problem. Driven by intense budgetary pressures, Congress has begun to dig for savings in pay and benefit programs. Military retirement—long regarded as one of the best benefits the services have to offer—has dropped in value by twenty-six percent since 1980. Military pay trails compensation in the civilian world by 9.4 percent. Appropriated fund support for morale, welfare, and recreation activities will be reduced, DoD-wide, by $69.5 million this year. Some overseas tours have been lengthened, and base-of-preference assignments have been canceled to save money.

This is a bad time for the comparative attractiveness of a military career to be diminished. The population of military-age young people in the United States is declining, and with each passing year, the services will have to compete harder with other prospective employers for the talent available. Secretary Aldridge's perception of a coming crisis is well founded.

Unfortunately, the end of the reductions and economies is not yet in sight. The Air Force must absorb a $95 million cut in Permanent Change of Station (PCS) funding this year. No feasible idea identified so far would result in savings anywhere near that amount. Cancellation of all Stateside moves for the entire year would save no more than $50 million. The Air Force reduced PCS moves from 642,000 in 1974 to 287,000 in 1986, but the cost per move has gone up. Most of the PCS budget is used for overseas assignments.

To save money last year, USAF delayed the return of people completing overseas tours until the new fiscal year had begun. This worked a real hardship on families with children, who did not arrive in their new locations until months after school had started. The Air Force has said that it does not intend to delay returns from overseas again.

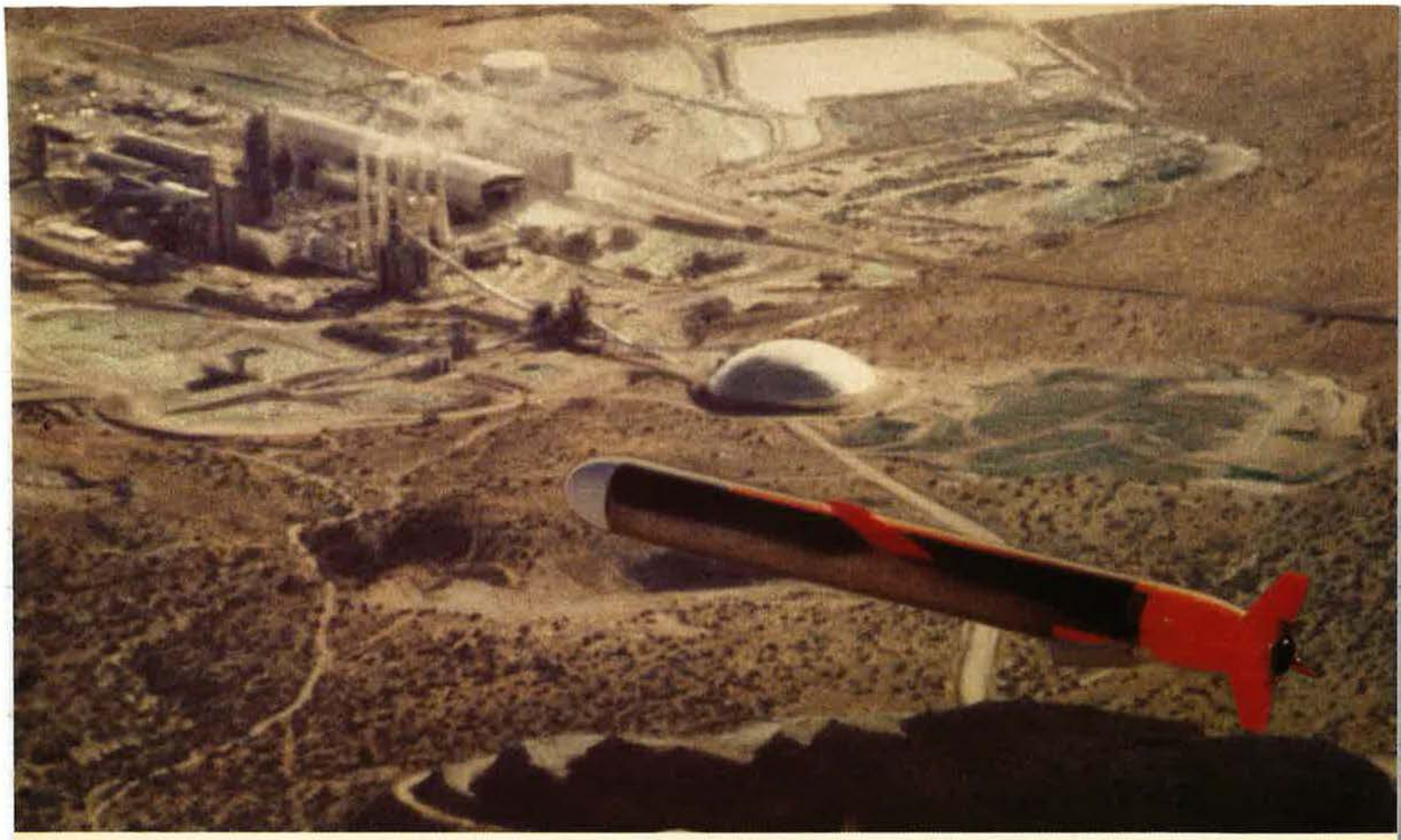
Finally, in one of the hardest-hitting manpower directives to date, Congress has told the Defense Department to reduce officer personnel strength by six percent over the next three years, beginning with a one percent cut this year. The situation took on new dimensions December 4 when Secretary of the Navy John Lehman suggested that the whole cut fall on the Air Force and the Army. Citing a "grotesque imbalance" among the services in officer-enlisted ratios, he proposed that the Navy and the Marines be exempt from reductions until all services are within a ratio of 1:6.5. The present ratios, he said, are as follows: Marines, 1:8.9; Navy, 1:7.0; Army, 1:6.1; and Air Force, 1:4.5.

Secretary Lehman's comparison is catchy, but there is less to it than meets the eye. The question, "How many people do you need?" is meaningless without also asking, "To do what?" The answer will vary with mission and circumstances. That, one presumes, is why Mr. Lehman's Navy requires a richer mix of officers than does Mr. Lehman's Marine Corps. The Secretary's proposal and the arbitrary percentage cut ordered by Congress have a misconception in common: Both presume that any organization, regardless of function, should fit some universally ideal configuration model that prescribes a "correct" percentage of officers.

Perhaps the sea services have been shortchanged on officers, but the raw numbers and ratios are no proof that this is so. Valid force configurations are determined only by the careful analysis of specific requirements. This is how the services and their subordinate units justified their manpower allocations in the first place. If existing force levels and officer percentages are excessive in terms of actual requirements, then no reasonable person could object to reductions. But it makes no sense to cut on the basis of intuition, magic ratios, or whim.

The Gramm-Rudman-Hollings budget reduction drill has the Administration and Congress in a tight spot. There have already been instances when long-term logic lost out to the urgency of short-term savings. It could happen again in this case. If so, another military manpower crisis becomes a virtual certainty. Then, once recruiting and retention have deteriorated to an adequate mess, we will decide that such a condition is intolerable and begin rebuilding. Because of the unfavorable demographic trends, the reconstruction promises to be even more difficult and expensive than it was last time.

The short-term gain of military manpower economies may look good now, but it could be some of the worst money the nation has ever saved. ■



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AIRMAIL

General LeMay

I enjoyed reading Maj. Gen. Dale O. Smith's article about Gen. Curtis LeMay *(see "The Airman Who Shook the World," January '87 issue, p. 100).* I certainly agree with General Smith's main point about the significance of General LeMay's contributions to Air Force history.

However, two points should be clarified. During the strategic bombing campaign over Japan, General LeMay's switch to low-level, nighttime bombing was not taken "contrary to all advice." Generals Power and Davies, among others, strongly supported this change.

LeMay's incendiary campaign was not only with approval from Washington, it had been most strongly advocated by Generals Arnold and Norstad (from Washington) over a period of weeks prior to the great firebombing raid on Tokyo of March 9–10, 1945. General LeMay mentions in his own book, *Mission With LeMay,* that he realized "the turkey was around my neck." After two months without dramatic results (since January 1945), he knew he would be in a precarious position, if he could not show such results shortly.

The fact was that General Arnold wanted results quickly, and he was far from willing to wait indefinitely to get them. General LeMay's decision turned the campaign around.

Herman S. Wolk
Office of Air Force History
Bolling AFB, D. C.

Perfection and SDI

I have never written a letter to the editor before, but the letter by Col. Warren W. Luce, USAF (Ret.), in the January issue was the last straw *(see "Airmail," January '87 issue, p. 13).* I have been reading for some time now the running "Star Wars" commentary in "Airmail," and I have noticed the same common thread that is hammered out by the media in general: If a defense isn't absolutely invulnerable, it is a *complete* waste of time if it "costs too much."

This attitude is particularly annoying when it is espoused by those who already know better by virtue of their enlistment in the armed forces. After all, no one supposes that the Army, Navy, Air Force, and Marines could totally prevent any damage whatsoever to US interests in case of a conventional conflict. If "imperfect" defenses are not worth the investment, why did they bother to join up?

In any case, my point is that the purpose of any countermeasure (defense) is both to stop *and* deter an attacker. Of course, one of the best ways to deter attack is to raise the level of uncertainty that the attacker must deal with. Assuming that an attacker wants first and foremost actually to hit the target, anything that makes that more uncertain works to the benefit of the defender.

The second assumption is that the attacker wishes to survive the encounter. A one-shot "suicide" or "consequences do not matter" type of assault cannot be, for all intents and purposes, defended against. We assume that the attacker wishes to be around to enjoy the benefits of successful attack. (This, of course, is the premise behind the MAD doctrine of deterrence.) It works well so long as the attacker actually believes that there is a credible risk of being stopped or suffering "unacceptable" damage. . . .

The whole point being missed, it appears to me, in the SDI debate is the effectiveness of SDI as a means of establishing the credibility of our defense, not its invulnerability. No attacker will "test" it to check and see if it works. If it looks as if it will work, then I, as an attacker, have a real targeting problem. How much of my attack will get through? . . .

SDI is not designed to eliminate nuclear weapons as a threat. It is designed to eliminate or reduce ballistic missile attack as a threat. . . .

SDI is expensive, and it is not perfect. The expense may be debatable, but to debate whether or not it is "perfect" is just plain stupid. I wish those who insist that "gee, it's not a perfect plan" would be so kind as to come up with an example of something in this life that is perfect or shut up.

J. David Byrd III
Arlington, Va.

Glue That Sticks

Thank you for your fine articles on training in the December 1986 issue of AIR FORCE Magazine. In particular, we enjoyed the article by Assistant Secretary of the Air Force Tidal W. McCoy titled "New Ways to Train."

The opening remarks were right on: "Training is unglamorous. It doesn't inspire the spirited debates we're accustomed to on weapon systems acquisition. . . . Training receives little attention from the budgeteers in Congress. . . . Training is the glue that bonds the superior weapons we buy to the superior people we recruit to form the superlative fighting machine the US Air Force is today."

Changes are now being made in both the services and the marketplace with regard to the emphasis and approach to training. Both now see a requirement for "total training systems." The services have exciting new training R&D initiatives ranging from long-required training effectiveness efforts to intelligent tutoring systems. The latter will hopefully apply the new technology of artificial intelligence to what should be a very appropriate arena—quickly and effectively teaching young folks with minimal job experience to operate and maintain critical, sophisticated machines and systems. The many training system vendors now also display an acceptance of the idea of competing for the development of training systems to train not only the system operators but

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also the planners and maintainers.

Much in concert with your magazine's expressed views, the Defense Science Board has recently established a task force on training. Their present focus is on computer applications to training and wargaming.

Your fine magazine combined interest and focus on training and training systems that will help the Air Force to ensure that the "glue that bonds the superior weapons . . . to the superior people" is a high-quality glue that sticks.

Col. Dennis W. Jarvi, USAF
Commander, Air Force Human Resources Laboratory
Brooks AFB, Tex.

Aircraft Production

I applaud Dr. Jacques Gansler for his most astute observations regarding the precipitous decline in the number of military aircraft introduced by the US and its allies during the past three decades *(see "The Dangerous Dive in Aircraft Production," December '86 issue, p. 112).* I wholeheartedly endorse both his estimate of the danger and his recommendations for dealing with the problem.

There is one factor, however, that was not mentioned that is equally if not more significant. I refer, of course, to the contribution that improved reliability and maintainability could make to reducing the *life-cycle cost* of these systems, thereby freeing up scarce defense dollars with which to procure the additional types and quantities of aircraft needed.

Such improvements in R&M contribute in yet another way by making available for combat more of whatever quantity of aircraft is produced.

I trust the defense industry will be as diligent in meeting this challenge as Dr. Gansler urges it to be in reducing the acquisition cost of weapon systems.

Gen. James P. Mullins, USAF (Ret.)
Del Mar, Calif.

"Skid Row" Airmen?

For more than thirty years I have been reading AIR FORCE Magazine, and this is the first time that I have become exercised enough to write you. . . .

I am writing about Gen. T. R. Milton's article "Operating in the Shadows" in the December 1986 issue. I flew my combat tour from Udorn in northern Thailand where Air America and Continental Air Service happened to be based for that area of operations. Although the unit I flew with used F-4Ds and RF-4Cs, many of our missions dovetailed with those of these organizations and the Raven FACs from northern Laos.

These air operations were not raunchy; they measured up to professional military standards and on occasion exceeded them because of the exceptional pilot skills and experience in these units. I have personally witnessed a Continental Air Service helicopter pilot flying with no guns (except possibly the pilot's side arm) pick up an F-4 crew member down on the Plain of Jars when our Jolly Green Giant helicopters had been driven off by ground fire.

General Milton seems vexed that Eugene Hasenfus did not act like a good soldier when captured. Perhaps the Nicaraguan government would not have been impressed if he had presented a Geneva Convention Card and given his name, rank, and serial number.

Our leaders at the national level were tripping on each other to appear before hasty press conferences to deny official sanction of Mr. Hasenfus and to depict him and his deceased crew members as soldiers of fortune and profiteering gunrunners. Evidence will indeed show, eventually, that profits—and big ones—were being made here and in Iran from gunrunning—and not by "skid row" airmen.

It is tragic and demeaning when former USAF officers trade on the uniform to merchant words, weapons, or goods and services.

Col. Robert M. Byrom, USAF (Ret.)
Crozet, Va.

Gen. T. R. Milton's December 1986 article "Operating in the Shadows" concerning the incident in Nicaragua involving the downing of a C-123 caused me great dismay.

For one thing, General Milton makes the assumption that the mission was somehow involved with the United States government, even though the government had denied any involvement, and none has been proven. For the author to write such an article, and for AIR FORCE Magazine to print it, is to provide fuel to the fire of those who seek to "prove" US government involvement. . . .

General Milton also implies that Eugene Hasenfus somehow lacks the moral rectitude possessed by the military personnel who were imprisoned in Hanoi. He ignores the fact that while military personnel are governed by the Geneva Convention and can expect eventual repatriation or other means being used to recover them from enemy captivity, civilian personnel operating under contract to the US government have no such hope. In fact, the fate of civilians, such as Hasenfus, who are shot down during clandestine operations is certain—either trial as a civilian, with no support from the United States government, or even instant death without trial. . . .

As for General Milton's derogatory comments concerning the "skid row" appearance of Air America personnel, it would do him well if he were to remember that the airlift performed into both Laos and Cambodia was performed by civilian contract crews of that line. Furthermore, most of the fixed-wing pilots who worked for Air America were retired Air Force airlift and other crew members. In spite of their appearance—and all of the Air America personnel I ever saw looked quite professional—they did an outstanding job, flying missions that were overall much more hazardous than those flown by military crews. And I say that from the standpoint of an Air Force C-130 crew member with two tours in Southeast Asia.

General Milton also questions the use of the C-123 in the clandestine role. What does he propose to use? In order to maintain distance from the United States government, any operation of this nature, if supported in the clandestine role, would require the use of an airplane that cannot be traced to the military. The C-130 is not in civilian use in that area, or anywhere for that matter, except by organizations that are connected with the US government. On the other hand, there are numbers of surplus C-123s and C-7s, neither of which is in the active US inventory anymore, available for use by civilian contract carriers or foreign operators. This makes these two types logical choices for clandestine operations. . . .

In short, although I often agree with General Milton's articles, in this case I think he may have spoken out of turn and would have been better off if he had left the issue alone.

Sam McGowan
Argillite, Ky.

Farewell to Old Shaky

I guess I can now understand the nostalgia associated with Air Force days gone by.

I have flown more than 6,900 hours as a C-124 navigator, including 105 hours in C-124 52-0994 *(see "Aerospace World," December '86 issue, p. 36),* to such unusual destinations as Tehran, Elisabethville, New Delhi, Dublin, and Accra. I have helped deliver a cherry picker in a C-124 and have dropped hundreds of paratroopers. My stories about "Old Shaky"

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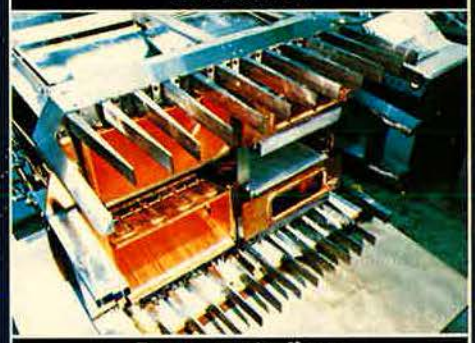

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alone would make a thick book.

I am glad that the 62d Military Airlift Wing (I was in the 7th MAS at one time) will maintain this proud "Old Shaky" in its museum. I hope to be able to visit it again some day.

Lt. Col. Richard Bode, USAF (Ret.)
Springfield, Mo.

Name the Enlisted!

I have been a member of the Air Force Association for almost three decades and have always been very proud of how the Association has been involved with the "Total Force" and, most especially, how AFA has bestowed many honors on the enlisted men and women in so many ways.

However, you do slip up every now and then by failing to recognize *by name* those enlisted personnel in the photographs in the magazine. In the December 1986 issue, not one person was identified by name in the "many" photos of enlisted men and women around the Air Force. Of the officers shown, only two were not identified, and that is just as well—you couldn't see their faces.

You might say that they were received by the magazine that way—without names. If that is the case, send them back and tell the PA folks to put identification on them.

Our enlisted force is equally proud of the part it plays in the Air Force. Enlisted members deserve to have their names printed in the "prestigious" AIR FORCE Magazine as much as officers.

CMSgt. John E. Schmidt, Jr., USAF (Ret.)
Tallahassee, Fla.

To the Defense

I rise to the defense of two gentlemen who need no defense—except perhaps from Mrs. Paul P. Douglas, Jr. *(see "Airmail," December '86 issue, p. 10).*

The first is Jack Broughton. I'm proud to know Jack, but I can't speak to his abilities as an Air Force officer and combat leader because I never served. Instead, I'll defer to Brig. Gen. Chuck Yeager, that arbiter of the "right stuff," who wrote, "Jack was a helluva commander and a great combat pilot. His guys loved him."

The second is John L. Frisbee. I'm proud to know him, also, and—although he also needs no defense—I'll speak on his behalf. In this case, I have the credentials to do so; I've been writing about aviation for more years than I care to remember. Jack Frisbee is an honest and honorable man, and his writings reflect those characteristics. He is not likely to leave "much of the story . . . unprinted."

Mrs. Douglas's last sentence is completely uncalled for, with its implication that we are making "heroes out of former members whose reputations might be questionable." If she is referring to Jack Broughton, I can assure Mrs. Douglas that there is a large number of other former members (to whom I talked while researching my recent book on the F-105) who remember Jack Broughton as a genuine American hero, a combat commander who they would follow—and did—into the jaws of hell and a leader who led, rather than sent, his men into the fight. With them, his reputation is untarnished.

And although I am certain that Mrs. Douglas did not mean it in this sense, "the Air Force did itself a disservice." Jack Broughton deserved better from the country that he honored with his service.

David A. Anderton
Ridgewood, N. J.

The letter written by Mrs. Paul P. Douglas, Jr., in the December 1986 issue indicates that the reputation of Col. Jack Broughton might be questionable.

In the minds of hundreds of fighter pilots and acquaintances of Colonel Broughton, the record of outstanding leadership in times of combat and otherwise and faithful service to his country speaks for itself. Colonel Broughton's battlefield valor and devotion to the men under his command made him a hero long before his court-martial, which only served to deprive the Air Force and the American people of one of its finest officers and leaders.

Col. C. L. Van Etten, USAF (Ret.)
Brandon, Fla.

It is a sad day in the history of the Air Force Association when the Editor in Chief and Publisher permit the printing of the letter by Mrs. Paul P. Douglas, Jr., about Col. Jack Broughton.

Mrs. Douglas is certainly entitled to have an opinion, but I firmly believe that the Air Force Association's magazine owes its members more than to permit an unqualified source to pass judgment on any officer. If your intent in printing her letter was to embarrass

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Mrs. Douglas, let there be little doubt that you have succeeded.

Unfortunately, you have departed from the standards expected of an organization of professionals.

Col. Edward A. Zompa,
USAF (Ret.)
Madison, Ala.

Kalamazoo P-39Q

The Kalamazoo Aviation History Museum is compiling the history of the Museum's P-39Q, one of two flying examples left in the world.

This aircraft, AAF 44-3908, was delivered in February 1944 and first assigned to the 3035th Base Unit at Victorville, Calif., in September 1944. Subsequent duty posts were with the 2117th Base Unit at Buckingham Field, Fla., in July 1945 and finally to Tyndall Field, Fla., in October 1945.

The aircraft was surplused to Altus, Okla., in November 1945, being purchased by a civilian in April 1947. There is reason to believe that this aircraft, or at least portions of it, were once part of a modified, two-seat trainer P-39.

The Museum would like to correspond with any P-39 pilots who were stationed at any of these installations during these time periods or anyone who had the opportunity to fly in one of the two-seat conversions. Anyone having any such information is asked to contact the address below.

Theodore Damick
Kalamazoo Aviation History Museum
2101 E. Milham Rd.
Kalamazoo, Mich. 49002-3099

Air Force Artifacts

In preparation for the opening of our $15 million Great Gallery addition to the Museum of Flight in mid-1987, we are looking for Air Force artifacts. These artifacts will be used in future displays and also as reference material in our library research center.

Any of the following items would be of great value and assistance to us: wings, badges, rank insignia, unit patches, uniforms, flight manuals, and aircraft photos. Items need not be new and can be USAAC, USAAF, or USAF.

Any assistance from readers will be acknowledged and greatly appreciated.

Kent Kistler
Museum of Flight
9404 E. Marginal Way S.
Seattle, Wash. 98108

Pierce McKennon Airport

A group of our local citizens is attempting to change the name of the Fort Smith Municipal Airport to the Pierce McKennon Airport in honor of Arkansas's greatest ace (twelve victories, 4th Fighter Group). Surprisingly, our youthful airport commission opposes this change. Those of us who knew Pierce are becoming fewer in number. He died in a flying accident forty years ago.

We feel it would be a great help to hear from his former squadron mates or others who could relate anecdotes or comments concerning Pierce. Letters should be addressed to: Editor, Southwest *Times Record,* Fort Smith, Ark., 72901, or to the address below.

C. K. Gray
2607 Riviera Circle
Fort Smith, Ark. 72903

AIRMAIL

USAF in Britain

I am writing a book that will detail the history and development of the US Air Force in Britain and would appreciate the help of readers who have been based in the UK or who have visited British bases whilst on TDY or transit between 1947–77.

As the history will include details of every flying unit to be deployed to the UK, of which there are more than 250 squadrons from the Air Force, ANG, and AFRES, I would be very pleased to hear from anyone who can supply me with information on their visits to Britain, particularly if they can furnish details on the units they were assigned to, the bases they visited, dates of deployment, and the tail number of the aircraft they flew. Also of interest would be personal accounts of participation in wargames, bombing competitions, and in-flight emergencies.

To illustrate the book, I would like to obtain photographs of all types of USAF aircraft in or en route to Britain. All photographs loaned will be handled with care and returned as soon as possible with postage costs reimbursed to the sender.

Please contact me at the address below.

Graham Luxton
20, Buckden Close
Woodley
Berkshire RG5 4HB
United Kingdom

East Meets West

In hopes of preserving a piece of social history that flourished during the occupation and early postoccupation period here in Japan, and particularly in the greater Yokohama area, we are compiling a list of expressions, catch phrases, and substandard words, laudatory and pejorative, so abundantly in evidence in the civilian-military relationship of the period. To jog the memories of readers, particularly of those survivors who look back with some fondness to that vanished way of life, we offer such expressions as "boy-san," "brownbagger," "long-haired dictionary," "moose," "skivvy," "you Number Ten," and the like. . . .

We solicit the submission of words or phrases that any readers may recall and, upon publication, will gratefully acknowledge those people, civilian and military, kind enough to cooperate in our modest endeavor. Incidentally, any suggestions about other individuals or groups we could contact regarding this project will also be gratefully received.

All items and correspondence should be sent to the address below.

David Gordon
Richard Spear
12-9, Kugayama, 2-chome
Suginami-ku, Tokyo 168
Japan

B-45 Tornado

I am looking for information on the North American B-45 Tornado medium bomber for a book to be published on the aircraft.

I would appreciate hearing from former aircrew members, maintenance and other support personnel, and North American Aviation employees involved in the development of this aircraft. Of particular interest is any information on those aircraft operating in the United Kingdom and on B-45As that were converted to target tugs.

Any photographs, technical data, and personal anecdotes concerning the development and operational life of the B-45 would be invaluable. All submissions will be handled carefully, credited if used, and returned in good condition.

John W. Sheehan
1562 S. Spruce St.
Denver, Colo. 80231

Air Force Songs

After flying two World War II combat tours with the 354th Fighter Group, I have answered what seems like hundreds of letters about my "most exciting" experiences, opinions of enemy aircraft, requests for autographs and pictures, memorabilia, or you name it. Now I wonder if I might turn the tables.

I am trying to collect the words (and

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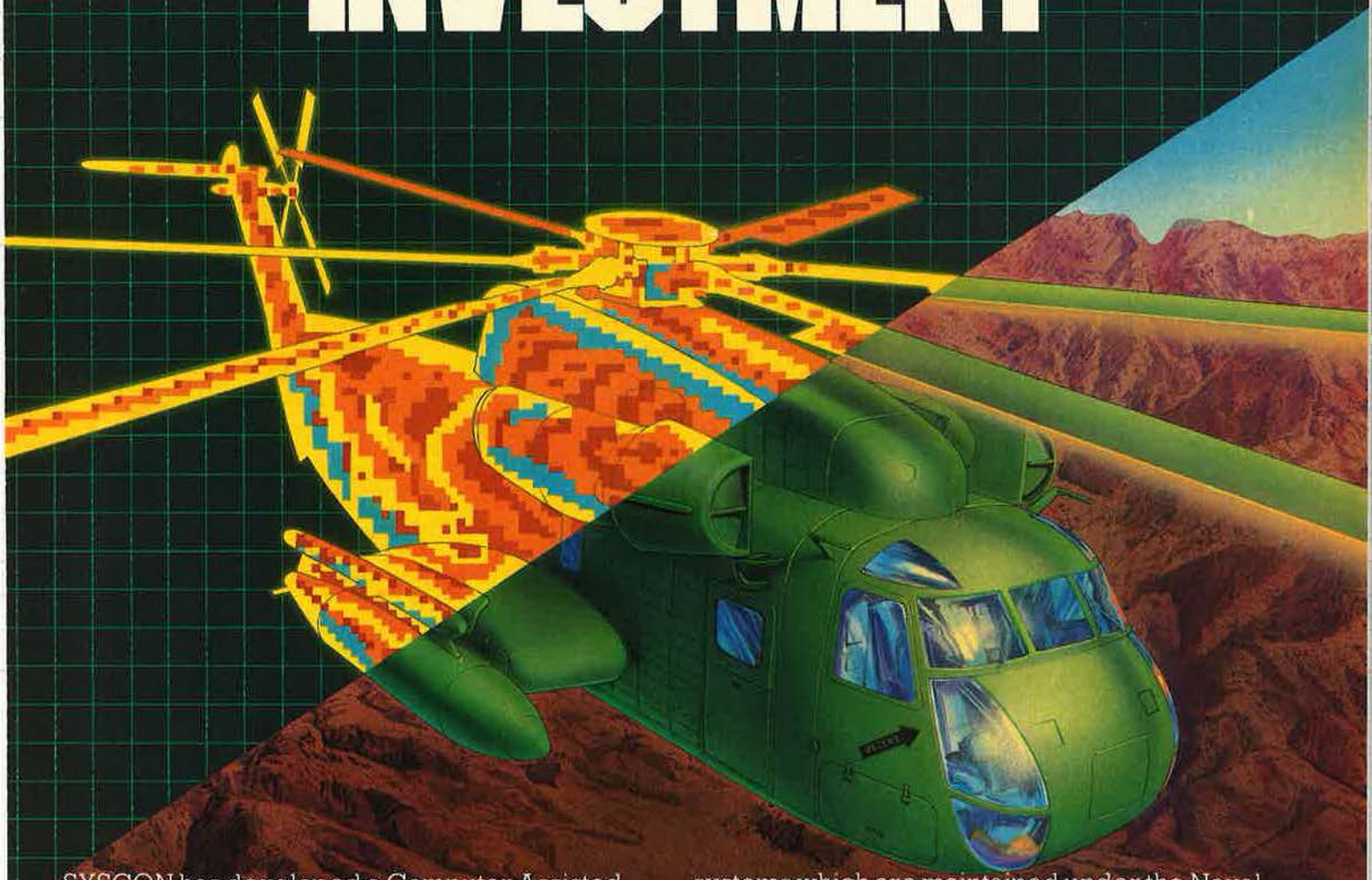

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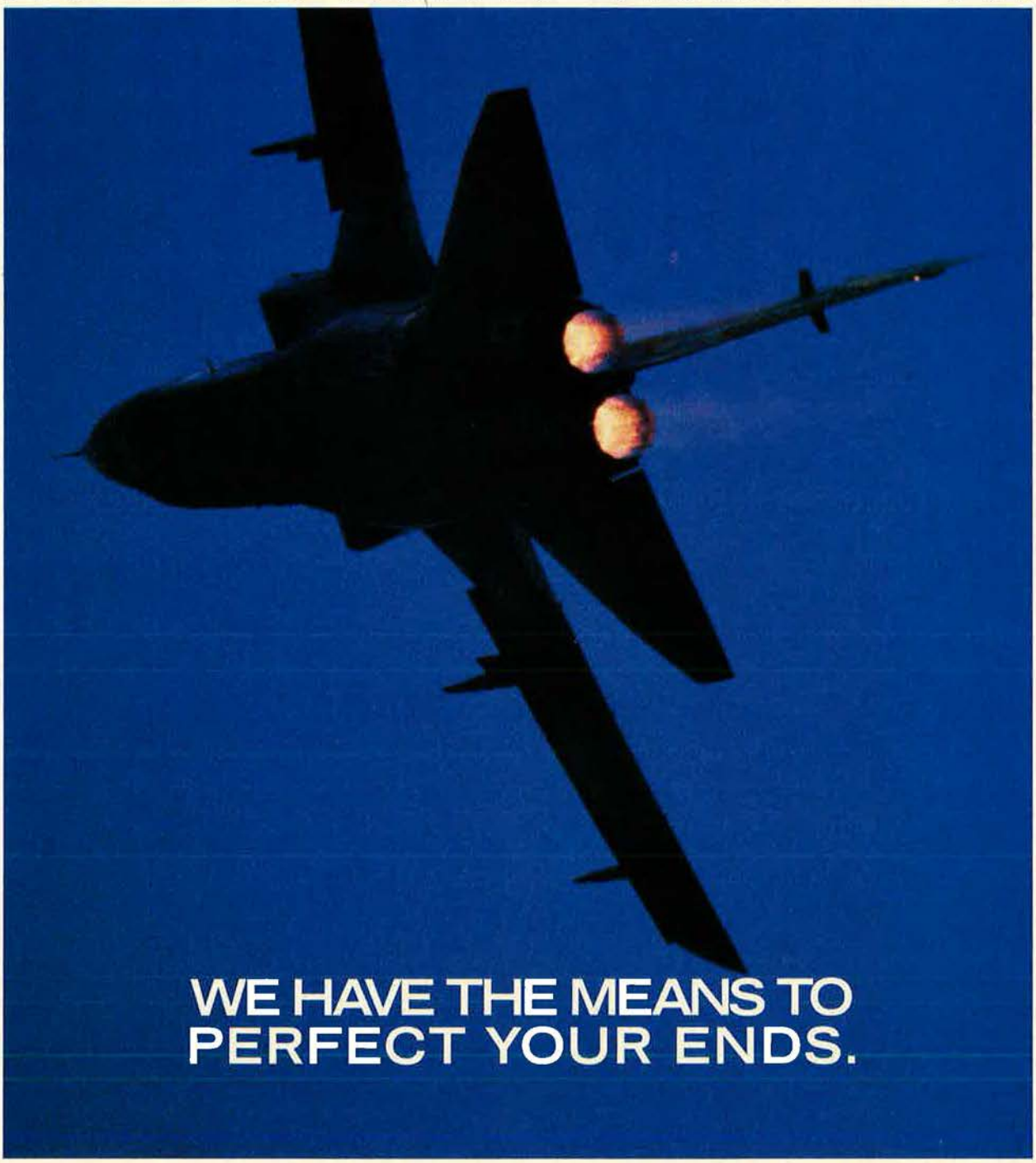

Lucas provides the main engine controls and thrust reverser actuation for the Tornado. Which is hardly surprising, as virtually all the world's most advanced aircraft and missiles depend on Lucas technology. For details contact: Lucas Aerospace Ltd, Brueton House, New Road, Solihull, West Midlands, B91 3TX, England. Tel: 021-704 5171. Telex: 335334. Operating Companies in Australia, Canada, France, UK, USA and W. Germany.

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even melodies) to the many songs we sang around the upright piano in the evenings. I realize that some were not to be sung in polite company, but we enjoyed and relaxed with them many, many times.

Dr. Clayton Kelly Gross
7000 SW Merry Lane
Beaverton, Ore. 97005

Colin Clark's A-7D

Sometime in the future, the USAF Museum plans to acquire a A-7D for our collection. We would like to mark it like the one flown by Maj. Colin A. Clark of the 354th Tactical Fighter Wing on November 18, 1972, when he participated in a nine-hour-plus rescue mission in Southeast Asia.

The problem is that we do not have the necessary data to mark the aircraft—serial number, call sign, etc. Does anyone have any photos of the plane or know the whereabouts of Major Clark? We've attempted to locate him through Air Force records, but have been unable to do so. We are now wondering if he was actually Air Force or on loan from another service.

Vivian M. White
Research Division
USAF Musuem
Wright-Patterson AFB, Ohio
45433-6518

47th Bomb Group

I am presently researching the history of the 47th Bomb Group (Light), constituted on November 20, 1940. The group was assigned to the Twelfth Air Force and served in the Mediterranean theater until the end of the war. The unit distinguished itself in battles at Kasserine Pass in North Africa and the Po Valley in Italy, flying around-the-clock missions.

I would appreciate any information regarding the unit from its activation and through the war to its deactivation. Personal accounts, photos, official documents, etc., would be welcomed. All material will be copied and returned if the sender so desires.

All of this information will be compiled for publication as a historical account of the war years.

Robert B. Kinn
462 Wimbish Dr.
Danville, Va. 24541

312th Bomb Group

A new historical account of the 312th Bomb Group, Fifth Air Force, 1943–45, is being compiled at this time, and the Australian author would like to establish contact with former pilot members.

The history of the 312th is unique in that it arrived in the Southwest Pacific theater as a dive-bomb group and saw the end of the war as a bomb group (very heavy). While in combat, the group transitioned from P-40s to A-20s and, finally, was in the process of converting to the B-32 heavy bomber in the final months of the war.

Please write to me at the address below.

Michael J. Claringbould
48 Warramoo Crescent
Narrabundah 2604
Australia

AIRMAIL

P-51 *Angel's Playmate*

During World War II, the 9th Weather Reconnaissance Squadron (Provisional) officially came into being on June 2, 1944. The 9th WRS absorbed the 107th Tactical Reconnaissance Squadron weather flight, and the unit was activated at Middle Wallop in England. Maj. Maxwell W. Roman was the commanding officer. Equipment used was the P-51B Mustang, and the squadron code was "80."

With reference to the above, I am looking for information concerning an aircraft named *Angel's Playmate.* Its pilot was Lt. Robert G. Ogilvie, and the squadron line chief was Sgt. Frank K. Holub.

Please contact me at the address below.

Seymour B. Feldman
12213 Victoria Falls, NE
Albuquerque, N. M. 87111

Project 100,000

Does anybody know anything about "Project 100,000"? Project 100,000 allowed men who were overweight, underweight, illiterate, or otherwise disqualified from military service to join and lose weight, gain weight, attend school, or do whatever was necessary to qualify for military service. This all took place in the late 1960s.

I am doing a research project on military personnel management and would like to hear from Project 100,000 participants, personnel managers, basic training instructors, and any others who may have knowledge of the project.

Any assistance would be greatly appreciated. Please write to the address below.

Richard Howard
P. O. Box 354
O'Fallon, Ill. 62269

3051st AAFBU

I own a restored 1943 Stearman PT-13D Kaydet trainer that was stationed at Visalia, Calif., with the 3051st AAF Base Unit from 1944 through 1946.

I am soliciting information, photographs, or any other material or memorabilia on the 3051st AAFBU. I am particularly interested in the squadron patch for this unit. I have all of the original AAF paperwork on the airplane, and I would be willing to share copies of this with interested parties.

Anyone having any information on the 3051st AAFBU is asked to call or contact me at the address below.

Larry E. Morris
Rte. 8, Box 29
Concord, N. C. 28025
Phone: (704) 786-1242

Missile Units

I am seeking contact with those who served with the following USAF units: 17th Tactical Missile Squadron (TM-61 Matador), Tainan AB, Taiwan, 1958; 702d Strategic Missile Wing (SM-62 Snark), Presque Isle AFB, Me., 1960; and 445th Bomb Squadron (GAM-63 Rascal), Pinecastle (McCoy) AFB, Fla., 1959.

I need data, photos depicting colors, markings, codes, etc. I will pay for any copies of operational photos.

Ron Andrini
238 State St.
San Mateo, Calif. 94401

F-111A/Bs at Takhli

I am currently writing a book about the General Dynamics F-111A/B used in the period 1972–74 operating out of Takhli in Thailand. The book will be finished in 1987. The information sought includes any actual experiences over Route Pack VI. Also needed are photos of and information on Takhli itself.

Any help will be appreciated, and proper credit will be given to all contributors. Photos will be returned. (Special information is needed on whether or not the F-111A/B was armed with the 20-mm Vulcan.)

Dennis C. Michels
148 Traylors Gate
Irmo, S. C. 29063
Phone: (803) 781-2047

Arc Light

Do you have a favorite "Arc Light" story? If so, I'm collecting them and would appreciate a copy of yours.

I'm particularly interested in the time periods of March to October 1968 and 1969 for crews from Fairchild, Pease, and Clinton-Sherman. Also, the time period from February through May 1971 is of interest. I

would like to hear about "HABU" or the snake crew as well.

Pictures or information on special patches and hat decorations would be appreciated and returned. Please send any material to the address below.

Col. James D. Hooppaw, USAF (Ret.)
W13518 Meadowview Lane
Nine Mile Falls, Wash. 99026

Military Flight Gear

I am still collecting information and photographs for a book on US military flight gear from post-World War II to the present. This is to include flight helmets, flight suits, and oxygen masks.

Any old tech manuals or catalogs would be useful, and any information would be gratefully acknowledged.

Richard Daniell
Quarters 4411E
USAF Academy, Colo. 80840

54th FTS

The 54th Flying Training Squadron is attempting to compile a history of the 54th. Former members of the 54th Transport Squadron, 54th Troop Carrier Squadron, or 54th Flying Training Squadron are requested to forward any photographs or background information for permanent retention.

1st Lt. Ed Norris, USAF
54th FTS/C, Flight/38
Reese AFB, Tex. 79489-5000
AUTOVON: 838-3759

3706th BMTS

The 3706th Basic Military Training Squadron, Lackland AFB, Tex., is compiling a unit history. Records at the Air Force Historical Research Center indicate that the squadron was formed in 1948.

We would like to hear from any former squadron members who could help us with any information that they could furnish.

Maj. Jeffrey K. Hutchinson, USAF
3706th BMTS/CD
Lackland AFB, Tex. 78236-5000

880th Airborne Engineers

In 1944, my Air Forces unit, the 880th Airborne Engineers, was sent to Hollandia in New Guinea to build and maintain airstrips. Do any readers recall this group?

If you have any information about the 880th, I would like to hear from you. Please contact the address below.

Gonzalo R. Cano
144 S. Robertson Blvd.
Los Angeles, Calif. 90048
Phone: (213) 274-7064

AIRMAIL

Roll Call

I am trying to locate the following crew members from World War II Flying Crew 9818: Louis Nickles, radioman; Evon C. Wellsandt, engineer; Harry Beard, ball gunner; and Clifford Mitchell, tail gunner. The crew trained on B-17s at Sioux City, Iowa, before being sent to the European Theater of Operations. The crew was attached to the 369th Bomb Squadron, 306th Bomb Group, stationed at Thurleigh in England.

Lt. Robert Grace, the pilot, and Lt. Walter Cochran, the navigator, met during the 306th reunion in Daytona, Ohio. They are now planning to attend the 306th reunion in Washington, D. C., in 1987 and would like the rest of the crew to be there.

Anyone having any information about these crew members should contact me at the address below.

Bedal Diaz
16235 Indian Creek Rd.
Cerritos, Calif. 90701
Phone: (213) 926-6885

I am trying to locate some crew members who served with me in Italy during World War II (1944) in the 741st Bomb Squadron, 455th Bomb Group, Fifteenth Air Force. I was the pilot of a B-24 named *Organized Confusion.*

The crew members were John E. Merfeld, Herbert B. Cornell, Robert L. Caldwell, Kenneth J. Vincent, James E. Weeks, and Don Keegan.

Anyone having any information about these men is asked to contact me at the address below. (There will be a reunion for all 455th personnel in October at Colorado Springs, Colo.)

Maj. Bill L. Disbrow, USAF (Ret.)
P. O. Box 2337
Stateline, Nev. 89449
Phone: (702) 588-4994

I am searching for five members of my old B-24 crew. We were in the 778th Bomb Squadron, 464th Bomb Group, located at Pantanella, Italy.

They are Leo V. Wesselhoff, James H. Poore, Jr., Edgar P. O'Brien, James F. Scalora, and Jimmie J. Holmes.

I would appreciate hearing from any of these men.

Maj. Bill Millar, USA (Ret.)
7908 Donegal Lane
Smithfield, Tex. 76180
Phone: (817) 281-2119

We are trying to locate four of our gunners so that we can hold a reunion of our B-17 crew from World War II. We served in the 711th Bomb Squadron, 447th Bomb Group, Eighth Air Force.

The four men are Eric L. Spruill, George A. Willmes, Larry V. Truitt, and Roy L. Bogard.

Any information that readers might have would be greatly appreciated.

Brig. Gen. Bob McMath, USAF (Ret.)
10012 N. 67th St.
Scottsdale, Ariz. 85253

I am trying to locate the following individuals who served in the Alaska region during World War II. I wish to contact these two men regarding some research I am doing on the crash of an aircraft in the Yukon during WW II.

They are Lt. Willis Pennington of the 7th Ferrying Group and Capt. R. C. Ragle.

Anyone knowing the whereabouts of these two men should please contact me at the following address.

David A. Beulke
525 Kay St.
Hutchinson, Minn. 55350

I am trying to locate two former aircrew members who served with me in the 738th Bomb Squadron, 454th Bomb Group, at San Giovanni Airfield, Italy.

They are Richard J. Schmid, engineer gunner, last known address in Philadelphia, Pa., and Perry L. Owen from Hollywood, Fla.

Lt. Col. Howard C. Horton, USAF (Ret.)
309 Wild Harbor Rd.
North Falmouth, Mass. 02556-2311
Phone: (617) 563-7285

I am trying to locate Sgt. Terrance O'Donnell, who was stationed at the microwave station at Hohenstadt, Germany, in 1958. I believe his hometown was Kingston, N. Y. Our unit was the 12th Radio Relay Squadron headquartered in Pforzheim, Germany.

Any information would be appreciated.

Ron Zimmer
9 N. Olney Ave.
Cherry Hill, N. J. 08003

I am looking for information on my uncle, 1st Lt. George P. Barrett. He was assigned to the 363d Fighter Squadron, 357th Fighter Group, during World War II. He was involved in a midair collision with two RAF P-51s over the North Sea on June 14, 1945.

I would like to hear from anyone who worked with him on that mission

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Probably.
No we don't
build aircraft.
And we won't
build the ATF.
We'll leave that
to other experts.
But what we do build,
the ATF needs.
Badly.
Avionics...That's us.
The ATF's eyes
and its ears.
Its heart
and brains.
Radar and ECM, E/O
and power generators.
And the
sophisticated
processing necessary
to fuse it all into a
networked sensor suite.
How do you go
about picking a company
to provide avionics
like these?
Any or all of them?
Or to integrate
them successfully?
Perhaps, you look for
experience.
Take radar for
instance.
We've been building
radars for about
50 years.
40,000 of them.
The record speaks
for itself.
Or take ECM.
Nearly 3,000 primary
jammers since the late
sixties.
And the first laser
designator ever.
And more militarized computers
than just about anyone.
Okay.
But what else
do you look for?
After all the past is past.
Maybe current systems and
technology.
Like our work in VHSIC and
in GaAs.
Or the radars for the
F-16 and the B-1B.
Or the 119 and 131
ECM Pods or ASPJ.
Or our AFTI Sensor/Tracker.
But current relevance
alone still isn't enough.
That won't guarantee success
for tomorrow.
But maybe the
Westinghouse Ultra
Reliable Radar will.
Or INEWS.
Or Coronet Prince.
Or our VHSIC PSP
or the Westinghouse VHSIC
1750A computer.
Or GaAs MMIC's.
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Current today.
And innovating for the
future.
Ready to provide any
or all of the sensors
needed for ATF.
And the processing and
coordination necessary to
make them work together.
No one knows the
individual disciplines
better.
No one can bring more
to their integration.
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Hughes has donated a trophy for excellence in air traffic safety. The trophy, named for the pioneer Air Traffic Controller, Glen A. Gilbert, has been donated to the Air Traffic Control Association and will be presented annually by the Association to an individual for a lifetime commitment to excellence, professionalism, and outstanding achievement in aviation and air traffic safety. The trophy stands almost three feet high and is made of crystal and silver. Hughes is a corporate member of the Air Traffic Control Association.

TV-guided Maverick missiles will let West German pilots strike surface targets with pinpoint precision. Maverick can be launched at great distances from a variety of aircraft against targets such as tanks, parked aircraft, and field fortifications. A TV camera in Maverick's nose magnifies a target scene for the pilot to view on a cockpit display. The pilot locates a target, locks onto it, fires the weapon, and can leave the area or attack other targets in the vicinity. The missile, meanwhile, guides itself to impact. Hughes has re-opened production on the AGM-65B Maverick to deliver tactical and training missiles to the Federal Republic of Germany beginning in 1987.

A hand-held infrared viewer helps reduce losses for a large insurer of boiler machinery. Insurance company engineers use Hughes' Probeye® infrared viewer to survey plants of applicants and policyholders. The Probeye viewer sees heat the way a camera sees light, converting it instantly into an image seen through the eyepiece. Inspectors check for potential hazards in piping systems, electrical connections, and pressure vessels. Infrared viewers are valuable tools for paper manufacturers, too. Moisture in paper sheets must be monitored continually during processing, since sharp differences can result in serious defects. The viewers pick up temperature changes caused by varying moisture conditions, enabling operators to stop the process and make corrections.

A proposed satellite system would provide mobile telephone and radio communications and rural telephone service direct via satellite. The mobile satellite network would relay two-way voice and data communications services from airplanes, cars, trains, or remote locations. Each vehicle or location would be equipped with antennas that will vary in size and power depending on users' needs. The system would rely on cooperation between the United States and Canada, each of which would provide a satellite from Hughes' new HS 393 line of spacecraft. The system would employ an antenna technique for supplying more power to the ground in most places than an ordinary antenna—the key element in a mobile satellite system. Hughes Communications Mobile Satellite Services, Inc. is seeking authorization from the Federal Communications Commission to operate the system.

For more information write to: P.O. Box 45068, Los Angeles CA 90045-0068

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and would also like to get some squadron and group patches. Any memorabilia that I could keep would be greatly appreciated.

Gene Barrett, Jr.
4327 N. 1st St.
F. E. Warren AFB, Wyo. 82001

I am searching for individuals having any knowledge about 1st Lt. James L. Badley, USAF, who was KIA in Vietnam in 1968. I am also searching for anyone who flew backseat in an F-4D out of Danang during 1968.

Please contact me at the address below.

O. G. Thomas
4107 Whitford Circle
Apt. 807
Glen Allen, Va. 23060

My uncle, Sgt. John D. Duckworth, lost his life during a B-29 raid on an urban area of Tokyo on May 26, 1945. He was based on Tinian Island in the Marianas and was a gunner with the 482d Bomb Squadron, 505th Bomb Group, 313th Bomb Wing.

I was born after his death and would now like to learn more about him. All my family will appreciate any information from anyone who knew him.

Beth Hanson
16 Friar Tucks Ct.
Ballston Lake, N. Y. 12019

I am trying to locate three members of my crew on the B-17 *Big Time Operator* who flew with the 532d Bomb Squadron of the 381st Bomb Group during World War II.

They are Fred T. Berg, Thomas J. Hester, and Joseph F. Mello.

Anyone knowing their whereabouts should contact me at the address below.

Ken Stone
12112 Arkley Dr.
Garden Grove, Calif. 92640
Phone: (714) 539-6728

I am trying to locate my close friend, Milton W. "Skip" Skillern. We were together on Guam in 1945 at Twentieth Air Force headquarters. Sergeant Skillern served as Gen. Curtis LeMay's secretary at that time. He is from Austin, Tex.

Please contact me at the address below.

Stan Lee
P. O. Box 5006
Santa Monica, Calif. 90405
Phone: (213) 399-1579

I am attempting to contact any former members of the 67th Fighter Squadron who were assigned to that unit between the years of 1942 and 1943.

I am researching the history of the squadron for that time period. It was the only aircraft squadron to spend the entire campaign stationed at Henderson Field in Guadalcanal.

Please contact me at the address below.

Joe F. Myers
6119 Idlebrook Dr.
Charlotte, N. C. 28212

I am looking for a P-47 Thunderbolt pilot named Tom who had blond hair and blue eyes and who flew out of England and Deauville, France. He knew and dated an Army nurse named Sylvia and held the rank of major or lieutenant colonel. He may have been from Arizona.

If you can help me to locate this man, please contact me at the address below.

J. David Heaphy
P. O. Box 771
New Rochelle, N. Y. 10802
Phone: (914) 632-2718

I am searching for a friend of mine whom I lost contact with after World War II. He is Sgt. Donald Dempsey Carson, and he served in the Pacific from 1944 until the end of the war.

Anyone knowing his whereabouts is asked to contact me at the address below.

Bruce L. Hickey
5781 Campus Ct.
Hazelwood, Mo. 63042
Phone: (314) 731-3881

We are trying to locate two World War II flying buddies—Sgt. Joseph W. Despot, last known address in Williamsburg, Pa., and Sgt. Donald W. Chastoen, last known address in Kempton, Ind. They were part of Boyd E. Leslie's B-25 crew in the 41st Bomb Group in the Pacific during the war.

Anyone having any information about these two airmen is asked to contact me at the address below.

Thomas Zachok
25 Monterey Dr.
Wayne, N. J. 07470
Phone: (201) 694-4672

For an upcoming reunion, I am trying to locate Lt. Rodney F. Marston. His last known address was in Shrewesbury, Mass. I am also looking for Lt. Sidney Morse, last known address in Brooklyn, N. Y. I flew with them during World War II in the 340th Bomb Squadron, 97th Bomb Group.

AIRMAIL

I would like to thank readers in advance for any help they might give.

Robert J. Sitterly
2258 Charing Cross Rd.
Baldwin, N. Y. 11510
Phone: (516) 223-2512

I am writing in an attempt to locate a buddy of mine whom I lost track of several years ago. We were in college together, and he was the best man at my wedding. His name is Gary Alexander, and in 1979 he was a lieutenant serving as a navigator.

If any readers know of him, I would like to hear about it.

John G. Pavelec
P. O. Box 168
Herndon, Va. 22070

I am seeking the following crew members of the B-26 *Pugnacious:* Lash, Back, Jenkins, Makouich, Dittmar, Patton, and Baroni. They served during 1943–44 in the Ninth Air Force in the ETO. I have a photo that I would like to give them.

Please contact me at the address below.

Maj. R. C. Harris,
USAF (Ret.)
4813 Burton SE
Albuquerque, N. M. 87108

I am carrying on research concerning B-17 operations in East Anglia from 1943 until the end of the war and would like to contact the two following individuals.

They are MSgt. Robert G. Levi of the 325th Bomb Squadron, 92d Bomb Group, and Frank O'Conwell, 813th Bomb Squadron, 482d Bomb Group, Eighth Air Force.

Please contact me at the address below.

Capt. Peter H. Liotta, USAF
1583 Mecklenburg
Ithaca, N. Y. 14850

I am trying to make contact with William Lovejoy, who served with the US armed forces during World War II. He was stationed at Bristol, England, in August 1944. He was a friend of my mother, Annie Currell.

Please contact me at the address below.

Eric W. Morris
Ulvstorp PL8019
53400 Vara
Sweden

I am trying to locate four missing members of my B-29 crew. We were based at North Field, Guam, in 1945 and participated in the low-altitude bombing of Tokyo, Nagoya, Kobe, and Osaka.

Our unit was the 30th Bomb Squadron, 19th Bomb Group, and Maj. Fred Blakely was the aircraft commander. The missing members include Oliver T. Johnson, Edwin L. Johnson, Alfred L. Marcum, and Royall T. Moore.

Anyone having any information about these men should contact me at the address below.

Floyd Shelp, Jr.
Rte. 5, Box 56
Caldwell, Idaho 83605
Phone: (208) 459-4805

I am trying to locate members of the Eighth Air Force who served in the 96th Bomb Group during World War II. My uncle, SSgt. Glen W. Wallace, was a ball-turret gunner on B-17G 43-37645.

It is presumed that the plane, with all aboard, went down in the North Sea on March 24, 1945. According to the information I have, 1st Lt. Ronald D. Birch was piloting the plane.

Any information that readers can provide me about this plane and its crew will be greatly appreciated.

Terry Hickman
4205 Santa Maria Dr.
Reno, Nev. 89502

I am in the process of preparing a written history of my father for my son. I would truly appreciate hearing from anyone who knew him.

His name was Aranda R. Callen. He retired from the Air Force as a chief master sergeant in 1973 after thirty-two years of service. The bulk of his service was with SAC in fire control. Dad died in 1982 while I was stationed in Germany. He never saw his grandson.

I would appreciate anyone's help with this project. Please contact me at the address below.

Aranda R. Callen, Jr.
2276 Windsong Dr., Apt. G
Indianapolis, Ind. 46229

I would like very much to establish contact with Alfred J. Dempsey, who was a member of pilot training Class 56-S.

I may be contacted at the address below.

Col. John A. Hall, USAF (Ret.)
425 Marion Dr.
Niceville, Fla. 32578

The 410th Bomb Group Association is searching for former members from World War II. For details on newsletters, reunions, and a group history, please contact the address below.

410th Bomb Group Ass'n
6 Laurel Lane
Syosset, N. Y. 11791
Phone: (516) 921-1016

I am searching for anyone who may have known my father, 1st Lt. Adam "Chuck" Schwindle. He was killed during a B-25 bombing mission to Piombino Beach Harbor in Italy on March 14, 1944.

Any information about him or his unit, the 381st Bomb Squadron, 310th Bomb Group, would be gratefully appreciated.

Lt. Col. James M. Schwindle,
USAF
P. O. Box 1362
Fairborn, Ohio 45324

I would like to contact anyone who knows the whereabouts of Bill Turner.

In 1956–57, Bill was a first lieutenant attending the reconnaissance-bombardment course at Mather AFB, Calif., where we inadvertently mixed up some home movies of his family (which I have) with my movies of Alaska (which I hope he has).

Capt. Michael S. Scherer,
USAF (Ret.)
4040 Collin Dr.
West Palm Beach, Fla. 33406
Phone: (305) 965-0912

AFROTC Det. 910

The cadets of AFROTC Detachment 910 at the University of Washington are conducting a search. We are seeking information on any and all of our alumni for the purpose of forming a detachment alumni association.

We are anxiously waiting to hear from you. Please send us a short biography, service history, and, if possible, a current unit patch.

We invite you to contact us at the address below.

AFROTC Det. 910
University of Washington
Clark Hall, DU-30
Seattle, Wash. 98195-0001

AFROTC Det. 775

We would like to hear from alumni of AFROTC Detachment 775 at the University of South Carolina. Please drop the detachment a line, briefly telling us what has happened in your career since you graduated from the University of South Carolina.

Please contact the address below.

Alumni Committee
AFROTC Det. 775
University of South Carolina
Columbia, S. C. 29208

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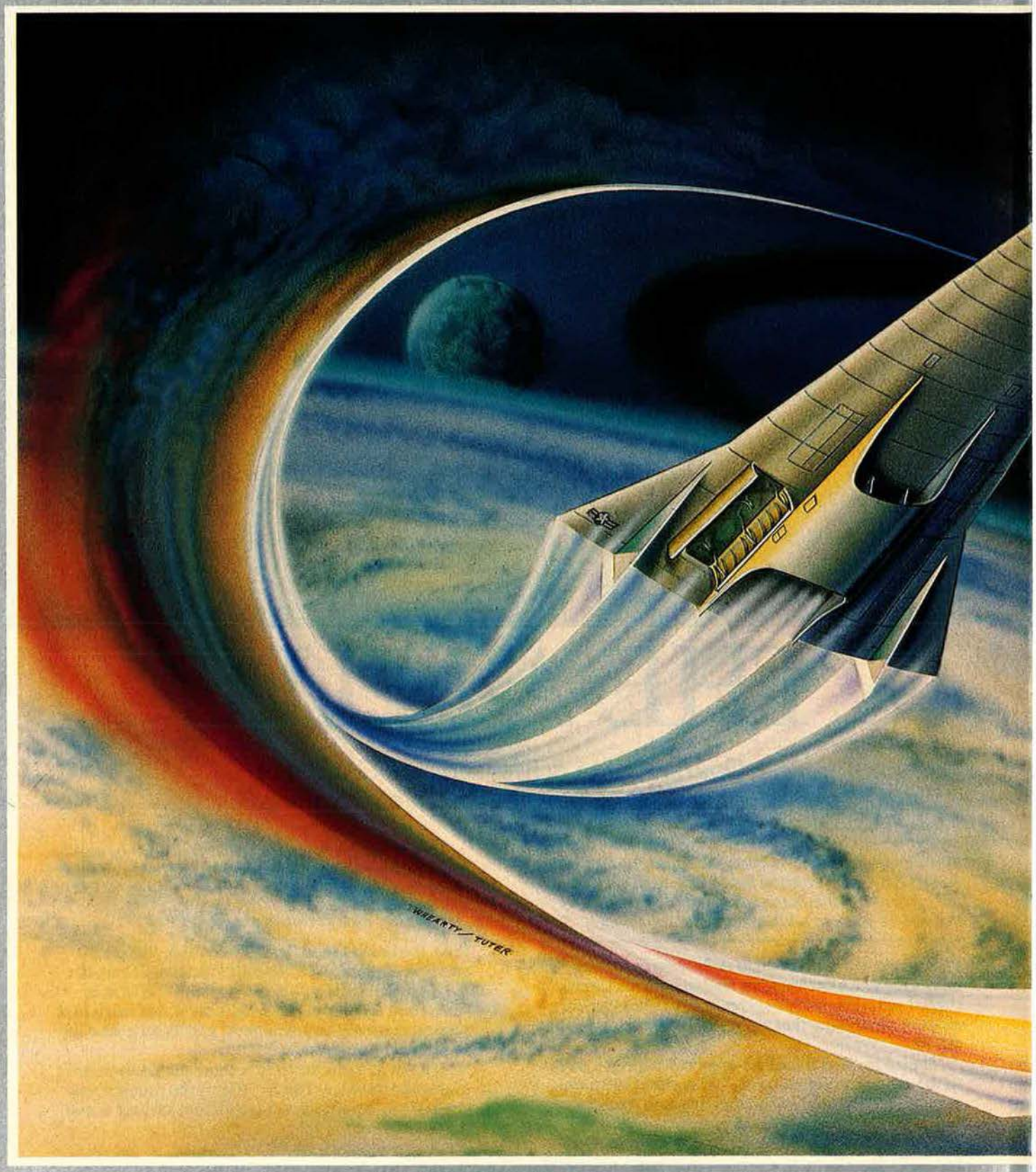
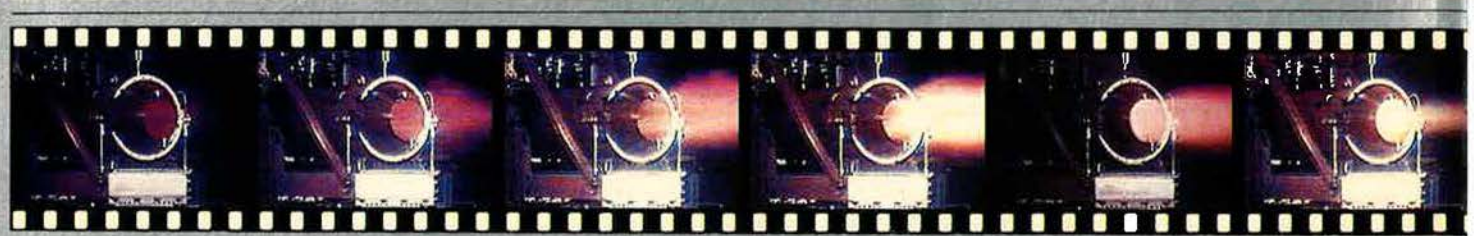
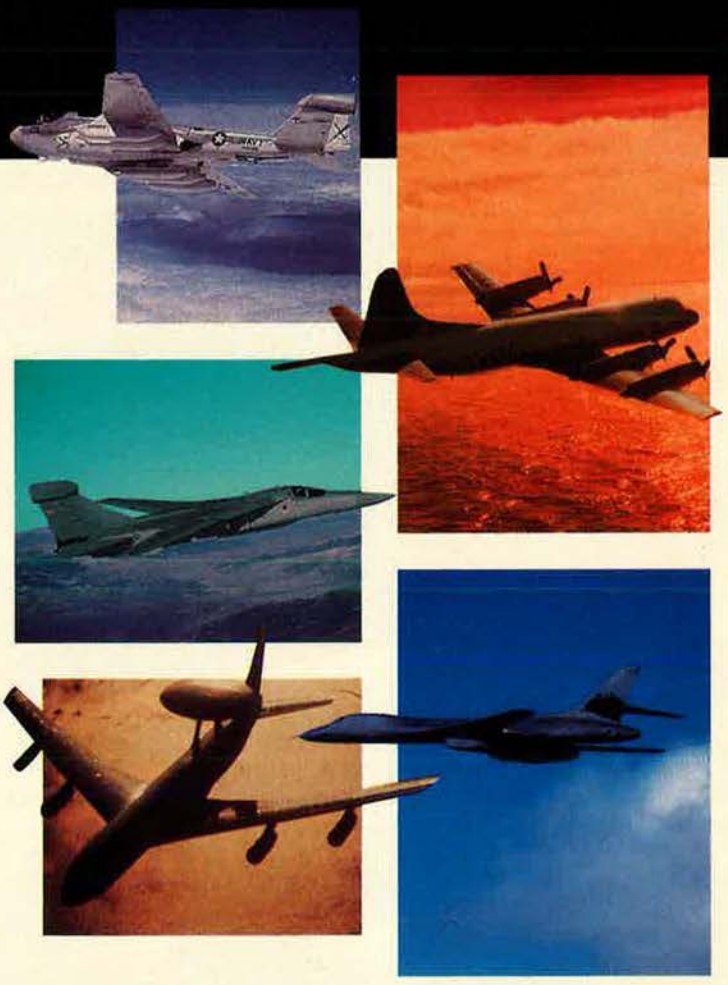




ATR firing demonstrating 10:1 turndown ratio

The Threats Are There



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IN FOCUS...

Two-Missile Program Continues

By Edgar Ulsamer, SENIOR EDITOR (POLICY & TECHNOLOGY)

After acrimonious internal infighting, the Administration has decided to press ahead with full-scale development of the Small ICBM while working on a rail-garrison basing mode for the MX Peacekeeper.

Washington, D. C., Jan. 6

On December 19, 1986, the White House decided to proceed with full-scale development of the Small Intercontinental Ballistic Missile (SICBM) and to begin development of a mobile, so-called "rail-garrison" basing mode for the MX Peacekeeper. In announcing the decision, the White House—in line with the findings of a comprehensive, eighteen-month study by the Air Force—stressed that the two programs constitute an integrated package and complement one another in a highly synergistic fashion.

Even though the President's order authorizes research and development *only* for the two ICBM modernization programs, it was preceded by acrimonious infighting within the civilian hierarchy of the Pentagon that also involved the US Arms Control and Disarmament Agency (ACDA). The opposition reportedly involved officials usually known for their "hard-line" views. Some of them were said to consider the relatively high costs of the SICBM a budgetary threat to the Strategic Defense Initiative (SDI, popularly known as "Star Wars"); others also were allegedly motivated by the wan hope that the Soviets might halt the fielding of mobile SS-24 and SS-25 ICBMs if the US canceled its corresponding development programs. The White House apparently found the opposition's logic wanting and opted for the Air Force's ICBM modernization package.

The cardinal traits of the Air Force's modernization package are that, in a generic sense, it provides the ICBM force with high survivability extending from "worst-case," bolt-out-of-the-blue scenarios to more plausible assumptions about gradual crisis escalation as well as great cost-effectiveness and operational flexibility. Undergirding the rationale for the integrated package is the SIOP's (single integrated operational plan) central, bedrock requirement for a total of 1,500 prompt, hard-target kill-capable ICBM warheads.

Of this total, 500 MIRVed warheads will be carried by the first fifty ten-MIRV MX Peacekeepers that are being deployed in modified Minuteman silos.

Another 500 warheads are to be carried by the second fifty MX Peacekeepers, which will be deployed in a mobile rail-garrison basing mode *(see "ICBM Basing Mode Questions," November '86 issue, p. 29).*

Lastly, the final 500 warheads would be carried by that many SICBMs deployed on individual hard mobile launchers (HMLs). The HMLs could be based at existing Minuteman facilities or dispersed over wide areas in "random movement" fashion.

The recent White House decision, of course, is merely a first step toward a 1,500-warhead ICBM force, for it contains the proviso that "the total quantity of systems to be produced, and the extent to which the missiles are to be deployed, will be dependent on the size of the Soviet threat and progress reached on arms-control agreements."

The genesis of the integrated ICBM modernization package can be traced to the 1983 report by the Presidential Commission on Strategic Forces, the so-called Scowcroft Commission, which recommended the immediate deployment of 100 MX ICBMs linked with the subsequent development and fielding of single-warhead SICBMs. The Scowcroft panel's recommendation initially received strong bipartisan support in Congress, but Capitol Hill, beginning with the 1984 DoD Authorization Act, modified the original plan with a number of restrictions. Key among them were the prohibition against deploying the second fifty MX Peacekeepers in basing modes that Congress did not deem more survivable than the silo-basing of the first fifty missiles and the mandate that the SICBM must be in full-scale development before the forty-first MX Peacekeeper can be deployed in a Minuteman silo.

The White House decision of December 19 safeguards the crucial linkage between MX and SICBM and satisfies all relevant congressional "riders" associated with the two weapon systems.

In the case of the MX program, the White House pointed out that the Presidential decision meets the congressional direction to consider alternate basing modes and deployment areas for the missile by developing a basing mode for placing the "missiles on railroad cars during peacetime at military installations around the country. During times of national emergency, the Peacekeeper missiles could be moved to classified locations."

The White House disclosed that the main operating base for the rail-garrison MX would be at F. E. Warren AFB, Wyo., where "there is already a sizable investment in Peacekeeper support facilities. Garrisons would be located at F. E. Warren AFB and at other defense installations throughout the continental US." Ten rail-garrison MX bases are to be considered in addition to the main operating base at F. E. Warren, but probably no more than seven will actually be picked and developed. The White House promised that the ten candidate rail garrisons will soon be identified publicly.

The rail-garrison concept, albeit still tentative and subject to modifications, revolves around placing two Peacekeeper ICBMs each on twenty-five trains that would be indistinguishable from other rolling stock and that could be "flushed" from their garrisons by the National Command Authorities to disperse over the 200,000-mile rail network of the US. There are various options for conceal-

ing the location of the trains, including "snuggling," meaning the intermingling of the MX trains with commercial counterparts at marshaling yards. Soviet overhead sensors or even ground-based intelligence agents would be hard pressed to tell the individual MX launch cars apart from thousands of look-alike commercial rolling stock.

Based on the experience with SAC's strategic nuclear armed bombers—which, over the past thirty years, have never had to be launched to their survival orbits—the Air Force doesn't expect that the garrisoned MX Peacekeepers will have to be "generated" (meaning flushed) very often, if at all. Nevertheless, the Air Force plans to use training trains, carrying no nuclear warheads, to exercise the weapon system and familiarize crews with MX operations on the national rail network. During periods of high international tension—when so ordered by the President—the missiles would disperse using existing private and commercial railroad tracks.

While in their garrisons, the missiles and their railroad cars would be kept in special, highly secure areas. Once generated, the trains might roam the rail network, be dispatched to special sidings that could include

IN FOCUS...

concealment and "shell-game" features, or use other means to create "position location uncertainty" for a potential attacker. During periods of dispersal, security teams would travel with the missile trains to provide protection against sabotage and conventional enemy attack.

The seventy-one-foot-long, 195,000-pound MX would initially be transported on its own railroad car to a garrison where it would be mated with its ten warheads. The missile can be launched from its car only when the train is stationary. Two SAC combat crew members aboard the missile train's command and control car are required to launch a missile upon receipt of authenticated launch orders from the National Command Authorities (NCA). The accuracy of the rail-mobile MX is expected to be approximately the same as that of the silo-based weapon.

Not counting the cost of the missiles themselves, the Air Force estimates that the rail-garrison basing mode will require about $2.5 billion in R&D funds and between $4 billion and $5 billion in procurement money. The cost of the deployed fifty missiles associated with this basing mode, depending on the rate at which they are acquired, is likely to be around $2.5 billion, making the total price tag about $10 billion.

The acquisition of the fifty missiles is part of a 223-MX buy contemplated by the Air Force, one way or another. One hundred of those missiles would be for deployment in line with the recommendations of the Scowcroft Commission. In addition—and regardless of whether fifty or a hundred MX Peacekeepers are actually deployed—108 missiles are required for operational test firings over the service life of the weapon, along with fifteen spares that are to be used to gauge aging and deterioration.

The Air Force's timetable with regard to the rail-garrison basing mode calls for completion of the siting phase by December 1987. This is to include selection of facility siting options along with routing of associated rail spurs and, if necessary, land or easement options. By November 1988, a comprehensive environmental impact statement covering all as-

pects of the weapon system and its operation is to be filed with the Environmental Protection Agency. Full program go-ahead is expected a month later, and the system is to achieve IOC (initial operational capability) two years thereafter.

There are no plans to retrofit any or all of the fifty silo-based MX Peacekeepers to the rail-garrison deployment mode. Auspiciously, the Air Force beat a schedule deadline set some eight years ago to achieve IOC of the silo-based MX almost concurrently with the President's decision to start development of the rail-garrison basing mode for the second fifty Peacekeepers.

The Strategic Air Command now has ten of the four-stage missiles on alert on the plains of southeastern Wyoming near F. E. Warren AFB. These missiles, which can deliver ten reentry vehicles each to separate targets more than 6,000 miles away, are the first new ICBMs to enter the US inventory since Minuteman III first entered service in 1970. With fifteen out of a scheduled twenty MX test flights completed—all successful and most with accuracies significantly greater than specified—and the weapon achieving operational status on cost and ahead of schedule, the Peacekeeper program has emerged as one of the Pentagon's model R&D and acquisition efforts.

By authorizing immediate full-scale development of the SICBM, the White House expects IOC of this 37,000-pound, single-RV missile in December 1992, or two years earlier than if a 52,000-pound MIRVed system had been chosen. The initial deployment is scheduled to involve Minuteman facilities at Malmstrom AFB, Mont. After activation of those SICBMs, follow-on systems could be deployed at other Minuteman facilities at F. E. Warren AFB (involving sites in Wyoming, Colorado, and Nebraska) and at Ellsworth AFB, S. D.

The new SICBM will be about fifty-three feet long, forty-six inches in diameter, and easily transportable using a hard mobile launcher that is about ninety-five feet long and weighs about 215,000 pounds. Boeing Aerospace Co. has just been awarded a fixed-price incentive contract pegged at some $283 million for the full-scale development of the SICBM's HML and scheduled to be completed in June 1991. The HML will be capable of speeds ranging from about fifteen mph in offroad travel to fifty-five mph on paved roads.

Those SICBMs situated at Minuteman facilities will perform strategic alert duties within the fenced areas of the sites. The missiles and their launchers would move out of the fenced areas only during periods of grave international tension or for major maintenance.

Additional SICBM HMLs could be deployed in random movement on large tracts of government land in the southwestern portion of the country. This could involve deployments at a Texas/New Mexico complex consisting of Fort Bliss, White Sands Missile Range, and Holloman AFB and at an Arizona complex consisting of the Luke AFB Range and Yuma Proving Ground. Holloman AFB and the Yuma Proving Ground would serve as the main operating bases for the respective complexes.

These HMLs would be moved randomly within the reservations to keep potential attackers from pinpointing their location in real time. Using a baseline planning number of 500 deployed systems, the Air Force expects the costs of the SICBM program to range between $39 billion and $42 billion. The R&D portion of the program is expected to absorb about $11 billion. The first test launch of the SICBM is to occur in 1989.

Assuming that all 500 SICBMs are

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deployed in HMLs operating at Minuteman facilities, the associated manpower requirement is expected to range around 5,300 slots. This compares to about 2,400 slots required to operate the MX/rail-garrison system. In probing the respective pluses and minuses associated with a single-RV-plus-penetration-aids version of the SICBM vs. two- or three-warhead designs, the Air Force concluded that—located at Minuteman sites—a three-warhead missile would not be sufficiently mobile to meet the weapon's survivability standards.

The two-warhead design, on the other hand, matched the single-RV version's mobility in random movement as well as at the Minuteman sites. The former also could have lowered life-cycle costs by about twelve percent and made possible manpower reductions of about twenty-five percent compared to the single-RV design. The Air Force—and subsequently the White House—ultimately opted for the single-warhead configuration because such a weapon can be fielded about two years sooner.

While the MX/rail-garrison system boasts formidable cost advantages in terms of both acquisition and operation compared to the SICBM, there are compelling military reasons for building a mixed force of silo-based and rail-garrisoned MIRVed MX Peacekeepers, on the one hand, and road/offroad mobile SICBMs, on the other. The SICBM provides the US with the capability to deal with tactical warning—meaning indications that the nation is under threat from Soviet strategic systems. As a result, the small, highly survivable missile in its hard mobile launcher provides unique deterrence to bolt-out-of-the-blue first strikes. In addition, under certain protracted nuclear war scenarios, there are advantages to assigning single-RV weapons with prompt hard-target kill capability to isolated surviving targets rather than having to dispatch a ten-warhead MX against each one.

The Peacekeeper force, on the other hand, is designed to respond most cost-effectively to strategic warning, meaning indications of stepped-up Soviet military readiness associated with an international crisis with enough lead time to disperse the rail-mobile ICBMs over a wide area.

The Soviets could not contemplate a successful attack on the fifty rail-borne Peacekeepers unless they devoted a nuclear arsenal eight times larger than their total existing one to this single task. In addition, there is no way that Soviet warplanners could know whether the US NCA would—upon receipt of tactical warning—decide to ride out the attack or launch its ICBMs, including the instantly ready silo-based Peacekeepers, "from under the attack."

Lastly, while the military need for the SICBM is self-evident, so is the imperative impelled by political reality: There is virtually no chance that the 100th Congress would approve go-ahead on MX/rail garrison—regardless of its merits—without an Administration commitment to the SICBM, which has become an article of faith with large and decisive elements of both chambers.

In light of the Administration's impromptu decision at the Reykjavik "presummit" to consider the elimination of ballistic missiles, some factions on Capitol Hill might be tempted to jump the gun and vote against any ICBM modernization program at this time. As a result, acceptance of the Air Force's integrated ICBM modernization package by Congress is not going to come easy in the months ahead.

IN FOCUS...

Washington Observations

★ There is confidence within SAC and the Air Force's R&D community that a series of problems plaguing the B-1B earlier this year will be largely corrected by 1988, without a breach of the program's $20.5 billion baseline cost ceiling. By then, retrofit of a stall inhibitor system (SIS) as well as of a stability enhancement function (SEF) device *(see "The B-1B Whisper Campaign," p. 29, June '85 issue)* will have been completed to permit operation of the strategic bomber consonant with the performance specifications.

While there may be questions about more rapid than anticipated Soviet threats to the aircraft's EW (electronic warfare) suite, the need for sporadic upgrades is unavoidable. The B-1B's "terrain-bounce" feature, meaning its ability to cause enemy radars to "see" the aircraft in places where it is not, and its tail-warning radar can give the B-1 the ability to penetrate heavily defended airspace even when its EW capabilities are not fully effective.

★ The Chief of Naval Operations, Adm. Carlisle Trost, recently told a seminar of the American Defense Institute on Capitol Hill that "if we are going to make seapower work in the twenty-first century, we are going to have to maintain our advantage in [antisubmarine warfare, or ASW]." Pointing out that the US will have to contend with more than 350 Soviet submarines that "are getting quieter and harder to detect," Admiral Trost provided this benchmark: "When you consider what the Germans were able to achieve in two world wars—and what our own Navy was able to achieve in four years in the Pacific [during World War II]—and when you consider that in each case the number of submarines at the start was one-fifth to one-tenth the size of today's Soviet submarine force, you have to respect the potential of the Soviet Navy to disrupt the sea lines of communications."

While passive acoustic ASW detection has been the "mother lode" of ASW since the advent of the nuclear submarine, the CNO said, "At some time in the future, it can be postulated that [the Soviet submarines] will become as quiet as the ambient sea, and then we will have to turn to other methods of detection."

★ Adm. William J. Crowe, Jr., Chairman of the Joint Chiefs of Staff, testifying before the House Armed Services Committee's Defense Policy Panel on the outcome of the presummit meeting at Reykjavik, asserted that "in the final analysis it should be kept in mind no agreements were reached, and despite some public hand-wringing and gnashing of teeth, our fundamental interests are still intact. At the same time, I would suggest that the whole arms-reduction dialogue has taken a significant and historic step as a result of Iceland." He added that "the challenge is now to capitalize on these events in ways that do not jeopardize our security."

He rejected media speculation that the Joint Staff was not consulted on a regular basis, but acknowledged that "the discussions concentrated more on arms-control details and went much further with arms-reduction proposals than had been anticipated in the preparations."

★ The Strategic Defense Initiative Organization's Deputy Director for Programs and Systems, Brig. Gen. Malcolm R. O'Neill, recently acknowledged that the NASA Space Shuttle is not "cost-effective" as the primary space-launch vehicle for SDI. He also disclosed that SDIO is working on neutral particle-beam sensors that could "radar-image" targets in space, penetrate them, weigh the contents, and determine if there are nuclear materials inside the vehicle that is being probed. ■

CAPITOL HILL

By Brian Green, AFA DIRECTOR OF LEGISLATIVE RESEARCH

Washington, D. C., Jan. 2

SASC Reorganized

Sen. Sam Nunn (D-Ga.), the new Chairman of the Senate Armed Services Committee (SASC), has reorganized SASC subcommittees along mission lines. The mission focus of the subcommittees is intended to improve congressional oversight of broad policy issues and to reduce the micromanagement of specific budget line items. The new subcommittees are:

- **Strategic Forces and Nuclear Deterrence.** This subcommittee will oversee policy, doctrine, programs, and major commands that support nuclear deterrence, including the Stealth bomber, ICBM modernization, SDI, the Strategic Air Command, and US Space Command. Chaired by Sen. James Exon (D-Neb.); Sen. Strom Thurmond (R-S. C.), ranking minority member.
- **Conventional Forces and Alliance Defense.** This panel will focus on defense of NATO and East Asia, R&D and procurement for tactical aviation and missiles, and improved coordination and cooperative weapons development and procurement with our allies. Chaired by Sen. Carl Levin (D-Mich.); Sen. Dan Quayle (R-Ind.), ranking minority member.
- **Force Projection and Regional Defense.** This subcommittee will oversee airlift, sealift, and the defense of those regions in which the US does not have substantial forces deployed. The Military Airlift Command and the new unified Special Operations Forces Command will fall under the purview of this body. Chaired by Sen. Ted Kennedy (D-Mass.); Sen. William Cohen (R-Me.), ranking minority member.
- **Manpower and Personnel.** Members of this subcommittee will review all defense manpower policies, including mobilization capabilities and retirement. Chaired by Sen. John Glenn (D-Ohio); Sen. Pete Wilson (R-Calif.), ranking minority member.
- **Readiness, Sustainability, and Support.** This subcommittee will monitor the military's ability to go to war and to sustain deployed forces. It will review operations and maintenance budgets, funding for spares and ammunition, and military construction. Chaired by Sen. Alan J. Dixon (D-Ill.); Sen. Gordon Humphrey (R-N. H.), ranking Republican.
- **Defense Industry and Technology.** This panel will review the US defense industrial base, technology base, acquisition policy, and some defense laboratories. Its mission is keyed on marshaling defense resources to assure US technological superiority. Chaired by Sen. Jeff Bingaman (D-N. M.); Sen. Phil Gramm (R-Tex.), ranking minority member.

New Committee Members

The new Democrats assigned to the SASC are Sen. Albert Gore (D-Tenn.), a vocal advocate of a single-warhead Small ICBM and an opponent of the MX ICBM, and Sens.-elect Tim Wirth (D-Colo.) and Richard Shelby (D-Ala.). Senator Gore and Senator Wirth are frequent critics of the Pentagon, while Senator Shelby supports defense requests more often.

The new Republicans on the committee are Sen. Steve Symms (R-Idaho) and Sen.-elect John McCain (R-Ariz.), both strong defense supporters. The lineup includes eleven Democrats and nine Republicans.

Pressure Builds on SALT II

The Senate has sent President Reagan a letter, signed by fifty-seven senators (ten Republicans and forty-seven Democrats), urging continued compliance with the unratified, expired SALT II Treaty. The House Democratic caucus, a meeting of House Democrats to determine committee assignments and legislative priorities, also approved a resolution urging continued US compliance as well as passage of "all appropriate legislation" to enforce Treaty limits.

In view of repeated Soviet arms-control violations, President Reagan decided several months ago that US strategic force structure should be determined by military requirements rather than the SALT II treaty. The US recently deployed a cruise-missile-carrying bomber that, had the treaty been in force, would have breached the numerical limits on multiwarhead nuclear weapons carriers.

The congressional actions portend continuing pressure on the Administration to abide by past agreements, whether or not approved and ratified, and to reach new agreements with the Soviets.

Air Force Testifies on B-1

Assistant Secretary of the Air Force for Research, Development and Logistics Dr. Thomas E. Cooper and Gen. Lawrence Skantze, Commander of Air Force Systems Command, testified that the B-1 bomber, now being deployed, is experiencing continuing development problems, but that technical fixes are in sight or being effected. At a recent hearing, they identified four B-1 problem areas: electronic countermeasures (ECM), the terrain-following radar, fuel "seeps and weeps" in the wing, and an aerodynamic problem that affects launches of the short-range attack missile (SRAM).

General Skantze testified that the ECM system is not yet performing up to its 1982 baseline standards and that improved Soviet capabilities already require that the system be upgraded. Both Dr. Cooper and General Skantze stressed that the US plays an electronic "cat-and-mouse" game with the Soviets and that ECM systems must inevitably evolve over time to keep pace with Soviet developments.

Secretary Cooper compared the "seeps and weeps" in the wings to a leaky roof and suggested that as the B-1 wings are stressed during flight, the leaks would be discovered and repaired. He also said that the Air Force understands the aerodynamic difficulties that occur during test launches of the SRAM from the aft bay when the bomber is in certain positions and that a fix is in sight.

General Skantze stated that the terrain-following radar, which permits the plane to fly low under enemy radar, had been tested down to 200 feet, but needed to be demonstrated away from established flight ranges. ■

DEFENSE DIALOG

AVAILABLE: LOW COST PRODUCTION. Rockwell International's computer-automated module assembly and wire preparation/harness fabrication systems are available for off-load electronic assembly and other competitive manufacturing procurements. Autonetics Strategic Systems Division's (ASSD) El Paso manufacturing capabilities include single and two-sided multilayer circuit board assembly with plated through-hole and surface-mounted components, electronic and electromechanical subassemblies and wire harness fabrication. These automated processes resulting from Tech Mod initiatives have dramatically enhanced first-time yields through in-circuit tests of modules and wire harness assemblies, producing a higher quality product at a lower cost.

EMMA, THE ADVISOR. The Air Force/Rockwell-developed Expert Missile Maintenance Aid (EMMA) applies Artificial Intelligence/Expert Systems techniques to the maintenance of a tactical weapon's guidance and control system. Capturing Air Force and Rockwell expertise, EMMA can aid in diagnosing field level maintenance problems. Applied to Rockwell's GBU-15 munition, EMMA technology is expected to save millions of dollars in life cycle costs. The EMMA system being developed holds promise for application to a series of tactical missile systems.

MATE IS READY. Now ASSD's Modular Automatic Test Equipment (MATE) system, used to demonstrate testing computer processors in the Peacekeeper Guidance System, can be applied to ICBM and aircraft test programs; a real-time, smart Test Replaceable Unit (TRU) has been achieved within the present MATE structure. Rockwell is also replacing portions of the Jovial written MATE Control and Support Software (MCSS) with Ada; applying Artificial Intelligence/Expert Systems to the MCSS; writing non-C/ATLAS modules in Ada or Jovial; and comparing system throughputs of the Sperry 1630 and HP A900 computer-hosted stations.

STRATEGIC HARDENED CPU. With the completion of the first full brassboard of the Electronics and Computer Assembly (ECA), Rockwell achieved a major milestone as guidance and control developer for the USAF Small ICBM. At the heart of ECA is ASSD's radiation-hardened MIL-STD-1750A central processor. Developed on schedule and within budget, the ECA is designed to survive in severe radiation environments, while controlling the staging and flight of the missile. Derivations of this basic architecture are available for both ground and space applications.

For more information, please call ASSD's Marketing Manager at (714) 762-4440.

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AEROSPACE WORLD

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

By Jeffrey P. Rhodes, DEFENSE EDITOR

After its nonstop, unrefueled flight around the world, Voyager touches down on Rogers Dry Lakebed at Edwards AFB, Calif. The December 23 landing was witnessed by close to 30,000 spectators and a national television audience. The aircraft has since been flown to Mojave, Calif., where it was built. (USAF photo by Sgt. Derek Daniels)

Washington, D. C., January 5

★ Aviation history was made on December 23 when pilots Dick Rutan and Jeana Yeager landed their experimental aircraft *Voyager* at Edwards AFB, Calif., at the finish of mankind's first-ever nonstop, unrefueled flight around the world.

Voyager's grueling 25,012-mile journey severely taxed the aircraft and its pilots. Through much of it, there was great concern that the aerodynamically advanced aircraft would run out of fuel. The pilots were forced to skirt a typhoon over the Pacific and thread the aircraft between threatening thunderstorms and the airspace over Vietnam.

They also were buffeted in the cramped cockpit they shared. Burt Rutan, *Voyager*'s designer and brother of pilot Dick, described it as "a telephone booth on its side."

All obstacles were overcome, and the nation hailed the history-making feat.

At a ceremony in Los Angeles on December 29, President Reagan awarded Presidential Citizens Medals to Yeager and to both Rutans in recognition of their accomplishment.

On that occasion, the President said: "The flight of the *Voyager* brought us back to days of those magnificent men and their flying machines, and you reminded us all that aviation history is still being written by men and women with the spirit of adventure and derring-do."

Voyager was a triumph of many advanced aeronautical technologies USAF has been concentrating on for several years. For example, Air Force Systems Command's Aeronautical Systems Division (ASD) has been a leader in research on composites for making airframes lighter. Such composites were crucial to *Voyager*'s great range and fuel efficiency. In fact, the plane is constructed almost entirely of very light and very strong composite materials.

ASD's work with canards—in the Advanced Fighter Technology Integration (AFTI) F-16 program—made available much useful data for the *Voyager* design. So did the X-29 flight-test program—by ASD and the Defense Advanced Research Projects Agency (DARPA)—featuring a highly unstable aircraft with forward-swept wings and canards.

Voyager's winglets, which were damaged on takeoff and then came off, were of the type first deployed on a test aircraft—a KC-135—in the mid-1970s by ASD's Flight Dynamics Laboratory at Wright-Patterson AFB, Ohio.

Prior to *Voyager,* the first nonstop around-the-world flight (with four aerial refuelings) was completed by Capt. James Gallagher and crew in the B-50 Superfortress *Lucky Lady II,* which took off from Carswell AFB, Tex., on February 26, 1949, and returned on March 2. In 1962, Maj. Clyde P. Evely, piloting an Air Force B-52H, completed the longest flight without refueling, a straight-line distance of 12,532.28 miles—until Dick Rutan and Jeana Yeager made their record-breaking flight in *Voyager.*

★ One of the toughest fights on Capitol Hill before Congress adjourned last year was over the fate of the Fair-

child T-46A primary trainer. The Senate, after hearing the Air Force's budget priorities, had voted to kill the T-46 program, but the House of Representatives voted to appropriate $151 million to the development effort.

As a compromise, the Air Force was ordered to hold a competitive flyoff between the T-46, the Air Force's current Cessna T-37 trainer, an upgraded version of the T-37, and "any other suitable aircraft," which could include the McDonnell Douglas/British Aerospace T-45 Goshawk and the Beech T-34, among others.

In early December, though, Air Force Secretary Edward C. Aldridge, Jr., sent a letter to Congress asking for legislative relief from the mandated competition.

Secretary Aldridge noted in the letter that the Air Force does not have the funds in its five-year program to procure a new trainer. He also stated that given the current budgetary climate, he will not reorder Air Force priorities so that a new trainer could be funded.

While waiting for Congress's response to the letter, the Air Force is continuing to prepare for the competition. Funding for the flyoff will come from FY '86 monies that would have been allocated to procure the T-46. Should Congress insist that the competition be held, the Air Force is to complete the flyoff by January 1, 1988. The details of how and where the competition will be conducted have not been finalized.

Two T-46A prototypes have been undergoing testing at Edwards AFB, Calif.

Maria Junge (foreground) and Pam Smith, human-factors engineers at Lockheed Missiles and Space Co. in Sunnyvale, Calif., demonstrate on a full-scale mockup their design for a Space Station work area. The work stations will be used for a number of different jobs on the orbiting Space Station, which will likely be operational in the mid-1990s.

★ The nation's manned space program took another step toward recovery in mid-November when NASA announced major changes in the Space Shuttle program's management structure. These changes fulfill one of the key recommendations made by the Rogers Commission last summer when the final report on the *Challenger* disaster was released.

NASA Deputy Administrator Dale D. Myers said the changes were being made "to clarify the focal points of authority and responsibility in the Shuttle program and to establish clear lines of communication in the information-transfer and decision-making processes."

As part of the revamped structure, Shuttle management will be centralized at NASA headquarters in Washington, D. C., under the direction of Arnold D. Aldrich. Mr. Aldrich, who will carry the title of Director, National Space Transportation System (NSTS), will report directly to NASA Associate Administrator for Space Flight Rear Adm. Richard H. Truly. Mr. Aldrich had served previously as NSTS manager at the Johnson Space Center (JSC) in Houston, Tex.

Two deputies, one for Shuttle Program and the other for Shuttle Operations, will report directly to Mr. Aldrich. Richard H. Kohrs will be responsible for day-to-day management of the NSTS program and will be based at the Johnson Space Center.

Robert L. Crippen, who flew on the first Shuttle flight in 1981 and later served as mission commander on three other flights, will be in charge of all aspects of Shuttle missions, including final vehicle preparations and management of the launch-decision process. Mr. Crippen will be based either at JSC or at the Kennedy Space Center (KSC) in Florida.

It was also announced that William R. Marshall, Shuttle Projects Office manager at the Marshall Space Flight

The latest model of the venerable Stratotanker—the KC-135R—recently completed a five-week test program in the McKinley Climatic Laboratory at Eglin AFB, Fla. The KC-135R's hydraulics, fuel system, CFM56 engines, and auxiliary power unit were tested in temperatures as low as −50°F. No snow was involved in the tests.

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Center in Alabama, will report directly to Mr. Kohrs. The Marshall Space Flight Center, which manages the solid-rocket boosters and main engines for the Shuttle, was criticized in the Rogers Commission report for its tendency prior to the accident to manage in isolation.

Shuttle flights are scheduled to resume in February 1988.

★ The US aerospace industry must become as highly respected for its business propriety as it is for its products.

This was the main message conveyed by Dr. Karl G. Harr, Jr., in his annual address before the Aviation/Space Writers Association last December.

Dr. Harr later retired as President of the Aerospace Industries Association of America after having served nearly twenty-four years in the post. He was succeeded by Don Fuqua, who was chairman of the House of Representatives Science and Technology Committee when he was a congressman from Florida.

The aerospace industry, declared Dr. Harr, "must strive ceaselessly to ensure that the public never forgets how special we are to their future well-being at the same time as we, ourselves, never forget how specially responsible we must be to their judgments and criticism.

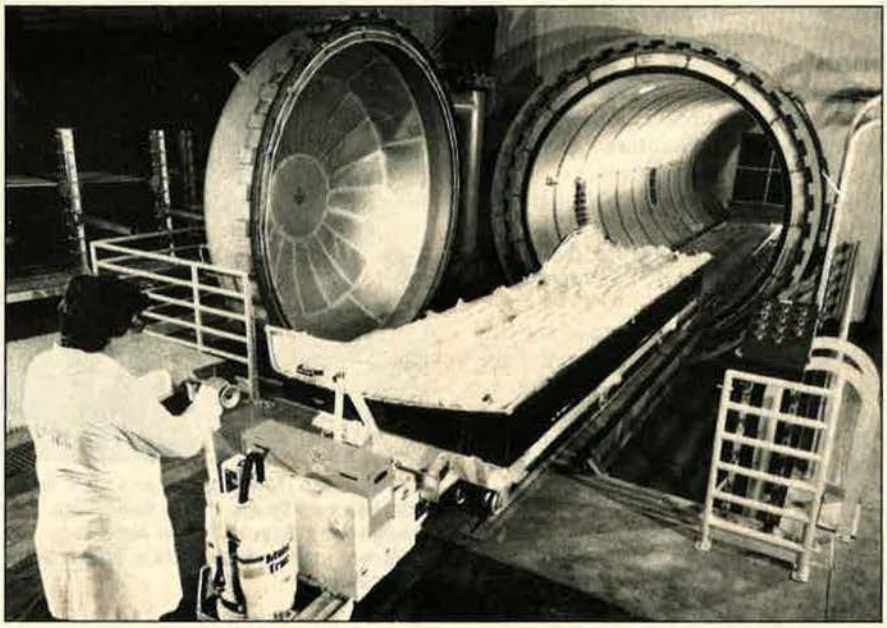
"We must be like Caesar's wife in our business affairs. The American people have long since granted us our specialness in terms of our technological systems management capability. Now we have a requirement for specialness in terms of our business behavior.

"The message has been sent and received. What's good enough for others simply will not do as far as we're concerned."

In his summary of industry developments, Dr. Harr described 1986 as "a very good year," with aerospace sales expected to top out at $103.5 billion—a seven percent jump over 1985 sales.

For 1987, AIA is predicting relatively smaller increases of sales in most product groups. Even so, total sales are expected to climb to a record level of almost $110 billion.

In 1986, Dr. Harr reported, sales of missiles and space products rose about ten percent over those of 1985, or seven percent in real, inflation-discounted terms. Military aircraft sales declined by one percent in real terms, having risen by only three percent with inflation a part of the calculation.



One of two large composite side skins for the Bell-Boeing V-22 Osprey tiltrotor aircraft is slid into a ten-foot-diameter, forty-foot-long autoclave at the Boeing Vertol plant in Philadelphia, Pa. The panel will undergo a cure cycle of less than ten hours with peak temperatures of approximately 350°F. and pressures of eighty-five psi. This is the largest composite part made to date for the Osprey.

★ When the 100th Congress convenes in January, the Democratic-controlled body will bring defense matters under close scrutiny. But most of the legislators can ponder defense subjects based on firsthand experience, though, since sixty-nine percent of the Senate has past military service, and just under half (49.5%) of the members of the House have seen time in a uniform.

In both houses, a majority of the lawmakers with military service were in the Army (including the Army National Guard and Army Reserve), followed by the Navy (including the Naval Reserve), the Air Force (including the Air Force Reserve, Air National Guard, and the Army Air Corps/Army Air Forces), the Marine Corps (including the Marine Corps Reserve), and the Coast Guard (including the Coast Guard Reserve). As might be expected, the percentages of members serving in each branch of the military are approximately the same for both houses.

On November 26 of last year, Capt. Susan E. Richardson became the first female ever to fly in a Lockheed U-2 or TR-1. Captain Richardson, an aerospace physiologist at Beale AFB, Calif., made the flight in a TR-1B to acquaint her with the environment in which SR-71 and U-2/TR-1 pilots fly. (USAF photo by Amn. David D. Zubiate)

In the Senate, sixty-nine of 100 members were in the military at some time. Counting those who served in the Guard and Reserve, thirty-seven of the sixty-nine senators (53.6%) served in the Army, seventeen members (24.6%) were in the Navy, thirteen (18.8%) were in the Air Force (including two with time in the AAC/AAF), eight were Marines (11.6%), and three senators (4.3%), including Senate Armed Services Committee Chairman Sam Nunn (D-Ga.), were in the Coast Guard. The breakdown by branch of service totals seventy-eight, rather than sixty-nine, because nine senators served in both the active-duty and reserve forces and are counted twice.

On the House side, 218 of 440 members and delegates spent some time defending the country. Again, counting those who served in the reserve forces only and those who were on both active duty and later in the reserve forces, 121 of the 218 representatives (55.5%) were in the Army, fifty-nine (27.1%) were in the Navy, forty members (18.3%) were in the Air Force (including eleven in the AAC/AAF), twenty were Marines (9.2%), and four representatives (1.8%) were in the Coast Guard. Twenty-six representatives were counted twice because of "double-duty."

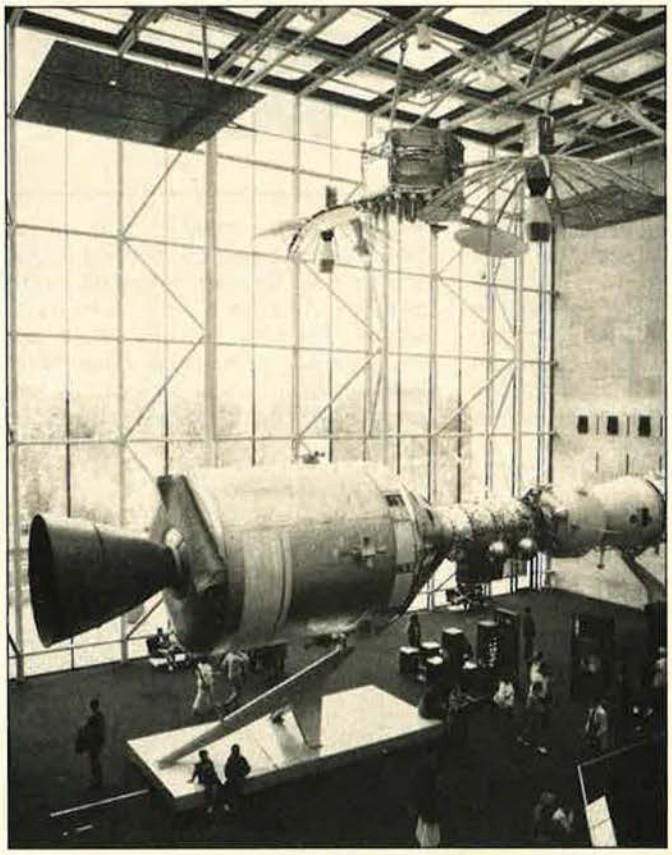
★ Competition is alive and well among contractors vying for Air Force business these days. In fact, for FY '86, the Air Force set a record for the amount of dollars it awarded competitively.

The Air Force awarded contracts worth $41.3 billion in FY '86, and of that amount, $21.063 billion, or fifty-one percent, was awarded competitively. This marked the first time the Air Force has topped the fifty-percent plateau. The percentage of competitive contract awards has risen steadily from 31.6 percent in FY '80.

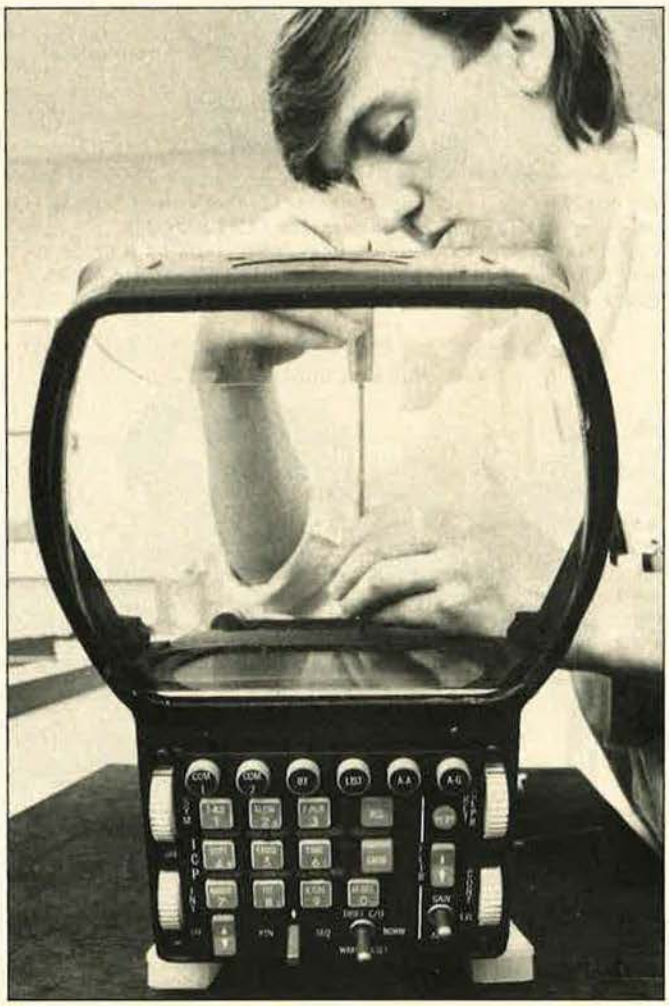
The Air Force also competitively awarded 2,765,200 (or nearly ninety percent) of its 3,100,000 individual contract actions during the same period. Sole-source procurements reached a record low of 10.8 percent. Single-source awards accounted for twenty-eight percent of the contract awards in 1980.

★ Boeing Aerospace Co. in Seattle, Wash., got some good news/bad news on December 8 when the company was selected by the Air Force to develop the new Short-Range Attack Missile (SRAM II) to augment and eventually replace the aging Boeing AGM-69A SRAM currently deployed.

The bad news was that the contract



TRW recently donated this full-scale replica of a fully deployed Tracking and Data Relay Satellite (TDRS) to the National Air and Space Museum in Washington, D. C. The model is displayed in Space Hall over the Apollo-Soyuz spacecraft. The three-satellite TDRS system will provide a continuous communications link between ground controllers and Space Shuttle astronauts or other spacecraft.



GEC Avionics Ltd. of Kent, England, recently received a $72 million order from General Dynamics for 450 of these new holographic head-up displays (HUDs) for F-16C aircraft. This HUD uses diffractive optics to provide the pilot with a wide field of view suitable for both night and day operations. The company drew on knowledge gained from the Air Force's LANTIRN program to develop this new HUD.

award will not be made until March of this year, if at all, depending on the outcome of a Department of Defense study. DoD is comparing the cost and effectiveness of reengining the AGM-69s against building the new missiles. The present SRAMs range in age from twelve to fifteen years old.

The contract, should it be issued to Boeing, will cover full-scale development and production of the first 400 missiles. Current plans call for the production of 1,633 SRAM IIs for deployment on B-1Bs and the Advanced Technology Bomber. Total estimated cost of development, production, and flight test is about $2.5 billion.

SRAM II will be roughly two-thirds the size of the AGM-69 and will be powered by a two-pulse solid-rocket motor. It will have an inertial guidance system utilizing a ring-laser gyroscope. The new missiles, which will be supersonic, will also have better range, performance, survivability, and accuracy than the AGM-69s. Initial operational capability for SRAM II on the B-1B is expected in 1992.

AEROSPACE WORLD

Martin Marietta and McDonnell Douglas were the other contractors participating in the SRAM II's system definition phase.

In related news, Boeing Military Co. in Wichita, Kan., was given the go-ahead by Air Force Systems Command's Aeronautical Systems Division at Wright-Patterson AFB, Ohio, for Lot 2 production of the rotary launchers that will carry the future SRAM IIs. The $54.7 million contract option that was exercised calls for twenty-six Common Strategic Rotary Launchers (CSRLs) and associated ground equipment. This marks the start of full-scale production on the CSRL.

The CSRLs can accommodate all existing and future nuclear bombs, cruise missiles, and SRAMs. The Air Force plans to buy 104 CSRLs in five production lots. The Lot 1 option covered the first five launchers.

The launchers will be installed on aircraft at the San Antonio Air Logistics Center at Kelly AFB, Tex. Carswell AFB, Tex., will get the first B-52H modified with the launchers in 1988, followed by Fairchild AFB, Wash., K. I. Sawyer AFB, Mich., and Minot AFB, N. D. IOC is expected in 1990, and the CSRL installations will be completed by 1993. The launchers can be installed in either B-52s or B-1Bs and will also fit the Advanced Technology Bombers when they enter service in the 1990s.

★ The Heritage Museum at Lowry AFB, Colo., recently acquired what is thought to be the last Boeing B-29 Superfortress available for restoration and display. The aircraft, named

Lear Siegler Inc. recently qualified its Integrated Armament Management System (IAMS) on the McDonnell Douglas MD-530MG Defender. The IAMS provides intergrated control of a variety of weapons. The Defender IAMS qualified with .50-caliber machine-gun pods, 7.62-mm twin machine-gun pods, and Mk 40 and Mk 66 2.75-inch folding-fin rockets.

Print and electronic journalists from seven countries were given their first opportunity to observe ground-launched cruise missile (GLCM) operations at RAF Greenham Common last November. After touring the base and seeing training demonstrations, the seventy-seven journalists interviewed the launch control officers of the 501st Tactical Missile Wing. (USAF photo by TSgt. Jack Siebold)

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JAFA

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

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

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

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

It's possible. This Department of the Navy program is producing an aircraft that streaks forward at turboprop speeds, providing unmatched rapid-response capability at very long ranges. Yet, it takes off, hovers and maneuvers like a helicopter.

Credit the Bell Boeing TiltRotor Team for turning a challenging concept into a startling reality. The TiltRotor will bring speed and range you'd need in a fast combat transport. It can reach up high or race across the terrain at treetop level.

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

Bell Boeing
THE TILTROTOR TEAM

"T Square 54" because of its position in the bomber box formation on flights from Saipan, was found derelict in an aircraft boneyard near the Naval Weapons Center at China Lake, Calif.

The aircraft was disassembled at China Lake, and the first section—the aft fuselage—was trucked to Lowry. The other sections, including the wings and forward fuselage, will be transported in the near future. Museum volunteers hope to have the bomber restored in time for the base's fiftieth anniversary, which will come on October 1 of this year.

There is a strong connection between the B-29 and the Air Force Technical Training Center at Lowry. During and after World War II, Lowry was one of several training centers for B-29 flight crews, flight engineers, and bombardiers. B-29 aerial reconnaissance techniques and powered turret mechanics were also taught there.

Heading up the restoration crew is Mel Blanscett, who was a B-29 flight-test engineer at Wright Field, Ohio, during the war. Mr. Blanscett has been a member of battle-damage repair teams for the past twenty years and has managed another B-29 restoration at Hill AFB, Utah.

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★ With today's high-performance fighters capable of withstanding up to nine times the force of gravity, the possibility is very real that a pilot could lapse into unconsciousness because of lessened blood flow to the brain resulting from high G forces. That's why researchers at the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL) at Wright-Patterson AFB, Ohio, are studying several ways to detect when pilots are suffering from G-induced loss of consciousness (GLC).

One of a number of methods under study is an eye-blink detector. Because the eyes do not blink immediately before and during periods of unconsciousness, the blink detector would note the lack of eye activity and would then hand over control of the aircraft to an artificial intelligence system. This system would stabilize the airplane until the pilot regained consciousness.

Designed and built by Energy Optics, Inc., of Albuquerque, N. M., under a $130,000 small-business innovative research contract, the eye-blink detector is about one inch long and the diameter of a pencil. Mounted on the left side of the nose cover of the pilot's oxygen mask, it uses infrared light reflected from the cornea of the pilot's eye to measure the blink rate.

Other methods under consideration include monitoring the pilot's head position to detect the drooping associated with unconsciousness and sensors in the pilot's helmet to detect loss of blood pressure in the artery nearest the brain. Other efforts include sensors that will detect the presence or absence of a hand grip on the throttle and stick.

Key to all of these methods, though, is developing a low false-alarm rate and sensors that don't interfere with the pilot while he is flying. Researchers at the lab believe that while AI systems that will be advanced enough to take control of the airplane when the pilot is unconscious are possible, it will be a number of years before such a system is ready.

Dick Field, left, a former B-29 pilot, and Mel Blanscett, a former Superfortress flight engineer, begin an inventory of work that needs to be done on the B-29 recently acquired for display at Lowry AFB, Colo. (USAF photo by Fred Hartwell)

A crew from the 1606th Civil Engineering Squadron at Kirtland AFB, N. M., put what was the first operational T-39 Sabreliner on a pedestal in front of Kirtland's base-operations building in late November. (USAF photo by MSgt. David Craft)

★ **MILESTONES**—In early December, **Lockheed-Georgia Co. delivered the 1,800th C-130 built** to the US Marine Corps. The aircraft, a KC-130T tanker/transport, was flown to NAS Glenview, Ill., where it will be flown by the Marine Reserve's Marine Aerial Refueler

Transport Squadron 234 (VMGR-234). In continuous production since 1954, more than forty derivatives of the C-130 have been engineered and built. More than 1,000 C-130s have gone to the US military (Air Force, Navy, Marines, and air reserve forces), while more than 600 aircraft have been sold to fifty-six foreign air forces. Airlines, corporations, and other governments have bought more than 100 examples of the commercial version of the C-130, the L-100. Production of C-130s continues at the rate of three aircraft per month.

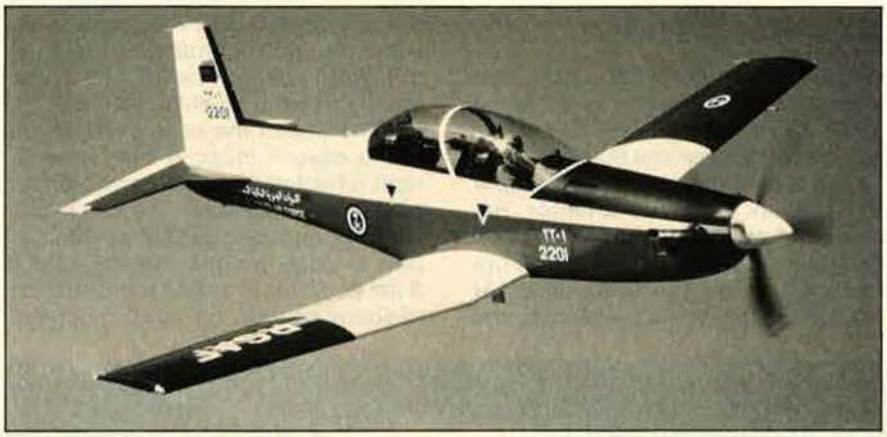
On December 18, **the first of the Navy's E-6A TACAMO** (Take Charge and Move Out) **aircraft rolled out** at Boeing's plant in Renton, Wash. The aircraft, with much longer endurance, will replace the EC-130 as the Navy's submarine communications aircraft. The E-6A was the only new type of airplane that the Navy procured in 1986, which was the seventy-fifth anniversary year of Naval aviation. It is also the first completely new Boeing airplane to enter Navy service since the 1930s. The Navy plans to acquire fifteen of the aircraft, and Tinker AFB, Okla., is being considered as one posible basing site for the E-6As.

★ **ON THE MOVE—Col. James A. Fain, Jr.,** has been appointed as the new **Director of the Advanced Tactical Fighter (ATF) Systems Program Office (SPO)** at Aeronautical Systems Division's headquarters at Wright-Patterson AFB, Ohio. He comes aboard at an important time, since the ATF program has just entered its demonstration/validation phase. A native of Ashland, Ala., Colonel Fain is a 1963 graduate of the Air Force Academy and has served as a test pilot. Prior to taking his new position, Colonel Fain oversaw development of the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system at ASD. He replaces Col. Albert C. Piccirillo, who will retire.

In late November, **James F. McGovern** was sworn in as the **new Under Secretary of the Air Force.** As the second-highest-ranking civilian in the Air Force, he will oversee the service's budget and will implement many of the Packard Commission's procurement reforms. He will also monitor development of several new weapon systems, including the Peacekeeper ICBM. A 1969 graduate of the US Naval Academy, he has logged more than 2,000 hours in fighters. He is also a lieutenant colonel in the Marine Corps Reserve. Mr. McGovern fills the vacancy created when Edward C. Aldridge, Jr., was named Secretary of the Air Force.

★ **NEWS NOTES—Hughes Aircraft Co. and General Electric Corp. are teaming up** to compete for the con-

AEROSPACE WORLD



The first of thirty Pilatus PC-9 trainers was delivered to the Royal Saudi Air Force in November. The aircraft was ferried from the factory in Stans, Switzerland, to British Aerospace's facility at Brough, England, for final acceptance. Five countries, including Australia, have more than 120 PC-9s on order.

SENIOR STAFF CHANGES

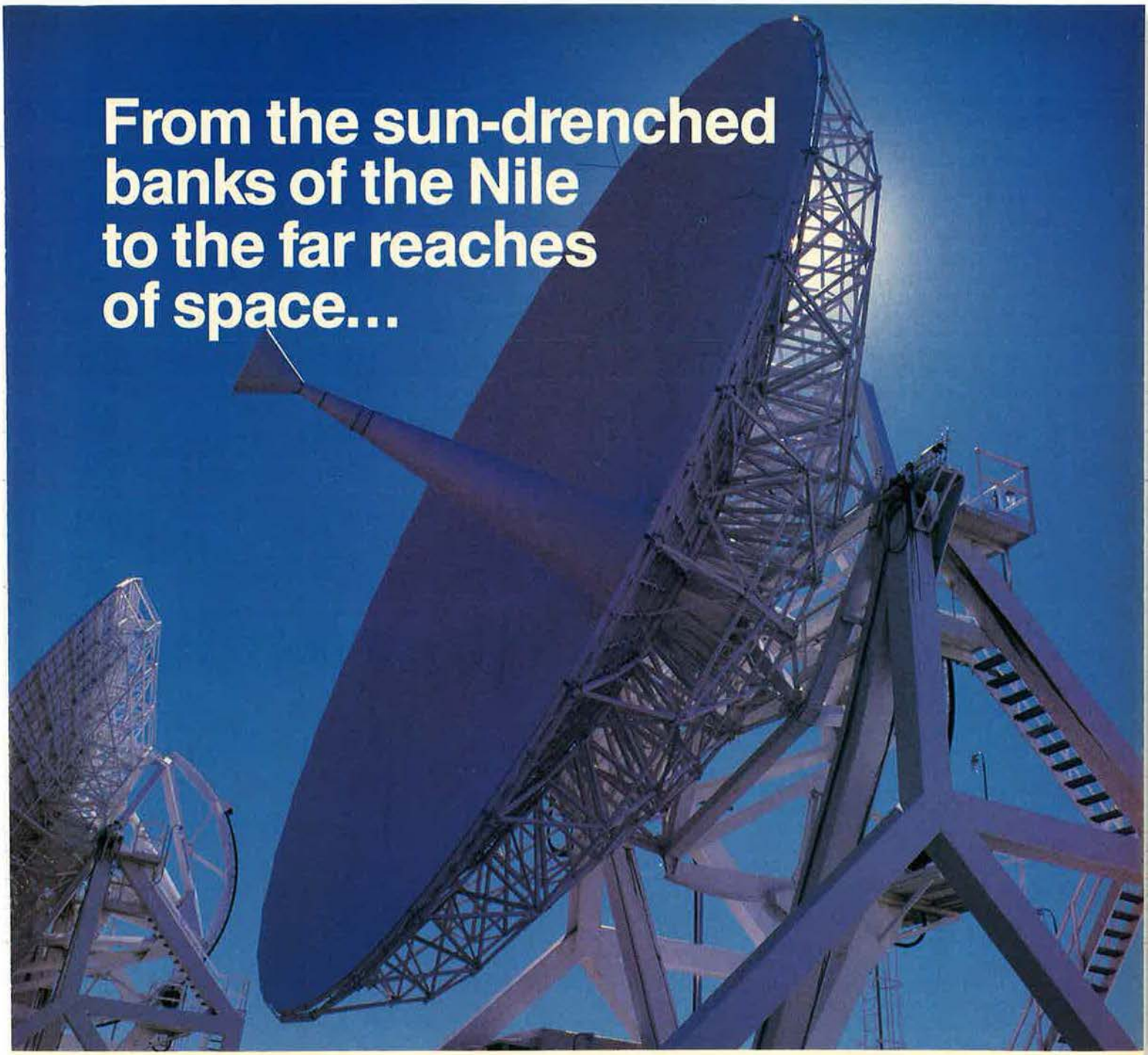
PROMOTIONS: To be **Major General:** Joseph W. **Ashy;** Thomas P. **Ball,** Jr.; Charles G. **Boyd;** Edward R. **Bracken;** George L. **Butler;** Harold N. **Campbell;** Vernon **Chong;** Gaylord W. **Clark;** Hugh L. **Cox** III; John R. **Farrington;** Ronald R. **Fogleman;** Larry D. **Fortner;** David M. **Goodrich;** William J. **Grove,** Jr.

Trevor A. **Hammond;** Paul A. **Harvey;** Frank B. **Horton** III; John E. **Jaquish;** James D. **Kellim;** Michael C. **Kerby;** Albert L. **Logan;** Thomas S. **Moorman,** Jr.; Eric B. **Nelson;** Fred R. **Nelson;** Robert R. **Rankine,** Jr.; Richard D. **Smith;** Donald **Snyder;** David J. **Teal;** Henry **Viccellio,** Jr.; Charles N. **Wood.**

CHANGES: B/G (M/G selectee) George L. Butler, from Dep. Dir., Ops., DCS/P&O, Hq. USAF, Washington, D. C., to Dir., Ops., DCS/P&O, Hq. USAF, Washington, D. C., replacing M/G Michael J. Dugan . . . **M/G Henry D. Canterbury,** from Dep. CINC, USSOUTHCOM, and Cmdr., USAF Southern AD, TAC, Quarry Heights, Panama, to Vice Cmdr., 9th AF, TAC, Shaw AFB, S. C., replacing B/G Robert I. McCann . . . **M/G Michael J. Dugan,** from Dir., Ops., DCS/P&O, Hq. USAF, Washington, D.C., to Ass't DCS/P&O, Hq. USAF, Washington, D. C., replacing M/G Eugene H. Fischer . . . **B/G Thomas E. Eggers,** from Spec. Ass't for Special Operations, DCS/RD&A, Hq. USAF, Washington, D. C., to Dep. Dir., Ops., DCS/P&O, Hq. USAF, Washington, D. C., replacing B/G (M/G selectee) George L. Butler . . . **M/G Eugene H. Fischer,** from Ass't DCS/P&O, Hq. USAF, Washington, D. C., to Dep. CINC, USSOUTHCOM, Quarry Heights, Panama, replacing M/G Henry D. Canterbury . . . **B/G John R. Hullender,** from DCS/Ops., Hq. ATC, Randolph AFB, Tex., to Dep. Dir., NMCC, J-3, OJCS, Washington, D. C.

M/G Hansford T. Johnson, from DCS/Ops., and Dep. Dir., Ops., SAC Operations Staff, Hq. SAC, Offutt AFB, Neb., to Vice CINCPACAF, Hq. PACAF, Hickam AFB, Hawaii, replacing M/G (L/G selectee) Craven C. Rogers, Jr. . . . **B/G Robert I. McCann,** from Vice Cmdr., 9th AF, TAC, Shaw AFB, S. C., to Spec. Ass't to Cmdr., 9th AF, TAC, Shaw AFB, S. C. . . . **M/G Ellie G. Schuler, Jr.,** from Ass't DCS/Ops., Hq. SAC, Offutt AFB, Neb., to DCS/Ops., and Dep. Dir., Ops., SAC Operations Staff, Hq. SAC, Offutt AFB, Neb., replacing M/G Hansford T. Johnson . . . **B/G (M/G selectee) David J. Teal,** from Dep. Dir. for Tactical Systems, ASD, AFSC, Wright-Patterson AFB, Ohio, to Senior Military Ass't to the Under Secretary of Defense for Acquisition, Washington, D. C. . . . **AFRES M/G James C. Wahlelthner,** from Cmdr., 4th AF (AFRES), McClellan AFB, Calif., to Member, Reserve Forces Policy Board, Washington, D. C., replacing AFRES M/G Robert G. Mortensen.

SENIOR ENLISTED ADVISOR CHANGES: CMSgt. Dennis Des Jardins, to SEA, Hq. AFSC, Andrews AFB, Md., replacing retired CMSgt. Billy D. Hall . . . **CMSgt. Rodney E. Ham,** to SEA, Hq. PACAF, Hickam AFB, Hawaii, replacing CMSgt. David A. Guzman. ■



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tract **to build the multimode radar for the Air Force's Advanced Tactical Fighter** (ATF). Hughes will have lead responsibility for the radar, while General Electric will be the principal subcontractor. The Hughes/GE team will be competing for the contract against Westinghouse and Texas Instruments, which had announced their teaming arrangement earlier. Hughes and General Electric are teammates on the triservice Microwave/Millimeter Wave Monolithic Integrated Circuit (MIMIC) program.

In late November, **Boeing Military Airplane Co. delivered the first of four 707 tanker/transports to Brazil.** In converting the 707 jetliners that once flew with the Brazilian airline VARIG, Boeing added hose-and-drogue refueling pods on the wingtips, an auxiliary power unit, and self-contained, folding airstairs. Structural inspection, refurbishment, maintenance, and electronic updates were carried out in Brazil before the airplane was brought to Boeing's Wichita, Kan., facility. Delivery of the final aircraft is set for November of this year.

Air Force Systems Command's **Armament Division** at Eglin AFB, Fla., **awarded Hughes Aircraft Co. a $28.6 million, long-lead contract for initial production of AIM-120A** Advanced Medium-Range Air-to-Air Missiles (AMRAAMs) on November 24. Under the contract, Lot 1 production will be for 105 of the nearly twelve-foot-long, 335-pound missiles. Hughes is the prime contractor for AMRAAM, and Raytheon is the second-source manufacturer. Armament Division is managing the joint Air Force/Navy AMRAAM program.

In related news, Hughes recently presented an AIM-120A exhibit to the Air Force Armament Museum at Eglin. The exhibit consists of an inert missile along with photographs of test launches and a brief description of the program.

The **Selective Service System reports** that since 1980, the first year of peacetime registration, **almost 16,000,000 young men have registered for the draft.** This represents a ninety-nine percent compliance rate among the nation's draft-eligible population. While it would take an act of Congress to reinstate the draft, it is a federal law (and several states have enacted similar legislation) that male US citizens and aliens between the ages of eighteen and twenty-six residing in the US must register within thirty days of their eighteenth birthday. Selective Service registration is a requirement for student financial aid under the Guaranteed Student Loan and Pell Grant Programs and for federal employment.

AEROSPACE WORLD

An **LGM-118A Peacekeeper** intercontinental ballistic missile **was successfully launched** from a modified Minuteman III silo at Vandenberg AFB, Calif., on December 5. The missile impacted 4,200 miles away in the Kwajalein Missile Test Range in the Pacific. Although two of the missile's ten unarmed reentry vehicles did not deploy, officials at the Ballistic Missile Office at Norton AFB, Calif., called the test "extremely successful." All other test objectives were met. Cause of the malfunction is under investigation.

Nelly Speersta, a twenty-three-year-old native of the Netherlands, became the **North Atlantic Treaty Organization's first female fighter pilot** after graduation ceremonies on December 13 at Sheppard AFB, Tex. She was a member of a thirty-two-pilot class at the Euro-NATO Joint Jet Pilot Training course. She will be returning to the Netherlands in the near future to begin specialized training.

★ **UPDATE**—The **Oscar 17 satellite** that had been displayed at the National Air and Space Museum for fifteen years prior to being recalled and refurbished as the Polar BEAR (Polar Beacon Experiments and Auroral Research) satellite **was successfully launched on November 13** by a Scout launch vehicle. *(See "Aerospace World," September '86 issue, p. 43.)* The Scout, made by the Missiles Division of LTV, lifted off from Vandenberg AFB, Calif., and placed the satellite with its three experiments into a 625-mile-high polar orbit. ■

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In better times, Martin Marietta Titan 34D Expendable Launch Vehicle (ELV) lifts off with spacebound military payload. Successive Titan 34D failures bracketed the destruction of Space Shuttle Challenger, putting USAF's space-launch program on hold last year. Things are looking up, now that Air Force Systems Command's Space Division has conducted its Titan 34D inspection and recovery program and has put into effect its comprehensive space-launch recovery plan, leading to a better mix of booster rockets to augment the Shuttles in assuring future US access to space.

Vital military payloads are still on the ground, but USAF is rebuilding its launch capability to be stronger and more versatile than that of the pre-*Challenger* era.

Coming Back In Space

BY JAMES W. CANAN
SENIOR EDITOR

THE US space program is beginning to lose the snakebitten look it took on last year amid a shocking succession of accidents befalling Space Shuttle *Challenger* and three unmanned launch vehicles.

The program still has a long, long way to go in fully recovering from the impact of those accidents. They left the Air Force incapable of launching growing numbers of satellites vital to national security.

This sobering—even scary—state of affairs will persist into next year and will not be much alleviated for another year or so after that.

Shuttle Orbiters will not fly again until February 1988, at the earliest. The first of the big Titan IV Complementary Expendable Launch Vehicles (CELVs) now being developed to carry outsized payloads high into space will not be ready for launch until early 1989.

Less powerful boosters are available, but they are relatively few in number and cannot take most high-priority military payloads to where they need to go in space.

Even so, Air Force space officials are feeling a bit better about the space program's prognosis these days. They believe that the space-launch recovery plan now in place to correct launch-system weaknesses glaringly exposed by the *Challenger* accident in particular will result in launch capabilities far better—more vigorous, more versatile, and less vulnerable—than those of the pre-*Challenger* era.

Such robust, resilient launch capabilities are sorely needed.

National security has become heavily dependent on the increasingly sophisticated satellites that provide communications, weather information, surveillance, early warning of attack, and navigational support to US strategic and conventional forces. Better satellites of all such varieties are in hand or in the making. They are worth nothing, however, while on the ground.

Blueprint for Launch

The space-launch recovery program devised by Air Force Systems Command's Space Division in Los Angeles, Calif., is a blueprint for getting those satellites launched as efficiently and as expeditiously as possible well into the 1990s.

Col. Donald C. DePree, SD's

Deputy for Space Transportation Systems, characterizes that program as "step one" in the space program's comeback and as "doable on the national level."

"Technical problems are the relatively easy ones," Colonel DePree declares. "They can always be fixed. The problems of decisions, strategies, and plans are the tough ones. In past months, those kinds of things have been thrashed out, and now it's over to us in the field to do the implementing."

The *Challenger* accident "made us come to grips with the need for a national-level strategy for space and made the nation realize that we do need assured access to space," Colonel DePree asserts.

Air Force officials take satisfaction in the American public's post-*Challenger* awareness of some other verities that USAF had always honored but was often stymied in getting across. These are that the US must:

- Exploit space for all it is worth as a military arena, which is plenty.
- Never get into the perilous position of depending too much on only one launch system, as it did with NASA's Shuttle-centered Space Transportation System (STS).
- Use man more judiciously in space and leave it to unmanned, expendable launch vehicles to truck satellites into orbit on all occasions not requiring human interaction with the hardware.
- Bear down in developing such spacecraft as modular unmanned launchers and manned aerospace planes.
- Acknowledge once and for all that space missions are inherently risky and should be populated, when necessary, by professional crews—period.

Space Division's space-launch recovery program addresses all this. It emphasizes USAF's future acquisition of Titan IVs to share heavy-lift duties with the Shuttles, of Medium Launch Vehicles (MLVs) to launch Navstar Global Positioning System (GPS) satellites, and of Space Launch Vehicles (SLVs)—modifications of Titan IIs that were deactivated as ICBM launchers—to boost medium-size military payloads into polar orbit from Vandenberg AFB, Calif.

The Air Force intends to launch military payloads on the Shuttles only when this is imperative or most convenient. In all other instances, it will launch such payloads on expendable boosters.

In keeping with this, USAF plans to design or to redesign several types of satellites to be capable of going either way. Among them are the Milstar Extremely High Frequency (EHF), tough-to-jam satellites that are expected to be the crowning glories of defense communications in the 1990s and beyond, the Defense Satellite Communications System (DSCS III) satellites, the Defense Support Program (DSP) early warning satellites, and the Navstar navigation satellites.

Prior to *Challenger,* the Defense Department's Strategic Defense Initiative Organization (SDIO) anticipated using the Shuttles for a great many tryouts of SDI technologies for space-oriented defense against ballistic missiles.

Now SDIO is considering moving a substantial number of such payloads off the Shuttles and onto unmanned launchers.

Comeback Momentum

A few months ago, Vice Chairman of the Joint Chiefs of Staff Gen. Robert T. Herres, then Commander in Chief of US Space Command and of North American Aerospace Defense Command, reflected on the post-*Challenger* comeback now gathering momentum.

General Herres said that a crucial element in that comeback will need to be better teamwork among military and civilian space officials in cutting the soaring costs of doing business in space.

"Despite the discouraging setbacks of past months, I am more convinced than ever that our goals, objectives, and ambitions are on track," the General said. "We *have* become dependent on space, and this means that what we seek to do there must be undertaken out of absolute necessity—and what must be done out of necessity must be done *right.*

"We can't expect our forces to prevail in war without space systems."

The latest and best of satellites for such systems are going nowhere for lack of launchers.

For instance, this month was to have marked the start of something big for the US armed forces. The first Navstar satellite of an eighteen-satellite GPS operational constellation was scheduled to be launched aboard a Shuttle Orbiter.

US forces, spread thinly in the execution of their global responsibilities, are counting on that Navstar constellation to give air, sea, and land units ultraprecise position-fixing data, thus enabling them to make the most of their mobility and firepower.

They will have to wait a long time for it to happen. Given the launch situation, the Air Force will be lucky to get the first Navstar operational satellite into orbit by early 1989.

By now, too, the new-generation DSCS III communications satellites should have been proliferating in space as scheduled. Only two are in orbit. The Air Force is taking deliveries on some of the twelve additional DSCS III satellites that it will need to position in space as an operational constellation and as spares, but it must store them because it has no way of launching them.

Those satellites are virtually indispensable. In relaying the critical military messages that make it possible for the US to deter war and to wage it, they will be much more capable and survivable than the older satellites of the DSCS II constellation now doing that job in space.

Across the spectrum, satellites needed by the armed forces for a variety of force-enhancing purposes are languishing in storage. The Air Force must pay extra to store them or to put off their production in order to avoid having to store them. Either way, space program costs go up.

USAF's Space Launch Complex Six (SLC-6) at Vandenberg AFB has also been idled. The first Shuttle launch from SLC-6 was to have taken place last July. It will not take place until 1992, and SLC-6 will remain on "operational caretaker status" until then.

Meanwhile, a launchpad at Vandenberg is being modified for launching the Titan IVs that USAF had the foresight to begin developing prior to the *Challenger* disaster to shoulder Shuttle-sized payloads.

The Air Force will buy twenty-three Titan IVs instead of the ten originally planned.

Assessing the Setback

The only officials who know how badly the launching limbo affects classified satellites are those with the need to know. Clearly, however, some of those high-priority spacecraft are on hold and will be joined in that status by others until the Shuttles and other lifters capable of handling them are in business.

Shortly after *Challenger* blew up last January 28, Space Division was charged with assessing how severely the space program had been set back by the disaster and the subsequent grounding of the remaining three Shuttle Orbiters, only two of which—*Discovery* and *Atlantis*—are capable of boosting most military payloads into space.

SD was also assigned to devise a plan for a proper mix of new and improved unmanned launchers of various capacities and purposes and to enfold in it NASA's plans for resumption of Shuttle flights and for a replacement Orbiter.

The resultant SD space recovery program would have to meet with the approval of the Air Staff, the Secretary of Defense, the National Security Council, and the President.

SD's job was even more complicated than it had seemed at first, for the space-launch situation soon became even worse.

Less than three months after *Challenger,* an Air Force Titan 34D ELV with a classified military payload exploded nine seconds after liftoff at Vandenberg AFB, Calif. This mishap marked the second straight failure of a Titan 34D, the first having occurred nine months earlier at Kennedy Space Center, Fla.

Now there would be no more Titan 34D launches until the design and construction of the six such ELVs remaining in USAF's inventory were rigorously and painstakingly reexamined—and there went USAF's medium- to heavy-lift capability until further notice.

Rockwell workers assemble subsystems of Navstar Global Positioning System (GPS) satellites in the "clean room." Space Division will develop Medium Launch Vehicles (MLVs) for the express purpose of launching these vital navigation satellites.

Then came yet another hitch for Space Division in formulating the space recovery program.

NASA had said that it expected Shuttle Orbiters to resume flying in early to mid-1987. But when it reflected on all that needed to be done to make the Shuttles safer, with emphasis on their solid rocket boosters (SRBs) and on crew-escape measures, it put off the first flight until February 1988.

Even that timetable may have to be slipped. Secretary of the Air Force Edward C. Aldridge, Jr., told an Air Force Association audience in Los Angeles last October that it could turn out to be "extremely tight."

Congress Responds

Working through the plight of the Titan 34D and the change in the Shuttle schedule, Space Division had barely completed its space-launch recovery plan when Congress, acting with extraordinary alacrity, approved the acquisition of a new Shuttle Orbiter to replace *Challenger,* with its first flight now scheduled for 1991, and also provided funds for a start on everything that SD had programmed to be done.

Lt. Col. Barry Zilin, who headed the team that devised the space-launch recovery program and who now directs SD's MLV program, says that "as part of the congressional action, we were directed to go out and buy additional Titan IVs, to make high-priority satellites dual-compatible with the Shuttles and the Titan IVs, and to develop and buy the MLVs for launching GPS satellites."

There is a down side to altering the Shuttles for safety purposes and to designing and building satellites for dual compatibility. Structural changes to the Orbiters and to their SRBs will add weight and, thusly, will reduce payload capacity by thousands of pounds. Moreover, says Colonel DePree, "designing payloads for versatility of launch is bound to drive up their costs."

"I believe," he continues, "that payloads will be designed to be optimized for launching either on the Shuttle or on ELVs, with some built-in capability to go the other way. R&D birds requiring man's interaction will have to be designed exclusively for the Shuttle."

What it comes down to, says Colonel DePree, is that "if we want guaranteed access to space for certain payloads for which we may have emergency needs, within certain time windows, then making them dual-compatible is the only strategy we can follow. Where some satellites are concerned, it doesn't make much difference whether we get them up one year or the next. But there are others that, if the sky is falling, we've got to get up somehow—and it's on those that we'll put our [dual-compatibility] resources.

"It's all workable. We'll sort it

McDonnell Douglas Delta rocket rises from its launch pad at Cape Canaveral, Fla. The successful launch of such a Delta last December helped the US space program along the comeback trail from the Challenger disaster and other launch failures. More-powerful rockets, such as the Titan IV Complementary Expendable Launch Vehicles (CELVs), will be needed, however, to enable USAF to boost heavier, bulkier payloads into optimum orbits. USAF will buy twenty-three Titan IVs for launching military satellites from Canaveral and from Vandenberg AFB, Calif., beginning in early 1989.

out. But the decisions will have to be made at the national level in terms of strategy. They can't be made on the basis of individual bits and pieces of space systems. We'd get lost in that.

"The important thing in all this is that we've been allowed to reassess and to change the decision of ten years ago that we would eventually launch all our satellites on the Shuttle. In the end, we'll be much stronger in our ability to react if something like the *Challenger* accident happens again.

"Maybe that's our *Challenger* legacy."

The weight to be added to the Shuttles in their structural changes will force USAF to lower its requirement that they be capable of boosting 32,000 pounds of payload into polar orbits out of Vandenberg and of landing—in case it's necessary—with 24,000 pounds of payload still aboard.

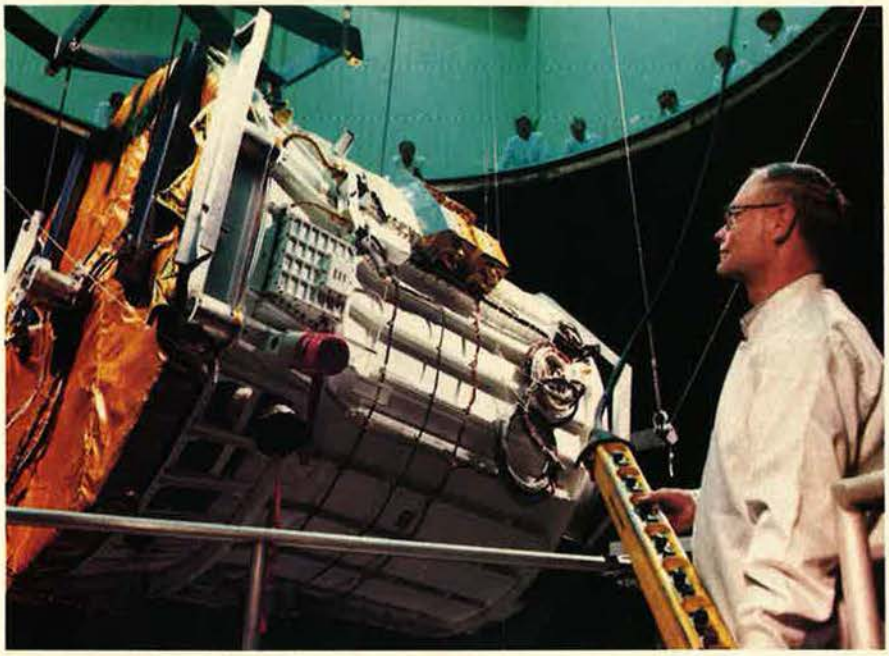
Even prior to *Challenger,* the 32,000-pound polar-orbit payload goal was shaping up as difficult to attain without throttling up the engines well beyond their recommended thrust limitations.

Now it seems that the additional weight in store for the Shuttles will force USAF to compromise on a Vandenberg payload launch weight that is well below the 32,000 pounds that had once been deemed to be necessary.

It may have to lower the Shuttle payload landing-weight limit of 24,000 pounds as well.

Such compromises will likely mean the end of experiments of the sort that Shuttle crews had been conducting in the middeck locker areas of the Orbiters. There are several such areas, each capable of holding 100 pounds of research gear.

In the past, they were used, for example, to check out crew interactions with hardware to be applied to primary payloads in subsequent flights and to do biomedical, oceanographic, meteorological, and optical research.



The Inertial Upper Stage (IUS) qualification test vehicle is lowered into the Boeing Aerospace Co.'s Large Vacuum Chamber for testing. The IUS takes payloads into high space from Shuttles and will also ride atop Titan IVs.

On one Shuttle flight, a middeck locker contained equipment for an SDI-related test in which a laser was beamed at the Orbiter from the Hawaiian island of Maui to check out its aiming, tracking, and atmosphere-penetration propensities.

Forgoing such experimentation "is where we're going to hurt," Colonel DePree declares.

Mixing Shuttles and ELVs

Withal, the Shuttle will continue to be highly important to USAF's space-launch aspirations.

"It's an excellent vehicle," says Colonel DePree, "but why not use it only for those missions where there's a payoff to having man in the loop? Why use man just to accompany satellites into orbit, throw them out of the bay, and come back home?"

Military payloads will be carried on fewer than half of the Shuttle flights now scheduled over the next few years—on two of five flights in 1988, on four of ten in 1989, and on four of eleven in 1990.

There is some skepticism in the military space community about NASA's ability to build up its Shuttle flight rates so sharply.

When it comes to hurling especially heavy payloads high into space, the Shuttles will give way to the Titan IVs.

NASA has abandoned its plan to use the General Dynamics Centaur rocket as a Shuttle upper stage in order to boost 10,000-pound payloads into geosynchronous orbit 22,300 miles above the planet—orbits in which early-warning satellites, many communications satellites, and others operate.

This will leave the Shuttle capable of boosting a maximum 5,100 pounds of payload into geosynchronous orbit from low-earth orbit by means of its Inertial Upper Stage (IUS).

The Air Force's Titan IVs, on the other hand, will accommodate Centaur G-prime upper stages, and this will make them the mightiest of all US launch vehicles in their weight-to-altitude prowess. They will also be compatible with the IUS.

Martin Marietta is building the Titan IVs as variants—mainly by virtue of their extended solid rocket boosters—of the company's Titan 34Ds.

Each Titan IV will be nearly 113 feet long and ten feet in diameter. Its two SRBs will generate a total 2,725,000 pounds of thrust; its first stage, 546,000 pounds of thrust; and its second stage, 104,000 pounds.

Delivery of two Titan IVs to the Air Force is scheduled for late this year, and the first of them is earmarked to launch a satellite into equatorial orbit from Cape Canaveral, Fla., in April 1988.

Titan IV launches of satellites into transpolar orbits from Vandenberg AFB are scheduled to commence in early to mid-1989.

The first Titan IV-Centaur launch of an ultraheavy military payload into geosynchronous orbit from Ca-

naveral is now scheduled for early 1990.

"We've progressed from a program for ten Titan IV launches at the Cape to one of twenty-three launches at the Cape and at Vandenberg," explains Col. Victor W. Whitehead, Space Division's Deputy for Expendable Launch Vehicles. "Before *Challenger,* we had three payloads signed up. Since *Challenger,* a large number of payloads have come over to us to fly on Titan IV. We're up to fifteen and counting."

The Titan IV design has breezed through its preliminary and critical design reviews and is "in good shape for us to make our initial launch date at the Cape," Colonel Whitehead says.

A Big Head Start

He joins the chorus in saluting Secretary Aldridge for having led the way in persuading the Administration and Congress to authorize the Titan IV (formerly the Titan 34D-7) CELV program in 1985.

NASA had objected to that program on grounds that the CELVs would compete with the Shuttles for payloads and hurt their chances of turning a profit with the commercial payloads that NASA saw in store for them.

Now, post-*Challenger,* the prospects of commercial payloads on the Shuttles are dim, and their profit-making potential is practically nil.

President Reagan ruled last year that the only commercial payloads to be qualified for Shuttle flights will be those already designed to be unique to the Shuttle or to be valuable to US national security or foreign policy.

Colonel Whitehead notes that Secretary (then Under Secretary) Aldridge "pushed for the CELVs when they weren't very popular in some circles—and thank goodness he did. We got a big head start on the Titan IV program as a result."

It now appears that USAF's Titan 34Ds will be ready to go to work sooner than might have been expected after two of them failed, one after the other, in August 1985 and in April 1986.

The first Titan 34D failure was probably caused by a leak of nitrogen tetroxide and the loss of a turbopump in a liquid engine. The second happened when rubber insulation debonded from the casing of a solid-rocket engine and let propellant burn through the casing.

With respect to the Titan 34D's basic design, this was actually good news. The disparity of causes indicated that the problems were isolated ones—not the result of any inherent or universal flaw in the boosters.

Space Division and the Titan 34D contractors have conducted an exhaustive review of the rocket's design and construction and have built up a considerable body of knowledge in testing all segments and components.

The upshot, says Colonel Whitehead, is that "we do not think we will have to do a redesign" of the Titan 34D.

The Testing Dividend

Aside from the eventual restoration of the rockets to service, a major benefit from Space Division's $160 million inspection and recovery program has been "the quantum leap forward we've been able to make in nondestructive testing," the Colonel says.

"We got together everybody we could find who knew anything at all about nondestructive testing—from the Department of Defense, the Department of Energy, from industry, from everywhere—and we put together a program to do all sorts of things that had never been done before.

"We used X-rays, thermography, ultrasonics, and lasers to inspect the innards, and we learned how to process all the data and put it together. Now we're giving the Cape and Vandenberg the capability to automate all this so that it will be repeatable from test to test."

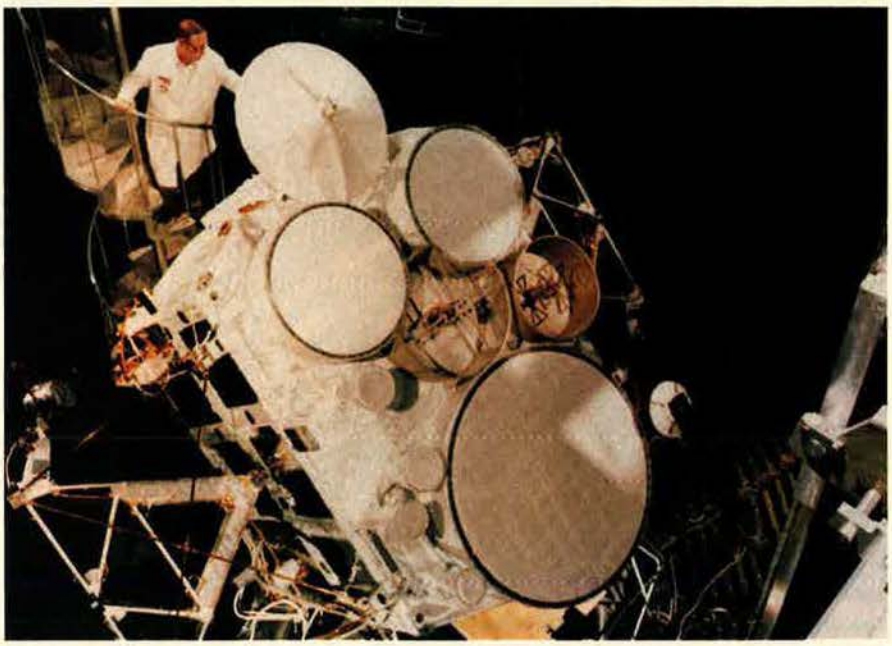
This means that the innovations in nondestructive testing resulting from the Titan 34D recovery program will be applicable to such testing of all US launch vehicles. Confidence levels will consequently rise.

Given the fatal failure of a field joint on one of *Challenger's* solid rocket boosters, Space Division has taken special care in testing such joints on the Titan 34D SRBs.

It has found, says Colonel Whitehead, that those joints "are probably the toughest parts of the old beasts."

This finding has great meaning for all Titan launchers and for the design of the Titan IV CELVs too, perhaps. Had it turned out otherwise, there might have been much bigger trouble all across the space-launch program.

Space Division expected its reassessment of the Titan 34Ds to be completed by early this year. The rockets could be back in action by the end of the year.



A Defense Satellite Communications System (DSCS III) satellite takes shape at a General Electric plant. The DSCS III constellation will form up in space several years later than USAF had planned prior to the* Challenger *catastrophe.

The Titan 34D testing touches on Space Division's MLV development program as well.

One of the rockets in the running for the MLV production contract is a modification of the Martin Marietta Titan 34D. The others are variants of the General Dynamics Atlas and of the McDonnell Douglas Delta.

SD plans to pick a winner from among the three by February 6. It desperately needs the MLVs to launch Navstar satellites and has scheduled them to begin doing so in January 1989.

Even if the MLV production and operational schedules are strictly kept, however, the deployment of Navstar satellites will have slipped badly from the timetable for their launches exclusively on Shuttles that were to have begun this month.

After *Challenger* went down, Space Division faced the harsh prospect of an indefinite delay in depositing a fully operational GPS constellation plus spares and replenishment satellites in space.

"We had an emergency need to get twenty-eight satellites costing over a billion dollars into orbit—and the Shuttle obviously wasn't going to do it," recalls SD's Colonel Zilin. "It was painful."

It still is, although a little less so. The current schedule calls for the launching of twenty-two GPS satellites by October 1991. Twelve will go up on MLVs and ten on Shuttles.

This schedule, too, could slip, however. There is going to be a lot of jockeying among the various military satellite programs for space on the Shuttles in the years ahead. Many questions of which satellites ride on which launchers may have to be settled at the national level.

"It's been a tough year," says Col. Gaylord B. Green, SD's Deputy for Space Navigation Systems and director of the GPS program.

GPS Sidelined

Frustration is especially keen in Colonel Green's shop because the seven engineering development GPS satellites now in space have performed so beautifully. This intensifies the itch to get on with launching the operational GPS satellites, many of which have already been produced.

All seven development satellites have exceeded the four years of life that the Air Force and Rockwell, its GPS prime contractor, believed they would average. Two are now weak as a result of their atomic clocks running down, but each has been in orbit for more than eight years.

Rubidium is the main element in those clocks. The newer Navstar engineering satellites have longer-lasting cesium clocks, as will the operational GPS satellites.

The satellites now in orbit can provide some useful navigation data. However, they are too few in number to provide the around-the-clock, three-dimensional time, distance, and position data that the fully operational Navstar constellation of eighteen satellites and at least three spares will be capable of providing.

"We won't have any real operational capability until we have worldwide coverage," explains Colonel Green. "What's up there now provides the Navy—only—with roughly eleven hours a day of two-dimensional accuracy.

"But we've had remarkable results from those satellites. They've met or exceeded everything we ever expected of them. This makes us very optimistic about the production satellites—and once we're able to deploy them in the operational mode, they'll dazzle folks, I'm sure."

The only plus in the long wait to begin such deployment is the extra time available to Space Division and to the services to integrate GPS terminals into aircraft, tanks, ships, submarines, and other combat and combat-support platforms.

GPS capability is a major element, for example, in the Air Force's upgrading of the avionics of its F-16Cs, F-15Cs, and F-111s. GPS is also a big player in the avionics integration of the F-15E dual-role fighter, of the Advanced Tactical Fighter (ATF), and presumably of the Advanced Technology Bomber (ATB).

There are no present plans to provide the B-1B bomber with GPS capability. The B-52 bomber, on the other hand, was on top of USAF's list of aircraft to incorporate GPS terminals.

Once the B-52s began using navigation data from the Navstar satellites now in space to help them in their bombing practice, "the results were spectacular," declares Col. Wayne Jones, SD's GPS deputy program manager.

In executing the GPS engineering development program, Space Division and Space Command have turned out to be quite a team.

When the two oldest Navstar development satellites went sour in space, SD decided to move one of them into a position nearer the other, thereby enabling the five satellites still functioning well to close ranks, as it were, and work better together.

The repositioning job fell to Space Command, which controls all US satellites in space. "They did the maneuver flawlessly," says Colonel Green. "They have supported us very well in operating our system."

DSCS II Holding Up

Fortunately, Space Division's DSCS II communications satellites, built by TRW, are also holding up in space much better than anticipated.

"We have a good constellation up there," says Col. Glenn D. Rogers, SD's Deputy for Defense Satellite Communications Systems. "The satellites are lasting longer than they were designed to last."

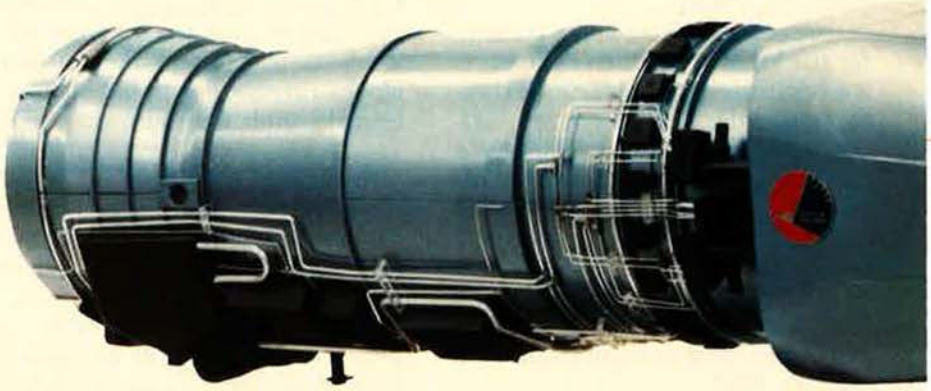
The newer and much heavier DSCS III satellites, being produced by General Electric, represent significant improvements in survivability, capacity, and ability to service many more users. Of the three in orbit, two are operational. Three more are in storage waiting to be launched.

In the future, DSCS III satellites will be built for Titan IV launch as well for Shuttle launch.

The complexity of the space-launch situation is exemplified by what has happened to DSCS III launch schedules in just the past seven months. They have been changed at least six times, and the dates of individual launches have been moved around by as much as two to three years.

"It's tough," Colonel Rogers says. "One thing that's comforting, though, is that the DSCS constellation should remain healthy until we again have a launch capability. Once we have it, we will have satellites available to upgrade and replenish the constellation." ■

By the turn of the century, USAF—building on work already in progress—may be testing powerplants that push a fighter straight up at speeds faster than Mach 1.



2000 Is (Ne

BY F. CLIFTON BERRY, JR.

THE year is 2000; the place is Edwards AFB, Calif. At the end of the three-mile-long runway, USAF's newest fighter, the YF-31, perches on its landing gear, its idling engine releasing shimmering heat waves. Cleared for takeoff, the YF-31's pilot advances the throttle to begin the aircraft's first test flight. The engine's rumble builds to a roar. He releases the brakes, and the sleek fighter begins to roll.

Old-timers in the crowd of observers are astonished. Less than twenty-five feet from brake release, the YF-31's nose rises. The main gear leaves the ground after another fifty feet. By 200 feet, the 50,000-pound YF-31 is fifty feet above the runway, nose pitching upward. Observers see the nearly transparent white plume from the engine exhaust. As the nose reaches the vertical, the aircraft continues to accelerate heavenward with a roar.

By the midpoint of the runway, the YF-31 is a vanishing speck shooting high into the clear desert sky. It quickly disappears from sight. There is silence for a moment, and then a sonic boom reaches the crowd. The YF-31 has exceeded Mach 1 in vertical flight its first time in the air.

In 1987, that scene is speculative. But it will surely be realized by the year 2000, if not well before. Such astonishing performance will be possible because the advanced propulsion systems to make it happen are already in development by the Air Force and industry.

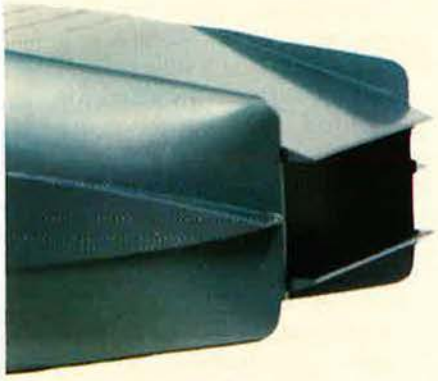
Propulsion advances take a long time to move from laboratory into reliable flight, ten to fifteen years. If US military aircraft of 2000 and beyond are to remain ahead of the competition, the groundwork must already be under way in earnest.

It is. Experts at Air Force Systems Command's Aeronautical Systems Division (ASD) and their counterparts in industry can already define the major trends in military aircraft propulsion between now and the year 2000.

First, ASD's Propulsion deputate says, more different propulsion development work is going on than ever before. Developments are cascading forward on a wide front, from the laboratory and the shop floor to enhancement work on operational aircraft. Advances all along that front are being introduced into operational use faster than before. At the same time, the laboratories are pushing the frontiers of technology to ensure continuous progress. And in the factories, manufacturing innovations are making the process more rational, more efficient, and more affordable.

USAF goals for aircraft propulsion are clearly established. Improved performance is one major and vital goal. Gen. Lawrence A. Skantze, Commander of AFSC, says, "Historically, the Air Force has emphasized performance—fly faster, turn quicker. . . ."

Formerly, performance was *the* goal. It overrode other considerations. That is changed. General



Pratt & Whitney and General Electric are the two companies competing for the powerplant contract for the Air Force's Advanced Tactical Fighter. Shown here is Pratt & Whitney's PW5000 demonstrator engine that is currently undergoing testing. The PW5000, with many advanced features such as thrust vectoring, is a forerunner of the F119-PW-100 ATF engine.

arly) Now

Skantze says that other goals are now being paid serious attention. Among them are the "-ilities": quality, which includes increased reliability, plus maintainability, durability, sustainability, and affordability. Still other goals include reducing costs and ensuring competition among suppliers at every level.

Both the Air Force and industry are following strategies that permit breakthroughs to be applied to existing systems in an evolutionary process. At the same time, they are pushing the frontiers of technology through basic research.

Building on the Present

The conceptual system approach is a break from past practices in propulsion development. It builds new capabilities more quickly by improving present engines and adapting engine configurations to more than one mission.

A major effort in that direction is a program called Increased Performance Engine (IPE). The IPE program improves two existing engines, the Pratt & Whitney F100-PW-220 and the General Electric F110-GE-100.

The Pratt & Whitney -220 evolved from the original F100 that powered the first F-15 and F-16 fighters. The GE F110 engine came into the picture when the Air Force decided to call for a second source to Pratt & Whitney. USAF conducted the Alternate Fighter Engine (AFE) competition, and now both the F100-PW-220 and F110-GE-100 are qualified. An annual competition determines what percentage of the next year's purchase of these engines goes to each of the two suppliers.

Both alternate fighter engines are now flying in operational aircraft. In July 1986, the Air Force accepted its first F-16 powered by the F110-GE-100, and in October 1986, the first F-15 fighter equipped with Pratt & Whitney's F100-PW-200 was delivered.

The Alternate Fighter Engine competition achieved two major goals: durability parity and cost competition. The meaning of cost competition is clear. "Durability parity" means that both of the alternate fighter engines are equally durable. They can operate for 4,000 tactical cycles, or about 2,000 hours, before teardown for major inspection. For a tactical fighter, that means the engine remains in the aircraft for up to eight to ten years before it must be removed.

Major goals of the Improved Performance Engine programs are to retain (and improve) the durability (at least 4,000 tactical cycles) of the alternate fighter engine, to reduce cost of ownership, and to achieve thrust parity. Present thrust is about 27,000 pounds for the F110-GE-100 and about 24,000 pounds for the F100-PW-220. Both will be improved to deliver the same thrust: 29,000 pounds. In the process, overall performance in operation will be improved.

At the same time, the Air Force is developing increased competition. The prime contractors, GE and Pratt & Whitney, are dual-sourcing critical components of both engines, such as fuel pumps and digital electronic controls. For example, GE formerly bought F110 fuel pumps only from Sundstrand. It has now brought in TRW as a second source for fuel pumps for the F110-GE-129 engine.

First flights of both IPE engines are not far off. Pratt & Whitney's engine, designated F100-PW-229, is scheduled to fly in an F-15 in November 1987. Soon after, in January 1988, GE's improved engine, tagged F110-GE-129, will take to the air in an F-16.

The result for aircrews will be higher performance of the F-15 and F-16 with lower maintenance requirements and costs. The improved performance engines can be installed in new aircraft or selectively retrofitted into existing ones.

STOL Maneuvering Demonstrator

In March 1988, two months after the F-16 flies with the GE -129, another derivative aircraft will take off on its maiden flight. The STOL Maneuvering Technology Demonstrator, or SMTD (STOL stands for Short Takeoff and Landing), is a

McDonnell Douglas F-15 that looks much like other USAF Eagles. But it is packed with modifications that give it "gee-whiz" performance.

The objectives of the SMTD program are to investigate, develop, and validate four promising technology areas that will give fighters a true STOL capability. They are:

- Advanced pilot/vehicle interface;
- Rough- and soft-field STOL landing gear;
- Two-dimensional (2-D) vectoring and reversing nozzle; and
- Integrated flight and propulsion control.

Why is STOL capability important for F-15s and future fighters? Because in future conflicts, the luxury of 10,000-foot runways will probably be only a memory. They will be cratered and cut, with only short stretches usable. Some fighters will probably have to operate from highways or rough and short fields as well.

Two of the four technologies—the 2-D vectoring and reversing nozzles and the integration of flight and propulsion controls—are pertinent to the SMTD. Together, they create extraordinary additional performance using the F100-PW-220 engines.

The label "2-D nozzles" on the SMTD means that the nozzles are rectangular (two dimensions, length and width) instead of circular. Exhaust from circular nozzles creates drag. If drag is reduced, performance is improved. More of the engine thrust is used to push the airplane along.

The nozzles are not only 2-D; they are also vectoring and reversing. Thrust need not flow straight back from the engine centerline. It can be directed up or down, or it can be reversed.

By integrating the flight controls with the propulsion controls, the SMTD pilot is able to use propulsive force as a flight control. A central computer uses software to bring together the flight controls, engine controls, and nozzle controls to achieve increased performance.

For example, for takeoff, the pilot advances the throttle and begins rolling. When he exerts back pressure on the stick, the nozzles move to vector the thrust, giving additional lift and pushing the F-15 SMTD into the air earlier. In flight, when the F-15 pilot needs to gain advantage over an enemy, vectoring enhances maneuverability. Roll rates are improved by nearly twenty percent, for instance.

Even more dramatic are improvements in agility. The F-15 SMTD can accelerate and decelerate, pitch, and point better than most other aircraft. When it is time to land, the vectoring, integrated propulsion, and precision flight path controls permit the pilot to plant the aircraft on the ground at slower speeds, in shorter distances, and in worse conditions than at present. For example, it will be able to operate from a wet runway only fifty feet by 1,500 feet, in a crosswind of from twenty-six to thirty knots, and with a 200-foot ceiling and a half mile of visibility—all without the need for active ground landing aids at the runway.

Another important SMTD feature is survivability. The aircraft will still be controllable and able to land in 2,000 feet even if a movable surface is shot off one side, a nozzle will not work, or one engine is lost.

In the past, the jumps in capability that the SMTD will deliver would have required designing a new air-

The Win-Win Deal

TechMod is the nickname for AFSC's Technology Modernization Program. It is a joint venture between USAF and industry to stimulate the use of new and existing manufacturing technologies and to invest the capital to put them into practice. In TechMod programs, both USAF and the contractor put up money in three phases.

During Phases I and II, USAF injects "seed money," which forms the bulk of the capital. That is used to analyze and identify opportunities. Phase II develops technologies and validates their applications in demonstration. In Phase III, the contractor provides the investment. That is the time when capital equipment is purchased and installed and the processes integrated into production.

The "Win-Win" comes about this way: For minimum investment, the Air Force saves money on engine purchases. The participating contractors can modernize their plants and be more competitive for all customers. The Air Force retains rights to the improvements. Immediate financial rewards to Air Force and supplier can be created. Over the long term, the industrial base is healthier and better able to surge when needed.

Propulsion TechMod managers at Aeronautical Systems Division say the program "addresses the entire manufacturing process, from raw materials to engine out the door." They calculate that for an investment of $132 million over the years 1982–86, potential savings of $750 million to $900 million were created for the Air Force. Examples demonstrate how the program works.

Rotating parts, such as disks and spools, are common to gas turbine engines. The parts are turned on lathes. This is a high-volume activity, with high potential for mistakes and defects. The criterion for success is "throughput," or the number of parts produced that meet specifications. Under the TechMod program, General Electric's Aircraft Engine Business Group conceived and has developed a Horizontal Turning Center at Wilmington, N. C., that is just now going into full use.

The Air Force invested $2.1 million in the project, and GE put up $19.6 million. The payoff? The Horizontal Turning Center will produce 100 percent more throughput and save a million man-hours of direct labor over ten years. The military engine programs that benefit right away from the new center are the F101 (B-1B bomber) and the F110 (F-15 and F-16 fighters). Net benefit to the Air Force is estimated at $13 million, or a payoff of better than six to one.

General Electric also wins. It achieves immediate savings. Soon, other GE military engines, such as the F108 (KC-135R) and the F404 (Navy/Marine F/A-18), will benefit. The center will also help GE cut costs and be more competitive on a civil engine like the CFM56 (Boeing 737-300 and Airbus A320). That is the "Win-Win."

Subcontractors also participate in TechMod. Precision Castparts Corp. is one of the major subcontractors in the turbine engine business. Under TechMod, it has pioneered computer-aided design and computer-aided machining (CAD/CAM) in manufacturing large complex castings.

Like rotating parts, complex cast parts are common in gas turbine engines. Most problems with large castings can be traced back to the original engineering design. The process has been somewhat trial and error: design the part, cast it, then try it. Through successive trials, castings are eventually created that are metallurgically sound.

Precision Castparts has developed a CAD/CAM workstation and communications links to transmit casting design data between its plant and its customers. The manufacturing benefits: metallurgically sound castings are produced earlier, with fewer trials. That will cut development costs, improve parts quality, and shorten delivery time. The system will be fully operational by July 1987. Engines to benefit are the Air Force F100, F101, F110, and Navy F404.

frame-engine combination. This program builds technology advances on existing systems. The results lead to derivative aircraft or earlier application of the technology to new fighters, such as the Advanced Tactical Fighter (ATF).

Propelling the ATF

Lt. Gen. William E. Thurman, Commander of Aeronautical Systems Division, which directs the Advanced Tactical Fighter program, declares that "the ATF will be the Air Force's air-superiority fighter for the year 2000 and beyond." Two companies, Lockheed and Northrop, are the prime contractors. Each leads a team in a fifty-month demonstration and validation phase of ATF development. Contracts worth $691 million to each team were awarded at the end of October 1986.

Propulsion for the ATF will be from either the competing Pratt & Whitney or General Electric engines. Contracts for those efforts were awarded three years earlier, in September 1983. The prototype ATF engines have benefited—and will benefit—from lessons learned in earlier engines and from technology developments now under way.

Both airframe teams are developing prototype aircraft for a flyoff evaluation. Lockheed's is the YF-22A; Northrop's is the YF-23A. Each team will build two prototypes—one to use the GE and the other the P&W engine. Under present plans, competition will be an option that can be carried throughout the program, even after full-scale development is started.

Requirements for the ATF are tough—and mostly classified. However, the propulsive thrust can be estimated. The Air Force wants a thrust-to-weight ratio (engine thrust/aircraft weight) of 1.2 or better. (The F-15 Eagle's T/W is about 1.05 with augmentation, or afterburning.) Assuming the aircraft will weigh about 50,000 pounds, then thrust of 60,000 pounds or more is needed. Consider other general requirements:

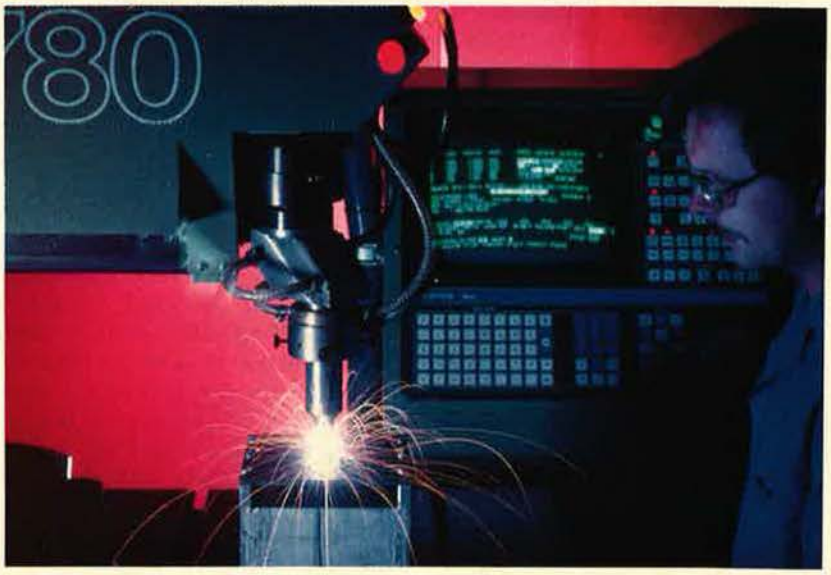
- **Supercruise.** The ATF will cruise long distances at supersonic speeds. At present, most supersonic aircraft do so for only short times and require augmentation (afterburning) to do so. The ATF engine must provide sustained supersonic cruise of about Mach 1.8 at 40,000 feet without augmentation. That means a turbojet or low-bypass turbofan with high turbine inlet temperatures and 2-D nozzles.
- **Range.** USAF wants substantially greater range from the ATF and wants to get it without using external fuel tanks. Low specific fuel consumption (sfc) is required from the engine, much more efficient than at present. (Specific fuel consumption is a measure of efficiency, expressed in pounds of fuel burned per pound of weight per hour. For instance, the thirty-year-old GE J85 engine in the T-38 Talon trainer has an sfc of 1.0. The lower the sfc, the better.)
- **Maneuverability.** The ATF has to win, both at long-range and close-in air combat. For that, it needs a high-thrust engine that weighs much less than existing engines and a system that integrates propulsion and flight controls for fighting agility.
- **Short-field capability.** Again, high thrust-to-weight ratio, thrust reversing and vectoring, and integrated propulsion and flight controls are needed.

TechMod: Modernizing the Factory

In the TechMod program, Aeronautical Systems Division invests "seed money" with industry to inject new technologies into the manufacturing process. Recent examples put into practice:

Company	Project	Benefits
Garrett	Automated Blade Inspection Cell	Reduce blade failures, life-cycle costs
Ladish Co.	Automated Machining Center	Better quality control
Pratt & Whitney	Turbine Airfoil Laser Work Center	Eliminate manual operations, reducing cost and lead time
Teledyne CAE	Metallizing Cell, Computer and Robot	Reduce part throughput time, cut scrap rate
Williams Int'l	Laser Machining Station	Cut labor 64 percent

Source: ASD/YZ Report, "TechMod Program Summary 1986."



As part of the cooperative TechMod program, both the Air Force and the contractor invest monies to stimulate the use of new and exciting manufacturing technologies. Shown here is a laser machining station at Williams International's plant in Michigan.

• **Survivability.** The ATF must be able to sustain damage without losing the aircraft.

• **Supportability.** ATF operations from remote fields with minimum equipment must be ensured. Less support equipment also means fewer transport aircraft sorties to reach an austere forward base.

• **Affordability.** Life-cycle cost must be minimized. This can be achieved by slashing the number of parts, by making it easy to get at the engine, and by minimizing the number of tools needed to perform maintenance.

The ATF engine will have built-in engine monitoring systems to ensure that the "-ilities" are achieved. They will be integrated with avionics, flight controls, and other system monitors. The information from all will be integrated into a diagnostic system. In the words of Col. Albert J. Piccirillo, outgoing ATF program manager, "We want to know early what's wrong and fix it right away. It is faster, cheaper, and creates more sorties." Colonel Piccirillo will be replaced by Col. James Fain.

Both ATF engines are undergoing ground tests now. Their Air Force designations are YF119 for the Pratt & Whitney and YF120 for the GE engine. Three flightworthy engines will be delivered to the Northrop and Lockheed ATF teams for installation in their prototype aircraft, now expected to fly in late 1989. By late 1990, source selection will be made, and the full-scale development process will begin. First flight of the winning ATF will take place at the end of 1992, and the first squadron will be in operation by early 1996.

To meet the accelerated ATF time schedule and to deliver reliable aircraft that will meet the requirements, the YF119 and YF120 engines must exploit every possible technology available today or reasonably expected in the near future. It will be done, say the companies (GE and P&W) and the customers (the Air Force developers).

Derivative Strategies

The successful ATF propulsion system will be but one of several achievements in the field between now and the year 2000. Others will evolve from continued attention to two basic approaches. First is creating derivatives of present models. Second is transforming breakthroughs in the laboratory to producible components of new engines.

The first approach is epitomized in the Engine Model Derivative Program (EMDP). It provides a framework for blending advances into existing systems and for future growth. That includes finding existing commercial applications that meet USAF requirements. EMDP, begun in 1978, demonstrates what is feasible. After demonstration, full-scale development can take place. The program shares costs with industry. Using fixed-price development contracts, EMDP and a contractor both put up money for a demonstration.

Past projects that have shown results include the GE F101 derivative fighter engine that became the F110. It reestablished competition for engines for the Air Force F-15 and F-16 and the Navy F-14 Tomcat. USAF cost was $83 million, but the competition is expected to save the service upward of $1 billion.

The GE and P&W Improved Performance Engines mentioned earlier evolved under the EMDP tent. Competition was again a major objective, along with higher thrust and incorporation of such developments as digital electronic engine controls.

Another EMDP project just finishing in January 1987 involves the Williams International FJ44 engine. The Williams FJ44 was a commercial development program with applicability in general aviation. The Air Force rationale in this case is to demonstrate that the FJ44 can be an alternative to the Garrett F109 engine in the T-46 trainer aircraft, if that program proceeds. Also, USAF has a choice of engines for new planes, such as lightweight attack or forward air control aircraft.

An example of demonstrating commercial adaptation for USAF use involves the reengining of Strategic Air Command's KC-135 tankers. Up to 390 aircraft in the KC-135A fleet are having their turbojet engines replaced with turbofans. The engine of choice for this batch has until now been the CFM56-2 turbofan from CFM International, a product of GE and SNECMA cooperation. In USAF use, it is designated the F108.

Now, under EMDP, a commercial engine is being considered for the KC-135 reengining. The rationale is to put competitive pressure on CFM International while minimizing Air Force upfront costs. The alternate engine is called the V2500. It is a 25,000-pound-thrust engine under development by the five-nation consortium called International Aero Engines in Hartford, Conn. Partners in IAE are Pratt & Whitney, Rolls-Royce, Japanese Aero Engine Corp., MTU (West Germany), and Fiat (Italy).

ASD analysts say that the V2500 can be a valid competitor. If the engine develops as planned and the analyses hold, they estimate the V2500 will use up to seventeen percent less fuel than the F108. Also, they estimate that a KC-135R with the V2500 engine will be able to carry about seventeen percent more fuel on a refueling mission to tank up other aircraft.

The advantages to the Air Force include leverage for improved warranties, expanded dual-sourcing, and contractor responsiveness.

Other possible payoffs from the EMDP in the early to mid-1990s are in propulsion for the B-1B bomber and the A-7 attack aircraft. For the B-1B, 2-D nozzles for its GE F101 engines could demonstrate a capability for additional thrust. On the A-7, adding augmentation (afterburning) to the Allison T41 engine or adapting the GE F110 or P&W F100 would give the Corsair II a supersonic capability. It would be an "A-7 Plus."

In the Laboratories

Research and exploratory development for high-performance propulsion advances by the year 2000 is now being conducted in laboratories of the Air Force and industry. More than twenty-five projects involving six engine companies are under the broad title of HPTET. HPTET stands for the High-Performance Turbine Engine Technology initiative.

Five years ago, Aeronautical Systems Division did a study to determine what could be done to get better turbine engine propulsion in the future. The study concluded that if materials could be improved—that is, be lighter and stronger while operating at higher temperatures—then

major advances could be made. The study recommended a focused effort to develop the technologies to make the necessary leaps.

Gen. Lawrence A. Skantze, Commander of Air Force Systems Command, endorsed the conclusions and recommendations. He got industry involved in the exercise. In the summer of 1985, Air Force and engine industry groups worked together to establish goals and identify the critical problems that must be overcome. The two main goals are to double engine thrust-to-weight ratio (T/W) and cut cruise fuel consumption in half by the year 2000. That wrote the marks on the wall, the targets to strive toward.

Engine T/W is thrust in pounds over weight in pounds. Today, for the latest F100-PW-220 engine, it is 24,000 pounds of thrust over 3,200 pounds of weight, or 7.5:1. The engine for the Advanced Tactical Fighter is expected to have a T/W of 10:1 in the mid-1990s, a major step forward. Rolls-Royce engine scientists agree that 10:1 will be achieved in the engine for the European Fighter Aircraft of the mid-1990s, and they see 12:1 as realistic by the year 2000. Under HPTET, the Air Force and laboratories of the engine manufacturers are striving to reach a T/W of between 15:1 to 20:1 by the year 2000. Even if they achieve only 12:1, that is more than fifty percent better than at present.

HPTET is a joint project of ASD's Aero Propulsion Laboratory and its Materials Laboratory. Engine companies participating in HPTET are Allison, Garrett, General Electric, Pratt & Whitney, Teledyne, and Williams International. Each company has described its own path toward overcoming critical problems and reaching the major goals. But all are working under the plan developed together with AFSC.

The focus is not on a single area, but across the board. For example, advances in computer capabilities mean that corresponding advances can be made in aerothermodynamics—the study of the effects of heat on gasses, as in air flow through gas turbines. That means efficiencies achieved from the start, in the basic design. Other elements of HPTET concentrate on breakthroughs in materials. The search is not limited to engine companies. Others, such as Lockheed and Alcoa, are pursuing advanced materials.

Ability to operate at higher temperatures is a major element in increasing engine efficiency. In simplified terms, at higher temperatures, more thrust is achieved from each pound of fuel. And efficiency is also improved by the use of lighter materials. If engine thrust remains constant but the engine weighs less, then thrust-to-weight ratio is improved.

The latest revolution in propulsion may be a highly advanced throwback to the past—the propeller, or more specifically, the fuel-efficient propfan. This scale model was tested last year, and testing of the actual article will begin this month.

Whither Propfans?

When asked to name the most promising technology for near-term subsonic applications, the answer at ASD is "propfans." The reason is fuel efficiency.

Anyone who thinks that propellers have progressed about as far as they can should discard the idea. The "big three" engine companies and others are spending heavily in funds and talent to develop advanced turboprop engines—propfans. The reasons boil down to a very persuasive one: fuel efficiency. Propfan-powered transports will be twenty percent more fuel efficient than current transports, such as the Boeing 757, powered by turbofans. The improved efficiency is even greater—forty to fifty percent greater—over the older DC-9 or Boeing 727 transports.

Air Force applications foreseen for propfans are mainly on transports and subsonic cruise missiles. For them, better fuel efficiency of the propfan pays off in increased range and payload.

NASA is conducting a Propfan Test Assessment program. Lockheed-Georgia is doing the work under contract to NASA, flying an Allison/Pratt & Whitney engine with a Hamilton Standard propfan on a specially modified Gulfstream G-II aircraft. First flight is scheduled for this month. The project evaluates structural integrity of propfan blades, noise and vibration inside the aircraft cabin, and outside noise.

At the same time, the Air Force has Lockheed-Georgia evaluating technologies for advanced tactical transports to fly in 2000 and beyond. It appears feasible to develop powerplants for tactical transports that would be capable of short or vertical takeoff and landing and that would be able to carry payloads of 55,000 pounds out to a radius of 1,000 nautical miles.

The Search Is On

So the search is on to develop materials both lighter and more tolerant of higher temperatures. Another important reason for the quest for new materials is to reduce US dependence on foreign suppliers for basic metals used in turbine engines. Something like 800 pounds of cobalt imported from Africa are used in an F100 fighter engine. If the cobalt can be replaced by other materials, then the US is not tied to a

string that can be jerked by an unfriendly supplier.

The names of materials presently used in aerospace applications are familiar: magnesium, aluminum, titanium, and so on. Propulsion scientists call the ideal material for turbine engines "Unobtainium," because it does not exist. Since Unobtainium is unobtainable, they must develop new materials or work wonders with existing ones. Both broad paths are being followed.

The internal structure of metals and alloys is defined by the method by which they are produced. Thus, casting, rolling, and forging produce metals and alloys whose properties are understood and predictable. Temperature and strength limits are known. However, if the methods of producing alloys can be changed, their internal properties can also be changed—for the better, in this case.

An example is melting the alloy into liquid form, then cooling it at superfast rates of one million degrees per second. Lockheed calls it Rapid Solidification Processing, or RSP, and visualizes applications primarily in structures and skins of aerospace vehicles operating at high temperatures, such as the Advanced Tactical Fighter, National Aerospace Plane, spacecraft, and missiles. The Pratt & Whitney name is Rapid Solidification Rate, or RSR. P&W aims mainly for applications in gas turbine engines.

With rapid solidification processes, alloys of known materials can be produced that are capable of use at higher temperatures. Thus, magnesium alloys can replace aluminum alloys, aluminum alloys can replace titanium, and so on up the temperature scale. In a gas turbine engine, Pratt & Whitney believes that alloys produced by rapid solidification can be used in compressor and turbine airfoils and disks to achieve these benefits:

- Fifty percent increase in thrust-to-weight ratio;
- Twenty to thirty percent reduced acquisition cost; and
- Three times longer part life in the hot sections.

Other new materials being investigated are not conventional metals as most people know them. Instead, they are composites, such as metal matrices, carbon/carbon or graphite/polymers, or ceramics. Only recently, such new materials were unsuitable for engine applications. Graphites are strong, but lose strength as temperatures increase. Carbon/carbons could tolerate temperatures, but were not strong. Recent developments under HPTET and other programs have developed composites that do not have the earlier shortcomings.

Other advances being pursued under HPTET aim at creating innovative engine structures. For instance, if an engine structure could be designed without bearings, then greater efficiency and reliability could be possible. Doing away with bearings is just one example of the innovative thinking sprouting under the aegis of HPTET.

The scientists monitoring the HPTET program for the Air Force summarize it as "an advanced, aggressive plan to meet military propulsion needs for 2000 and beyond. The major thrust is innovation." They also point out that the search for new materials is not only a US effort. In fact, their assessment is that Japanese and French laboratories are ahead of the US in ceramics and ceramic composites.

A scientist at Air Force Systems Command agrees. He points out the danger of investigating only a few promising areas because research funding is limited. According to USAF analyses, the Soviet Union is investigating more than thirty metal matrix materials for advanced applications, while USAF is limited by money shortages to only a few.

But funds will always be limited, except in time of war. But then is ten or fifteen years too late. Risky, exploratory research must be continuous if the Air Force is to be ready whenever it is needed. That requires spending money. But money can also be saved, especially in the manufacturing process—on the shop floor, between the research laboratory and the skies.

Competition and Collaboration

Competition has become an embedded and pervasive fact of life throughout Air Force propulsion development and acquisition. The case of the alternate fighter engine for the F-15 and F-16 is well known. But at ASD's Propulsion deputate, where all propulsion programs come together, the amount and percentage of competitive obligations have zoomed in the past three years. The numbers tell the story.

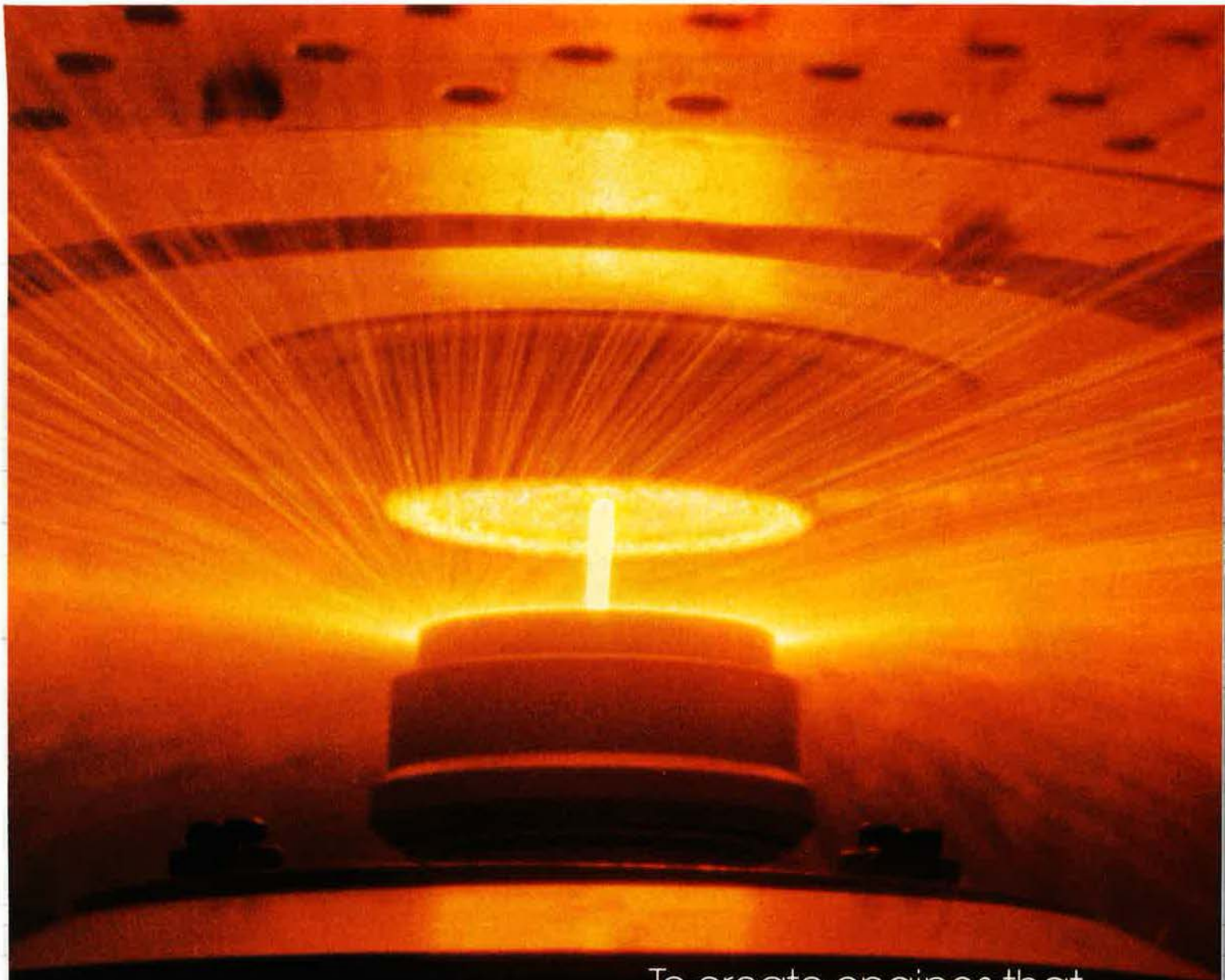
In FY '83, the Propulsion deputate obligated $1.415 billion. Of that amount, $89 million was competitive, for 6.3 percent. Competitive figures more than doubled in FY '84. Of $1.414 billion obligated, sixteen percent, or $227 million, was competitive. In the next year, the figures increased to 60.7 percent competitive ($2.095 billion out of $3.446 billion total). For FY '86, the competitive figure was 73.4 percent ($2.366 billion of $3.225 billion). The goal is ninety percent in FY '87, then to climb to ninety-five percent by FY '89.

Collaborative efforts are on the rise, too. For instance, the Air Force is not the only beneficiary of its propulsion work. The US Navy is improving its F-14 Tomcat fighters by fitting F110 engines, thereby achieving higher performance. In fact, USAF is buying the engines for the Navy's new F-14D models from GE. Propulsion for the Navy's Advanced Tactical Aircraft of the mid-1990s could be derived from Air Force propulsion advances. That would happen under an agreement they made in 1986 to share appropriate technologies on the Navy's ATA and the Air Force's ATF programs.

On the leading edge of research, the Air Force has been working since the summer of 1986 with the other military services, the Department of Defense, and NASA on developing a national initiative for high-performance turbine engine development. The program is still in the organizational stage. It will use the USAF High-Performance Turbine Engine Technology initiative as the nucleus. Bringing in the other participants can broaden the financial support base for a national turbine engine initiative.

At present, there is little formal foreign participation in USAF propulsion development. In Europe, the hottest new program is the European Fighter Aircraft. The consortia were formed in 1986 and are working to develop the engine and the aircraft itself to fly in the mid-1990s.

However, through collaboration and cooperative projects, foreign



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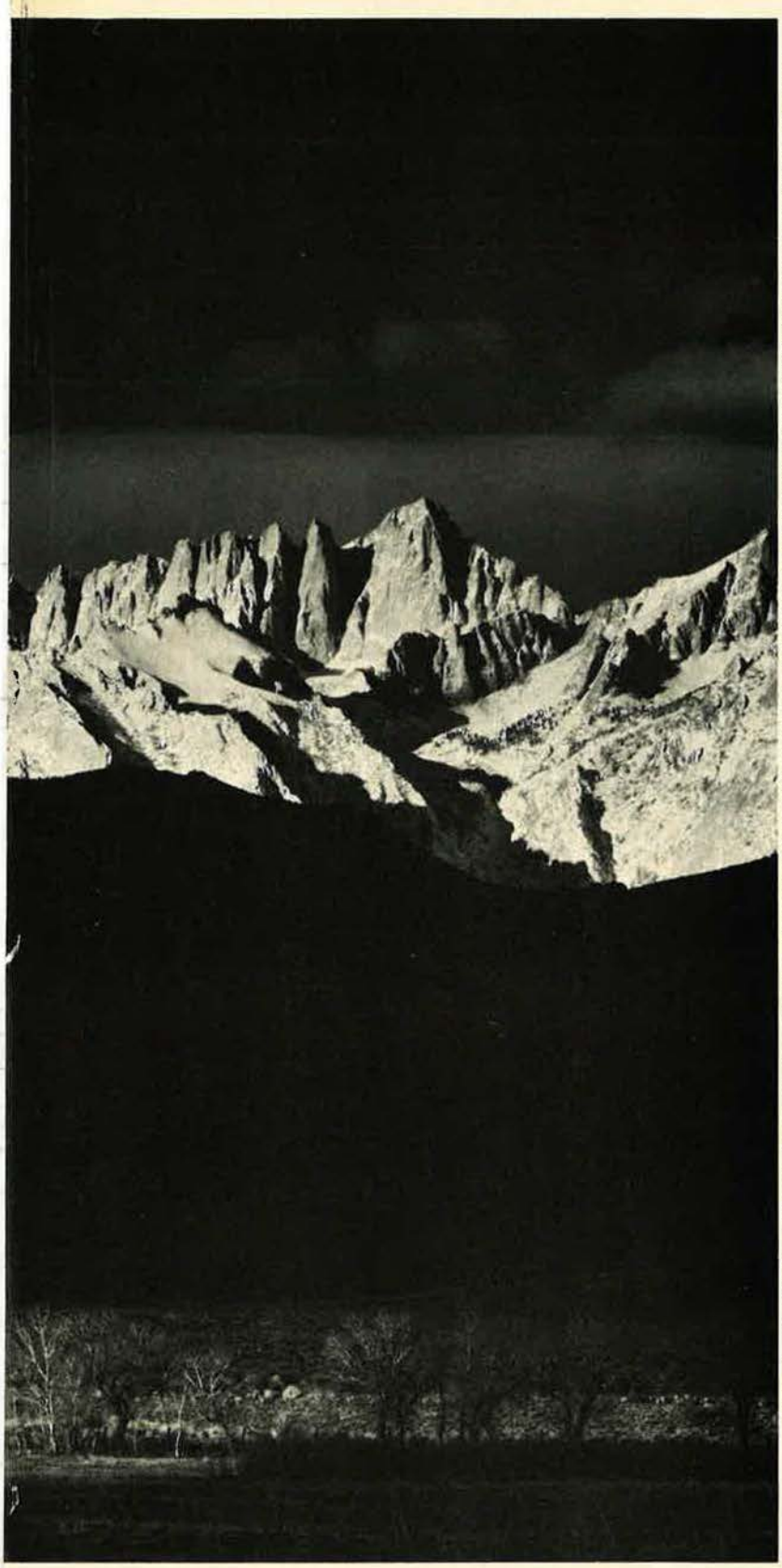

Winter Sunrise, The Sierra Nevada, From Lone Pine, California. Photograph by Ansel Adams. Courtesy of The Trustees of The Ansel Adams Publishing Rights Trust. All Rights Reserved.

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engine companies are working with their US counterparts. Through those arrangements, technology advances can be transferred to mutual advantage. Air Force developers take a keen interest in such arrangements. In a negative sense, the Air Force can prohibit transfer of leading technology abroad. In a positive vein, it can exploit a foreign advance for USAF propulsion systems. The criterion: Do what is best for the US.

A case in point is the USAF evaluation of the International Aero Engines V2500 for reengining KC-135 tankers. IAE's entry into the KC-135 game puts pressure on the GE/SNECMA joint company, CFM International, whose F108 engine is already being fitted on older tankers that become KC-135Rs.

Pratt & Whitney and Rolls-Royce are already partners in the Pegasus engine that powers US Marine Corps AV-8B Harrier jump jets. Pratt & Whitney has joined with Rolls-Royce and France's Turbomeca to sell their RTM 322 engine to the Army and Navy as an alternative to the GE T700 engine in the Blackhawk, Seahawk, and Apache helicopters.

Rolls-Royce, the British engine giant, is determined to widen its business base with US military customers. Its plans includes working with Pratt & Whitney on the Pegasus and RTM 322, as cited. Also, Rolls-Royce will bid to manufacture spares as the US services create competition for multiple sources. It is already performing overhaul of GE TF34 engines that power A-10 Thunderbolt IIs in the UK. With the Navy's T-45 Goshawk trainer, Rolls-Royce has a US base for its Adour engine. With partners McDonnell Douglas and British Aerospace, it can offer the Goshawk to the US Air Force for its trainer needs.

Remember the YF-31's first flight that opened this article? It could be flying as speculated, as the result of an agreement made in September 1986. Rolls-Royce and Pratt & Whitney agreed to study jointly the technology requirements for a supersonic vertical/short takeoff and landing aircraft engine. Their agreement followed a 1986 US-UK governmental agreement to collaborate on such joint studies.

This captive Harrier airframe powered by a Rolls-Royce Pegasus engine with thrust augmentation is providing data that may ultimately lead to a supersonic vertical or short takeoff and landing aircraft.

Matching Engines to Aircraft

In the maze of alphanumeric engine nomenclature, it is easy to lose sight of which engine powers which aircraft. Here are the major USAF aircraft and their engines:

Aircraft	Engine(s) & Manufacturer
A-7	TF41, Allison
A-10	TF34, GE
B-1B	F101, GE
B-52G	J57, P&W
B-52H	TF33, P&W
C-5	TF39, GE
C-17	F117, P&W
C-130	T56, Allison
FB-111	TF30, P&W
F-4	J79, GE
F-5	J85, GE
F-15	F100, P&W
F-16	F100, P&W; F110, GE
HH-53	T64, GE
KC-135A	J57, P&W
KC-135E	JT3D, P&W
KC-135R	CFM56, CFM International
T-37	J69, Continental
T-38	J85, GE
T-46	F109, Garrett
Air-Launched Cruise Missile	F107, Williams Int'l/Teledyne CAE

Clearly, an era of unprecedented progress in aircraft propulsion is happening. What flies in the year 2000 will be the product of work being done in 1987. Because of the way the Air Force is managing the progress for its needs, advances in every aspect of propulsion systems can be integrated into existing ones, steadily improving them.

It is an evolutionary revolution that keeps raising the standards and goals with quality products. Higher quality is imperative. To quote General Skantze once again: "A military-industry team that produces low-quality weapons won't produce very many because the country won't be around long to need them." ■

F. Clifton Berry, Jr., is a former Editor in Chief of AIR FORCE *Magazine. He has written on international security topics for nearly twenty years. He saw USAF service in the Berlin Airlift, 1948–49. Later, he was a paratrooper and officer in the 82d Airborne Division. He commanded airborne and infantry units in the US and Korea and saw Vietnam combat as operations officer of a light infantry brigade. He is a principal in FCB Associates, an information service on international aerospace topics.*

Roundtable experts warn of a dangerous lag in developing computer programs for the military.

Coming Up Short in Software

BY JOHN MORROCCO

COMPUTER technology has come a long way from the days during World War II when codebreakers first used huge machines that filled a small auditorium to help decipher Japanese and German codes. Today, small personal computers with 100 times the computing power of those early machines can be seen on desktops in business offices and in homes across the country.

Since those early days, the defense establishment has remained on the cutting edge of computer technology, developing new and more powerful machines with thumbnail-size semiconductor chips for use in advanced aircraft, robotic systems, and surveillance and communications equipment. Now on the horizon are high-speed "supercomputers," which can help spawn new technological advances, such as the National Aerospace Plane, and run highly complex systems, such as the network of sophisticated sensors and weapon systems envisaged by the Strategic Defense Initiative program.

Lagging Behind

But while the military services are making rapid strides in employing new technologies and advanced computers to develop more efficient, "smart" weapon systems, experts warn that the development of software to run these systems is lagging dangerously behind.

"Nowhere has change been more rapid or more dramatic than in the introduction of computing and its application to a wide range of defense systems, defense services, and in the vital functions of command and control and indications and warning," said retired Navy Adm. Bobby Inman, who chaired an Aerospace Education Foundation Roundtable discussion last November 6, 1986, on computers and software.

Mr. Inman, former director of the National Security Agency and now President of the Microelectronics and Computer Technology Corp. in Austin, Tex., warned, however, that there seems to be broad agreement

that the process of developing software to run these systems lags far behind by comparison.

Donald C. Latham, Assistant Secretary of Defense for Command Control Communications and Intelligence, agreed that the problem is "extremely serious."

The requirement for computerized systems to run and control SDI, strategic and tactical weapon systems, and systems to manage the Pentagon's enormous logistics, transportation, security, and personnel needs has become "ever more demanding," Secretary Latham said.

Dr. Ronald L. Kerber, Deputy Under Secretary of Defense for Research and Advanced Technology, said the large-scale use of computers is vital to the development of our research and technology base for the future.

"We couldn't embark on a project like the national aerospace plane without computers," said Dr. Kerber, who helped develop several chemical laser systems at the Air Force Weapons Lab in Albuquerque, N. M., in the late 1970s while on the faculty of Michigan State University.

Some computer scientists, for example, speculate that it will require 10,000,000 to 100,000,000 lines of computer code to run the strategic defensive shield envisioned by the Reagan Administration. By comparison, the Space Shuttle uses about 3,000,000 lines of computer code.

Supercomputers and Software

Secretary Latham cited the Pentagon's efforts to push the technology to the limit by developing supercomputers that can process information at ultrahigh speeds. The Defense Advanced Research Projects Agency's (DARPA) strategic computing initiative is just one such example, he said.

Dr. John H. Manley, Director Emeritus of the federally funded Software Engineering Institute at Carnegie-Mellon University, said researchers are working on shrinking these supercomputers to the size of match boxes so that they can be used in tactical systems as well as in strategic systems of grander scale.

Aerodynamically, the F-16 and the MiG-29 are about even. The quality edge depends on avionics and software.

One such use would be for vision systems for robotics, said Dr. Manley, who is also President of Computing Technology Transition, Inc., a private consulting firm specializing in software and systems engineering. "They could be put into such things as the autonomous land vehicle or thinking robots that have some intelligence [and] incorporated with those [systems that] require massive computing power but in very small sizes," he said.

"That is the key to the whole game in the future," said Mr. Latham, who manages most of the Pentagon's electronics and computer programs.

The tremendous explosion in the development of new sensors, for example, has given the military the ability to access larger quantities of information at a rapid rate. But it also requires faster and more accurate computers to analyze and process this flood of information.

In the tactical arena, for example, the advanced computerized fire-control systems and fly-by-wire, digital flight controls now employed on the F-16 fighter would have been impossible a few years ago. New and more sophisticated software, and its application to microprocessors that are embedded in modern fighter aircraft, has given the military a capability that it could never have hoped to achieve five or six years ago, said Secretary Latham.

"Avionics is the key to our advantage if we are ever going to hold it over the Soviets," Mr. Latham warned.

He noted that the Soviets have made great strides in their tactical aircraft, citing the new MiG-29 as a prime example. "The MiG-29 is about as good aerodynamically as the F-16 today," he said. "We've got to be able to build an aircraft that has some aerodynamic edge and some capabilities in the engine like supersonic cruise, but the key is avionics, and the key to avionics is a very intelligent architecture and software to make it all happen."

The Advanced Tactical Fighter (ATF), which the Air Force hopes will represent a quantum leap in fighter aircraft technology, poses a tremendous challenge in terms of the sophisticated avionics equipment it will require. A software architecture embodying an estimated 7,000,000 lines of code will be needed to make the ATF's avionics system work, Secretary Latham said.

He cited the area of cockpit automation as another exciting field that is being worked on and that offers great opportunities. There is a need for new programs to correlate information from computers embedded in the aircraft and to display that information to a pilot in a way that would make his job easier by allowing him to concentrate more on the mission.

"We have the computer systems," Mr. Latham said. "Now we have to look at how to develop the software to do that, to get that enhanced capability."

Deep Trouble

He also warned that "if major corporations that are involved in the defense business cannot execute these programs that involve very heavy software content, they are in deep trouble"—especially in terms of winning future business as the military begins to rely more and more on computer technology.

Computers and their software have become an integral part of the Air Force's weapon systems of the future. Of seventy new technology initiatives earmarked for development by the end of the century as part of the service's Project Forecast II, fifty are heavily dependent on new software, said Brig. Gen. Charles F. Stebbins, Air Force Systems Command's Deputy Chief of Staff for Science and Technology.

General Stebbins said one area of research that is particularly encouraging is the use of photonics in future systems.

"What we are trying to do is to build some systems, such as battle management systems, that are from start to finish photonic devices using photons instead of electronic devices using electrons," he said.

Photons would be less susceptible to the damaging effects of electromagnetic pulse created by a nuclear explosion or by other radiation. Their incorporation would create more survivable systems.

The experts participating in the AEF Roundtable agreed that the biggest challenge in translating new technological advances in computing into working weapon systems lies in the area of software development.

"We have a very serious problem in that field," said General Stebbins, who holds a doctorate in aerospace engineering from the University of Colorado. "I don't think we do a very good job in terms of specifying or understanding—in advance of procurement—the cost, scheduling, quality, and reliability of software and what we want to get out of the final system," he said.

General Stebbins suggested that there should be more emphasis on preliminary discussions between the designers and the users. "I think we get too far down the pike with a solution to a problem, and quite often it's the solution to the wrong problems, and we have to go back and start all over again," he complained.

"We are traditionally behind the power curve with software after building new hardware," agreed Dr. Manley. "We can build a computer or a supercomputer, but it takes us a year or two to learn how to program it."

Mr. Inman said that there appears to be too much emphasis on determining how to write a line of computer code and what it will cost instead of concentrating on the requirements and specifications for the whole system.

Dr. Manley said that the main problem is that software specialists are not involved enough in the up-front development stages of new systems and, as a result, are doomed to play catch-up.

"The software people, at this point in time, do not really get involved in the front-end systems requirements process enough to make their problems manageable by the time you get through the allocation process," he said.

Satisfying the Appetite

Dr. Manley predicted that it will take software engineers three to five years to be able to cope with the new generation of computers now nearly ready for use. He said that while the implementation of the new Department of Defense MIL-STD-2167 is a step in the right direction, there is still a long way to go to remedy the problem.

"We have such an appetite for the capability that comes next year and the year after that," agreed Dr. Kerber, "that we tend to get ahead of ourselves."

The problem is compounded because programmers constantly have to update software to keep it from becoming obsolete. Dr. Manley said software typically goes into maintenance just three to four years after it is developed.

The maintenance problem continues to loom larger. "No question about it," said Mr. Latham, "a very, very large amount of the DoD annual expenditures on software systems would be in this maintenance area."

"The senior Air Force leadership realizes that the software problem is really starting to eat our lunch," said General Stebbins. He noted that software maintenance costs alone run four times as much as the cost of initial development.

"We have a very serious problem in that field," the General declared. "We've left our programming up to the programmers as opposed to software engineers, and I think the difference there is the discipline that is required in terms of software engineering vs. the sort of 'art form' that programmers are using now."

The defense industry as a whole—not only the Department of Defense—is grappling with the problems of software development, manufacturing, and maintenance. At the same time, the United States is being pressured by foreign competitors, such as the Japanese, who can produce both hardware and software more rapidly and at a lower cost.

"We are moving at a snail-like pace at best in addressing the whole issue of manufacturing and of bringing computing power to bear now on our ability to produce the defensive systems that we need with the kind of productivity that makes a difference for our being competitive over the long term," Mr. Inman asserted.

Mr. Latham agreed, noting that while there are thirteen Japanese companies that can produce a one-megabyte memory, there are only two US companies that can do so for internal consumption. "We have got to be able to design, generate, produce, and maintain software at a

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much lower cost than we are doing today," he said.

Because of the complexities and costs involved, there has been a large-scale retrenchment within industry in the field of robotics, especially in the automotive business, Dr. Manley noted.

He cited the difficulties being encountered by General Motors Corp. in trying to develop software systems to run automated manufacturing systems using robots on the assembly line. "That has been a multiyear effort, and they still haven't solved that problem," he said. "So what we are talking about in terms of future weapon systems with new exotic computers is a much more difficult problem."

A Worsening of Shortages

One of the major problems is a shortage of trained systems engineers vs. programmers. While programmer shortages of the past have disappeared, Dr. Manley said, there is a "critical shortage" of people who can actually program sophisticated systems and engineer configuration changes.

He warned that by 1990, there will be an estimated shortfall of 1,000,000 professional programmers, systems engineers, and software managers based on current projections of increasing software components in systems that are currently being built. The outlook for the future is even less promising, said Dr. Kerber, when the shrinking number of engineering graduate students in universities today is taken into account.

The shortage of trained systems engineers with a knowledge of artificial intelligence, an area the military is becoming more and more interested in, is even more critical, General Stebbins said. This problem is compounded, he added, by the lack of sufficient documentation about software programs and by the military's overreliance on individuals who take their knowledge with them when they go to work in the civilian sector.

Pentagon officials are working on the problems, but progress has been slow.

It's a huge job to keep programs current. Software maintenance costs four times as much as the original development did.

For example, there is a great need for reusable programs that can be transferred from older systems to newer ones as they come on line. "We need the ability to transfer software from older systems to new systems without having to reprogram it," said Mr. Latham.

The introduction of Ada as the Pentagon's standard language for mission-critical computers is a modest start. "It will be the key that gets us up and running," said General Stebbins.

The Pentagon began working on the Ada computer programming language in 1975 and has spent nearly $1 billion on developing it. Ada is finally ready for use in all the Pentagon's mission-critical computer systems as well as for general-purpose computing tasks.

Implementing Ada will allow the Pentagon to develop a common software repository and offers great opportunity for cutting costs in computing. But critics have questioned whether the language will be ready in time to operate newer computer systems because of the long lag in its development time.

Dr. Kerber, who is in charge of the Pentagon's office of research and advanced technology, said the trend toward earlier prototyping of weapon systems would help alleviate the problem of playing catch-up by uncovering problems at an earlier stage in development.

"We have to develop the discipline to go with what we need, install it, and then go for product improvements," he said.

Dr. Kerber also expressed the thought that the recent establishment of a procurement czar to oversee all Pentagon procurement would add some discipline to the procurement process.

Computerizing the Pentagon's procurement process is one of the highest priorities of Richard Godwin, the newly appointed Under Secretary of Defense for Acquisition. Dr. Kerber said that Mr. Godwin has implemented a "major initiative" to use computers to access the reams of data the Pentagon maintains on its weapon systems programs. This will better enable procurement officials to track the progress of various programs and identify problems before they occur.

"We are working on the problem," said Dr. Kerber, "but I am not confident we are ahead of the problem." ■

John Morrocco is a Washington-based journalist specializing in aerospace and defense. He is the author of two books on the air war in Vietnam. Previously, he worked for Defense News *and* Investor's Daily. *His most recent article for this magazine was "A Glimpse of Things to Come" in November '86, and his other article for this February issue, "Trumps in Danger," may be found on p. 70.*

The Soviets have caught up with us in six basic technologies and are closing on us in six more.

Trumps in Danger

BY JOHN MORROCCO

THE United States still leads the world in new technologies and scientific research, but no longer holds the huge advantage it once did. In fact, its leadership is being seriously challenged.

From computer science to the automotive industry, America has seen its lead in science and technology gradually eroding. But nowhere

is the declining trend more alarming than in the field of military technology.

According to Pentagon analysis, the Soviet Union has caught up to the United States in six of the most important basic technology areas—aerodynamics and fluid dynamics, conventional warheads and chemical explosives, directed energy, nuclear warheads, optics, and power generation and energy storage techniques.

The Defense Department has further warned that of the fourteen areas where the United States still maintains an edge, that lead is slowly evaporating in six, including materiels, propulsion, radar, and submarine detection. These conclusions signify a "dangerous trend," according to Gen. Robert T. Marsh, USAF (Ret.), former commander of Air Force Systems Command and Chairman of AFA's Science and Technology Committee.

General Marsh headed a panel of five experts who addressed the issue of America's precarious lead in science and technology and discussed ways to meet the challenges of the future at an Aerospace Education Foundation Roundtable on October 16, 1986, entitled "Technology: Our Trump Card."

"The one source of competitive advantage that we have, either economically or militarily, is technology, and I think in this day and age, where we have reached military parity with the Soviet Union, the demands on restoring our technological edge in key areas is absolutely critical," said Dr. George Keyworth II, Chairman of the Keyworth Co.

Dr. Keyworth, the former science advisor to President Reagan and former Director of the White House Office of Science and Technology, said that the money the Pentagon spends on basic science and technology research represents "the most effective leveraging investments that this government makes."

For example, the Air Force is today fielding such weapon systems as B-1B bombers and F-16 and F-15 fighters that sprang from the research and development in science and technology that began ten or twenty years ago. "It's the place from which stealth technology came," said Dr. Keyworth.

Given the Soviet Union's growing technological know-how, investing in science and technology is more important than ever, said Dr. Thomas E. Cooper, Assistant Secretary of the Air Force for Research, Development, and Logistics. "I am saying it's virtually the difference between life and death right now," he said. "It's absolutely critical."

Secretary Cooper warned that the United States can no longer take for granted the superiority of its missiles or the ability of its bombers to penetrate enemy defenses, as it did twenty years ago. "Instead, we are looking at surprises in areas where we can lose that advantage to which we have been accustomed.

"Five years ago, we could say that Soviet submarines, for example, were a decade or more behind us," Secretary Cooper pointed out. "Now we see them so close in technology that we worry about the rate at which that advantage is eroding and our ability to protect it in the future."

No Sustained Commitment

Dr. Keyworth diagnosed the problem as one of a lack of sustained commitment on the part of the United States to its science and technology base. He contrasted this inconstancy with Soviet persistence in applying technology, year after year, to new systems. "I think it is the same challenge we are facing in competing with the Japanese and other nations in the marketplace," he said.

Charles A. Fowler, Chairman of the Defense Science Board, warned that the problem is serious. Members of the Defense Science Board have expressed real concern over the eroding US technology base, and Mr. Fowler said that the board will be focusing on the issue next summer.

Mr. Fowler noted that one of the differences between the Soviet and US approaches to research and development was that Moscow tends to stick to its projects while the Pentagon, often with Congress's help, tends to fold its tents when problems arise. The decision to cancel the Army's Sergeant York division air defense gun system is a case in point, he said.

"I don't think there is any question that the problems that were there could have been fixed fairly readily," he said. "Instead, we spent

a billion and a half dollars in development, built a few, then canceled the program." Mr. Fowler contrasted this with the Soviet development of a surface-to-air missile system that ran into problems at the test range. The Soviets continued to produce the system while simultaneously working to correct the flaw. They then backfitted the fix to the original models.

"This is a very fundamental issue that impacts on how the Soviets get more for their developments than we seem to in terms of deployed equipment," explained Mr. Fowler.

A dedicated financial commitment to basic science and technological research is also essential. From 1981 to 1986, the Pentagon increase in science and technology spending was the lowest of all the federal agencies.

Dr. Bernard Kulp, the recently retired Chief Scientist of Air Force Systems Command, said it is unrealistic to believe that you can keep your edge without maintaining a constant level of investment in research and development. Dr. Kulp pointed out that the investment in the science and technology base areas since 1980 has not kept up with the Reagan Administration's overall military buildup. The percentage of the Air Force investment in science and technology, for example, has actually decreased from 2.8 percent to 1.3 percent, he said.

Secretary Cooper responded that the figures were misleading, noting that the percentages only appear to have decreased because other portions of the budget have grown by leaps and bounds. He said the service's science and technology base has actually remained level in terms of constant dollars over the past five years. But he agreed there was concern about the future as overall spending levels decrease.

One problem is the lack of support for science and technology funding in the Pentagon and Congress. Basic research funding requests are less immune to budget cuts because they do not have the same constituency, either within the Pentagon or within private industry, that most major weapon systems have. Secretary Cooper notes that while lawmakers are rarely critical of such spending, they view it as only a form of "insurance."

Cuts in major weapons programs, such as the MX missile or the B-1B bomber, have an immediate effect in terms of production rate slowdowns. But the impact of cuts in science and technology research funding may not become apparent for five or ten years.

Dr. Keyworth said the government does not pay enough attention to convincing the American people and Congress of the value of science and technology. "The key is convincing them it is the difference between winning and losing," he stressed.

"If we can put some more form and substance to our science and technology programs, where we can show the cause and effect a little bit better," said Secretary Cooper, "I think there is a much better potential to get the budgets funded closer to the original requests."

Capturing Public Interest

General Marsh questioned whether the United States needed a large-scale program like the Manhattan Project or the drive to put a man on the moon to stimulate and focus the nation's science and technology efforts. "Very large, very important national programs tied to a key issue of concern that most Americans share have historically tended to focus and make more effective our overall investment in research and development," agreed Dr. Keyworth. "They capture the imagination of young people and old people alike."

Secretary Cooper cited two likely candidates—the Strategic Defense Initiative and the National Aerospace Plane. SDI is by far the Pentagon's largest single research and development program.

Dr. Keyworth, who has played a large role in promoting the Strategic Defense Initiative, thinks it could provide a tremendous stimulus for scientific and technological research for many years to come, both in terms of the strategic applications and commercial spin-offs.

SDI currently consumes about $3 billion a year, or about six percent of the Pentagon's $45 billion research and development budget and about two percent of the nation's total research and development budget of $135 billion. Dr. Keyworth says this is a small price to pay for a project that has created so much international leverage. "It is transforming the way we deal with other countries and the way we conduct our foreign policy," noted Dr. Keyworth. "It is putting us back in the leadership role that other nations expect us to be in."

The drive to develop a national aerospace plane capable of traveling at speeds from Mach 2 to Mach 20 in the atmosphere and in space is another project that is pushing science and technology to the limits. As opposed to SDI, which is aimed at developing new technologies to meet a perceived need, the national aerospace plane project is the classic case where a number of technologies have matured and evolved enough to offer a revolutionary capability. Recent advances in propulsion, composite materials, and fluid dynamics have made the national aerospace plane a real possibility, said Secretary Cooper.

Secretary Cooper said that once the next round of studies is completed and the feasibility of the project is confirmed, it could very well become a national goal. "All the technologies are known," he said. "It is just whether we can marry them all together."

The potential civilian and military benefits are enormous, the experts agreed. The concept of a single-stage-to-orbit vehicle holds the potential of greatly reducing the cost of putting payloads into space. Com-

mercially, it would keep the United States in the forefront of the civilian transport market.

In terms of defense applications, Secretary Cooper observed that the national aerospace plane holds "tremendous potential" as a reconnaissance vehicle or a strategic bomber. Dr. Keyworth predicted that the craft would give the United States a ten-year lead on the Soviets in terms of military capability and space access.

"The question now is whether we have the competitive spirit in this country to grab this opportunity and run with it," said Dr. Keyworth.

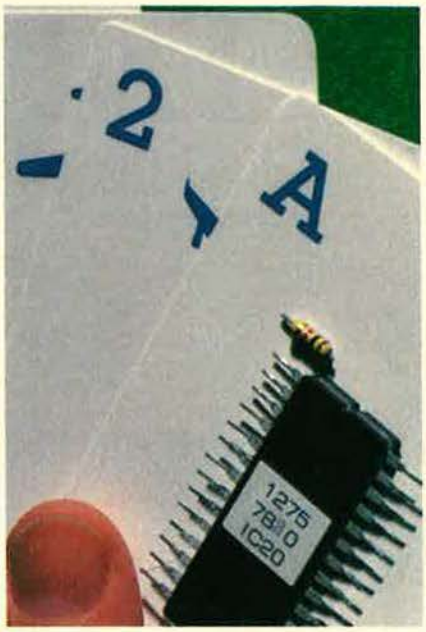
A Question of Affordability

General Marsh questioned, however, whether the Air Force could afford to push its ongoing projects and other new technological initiatives at the same time that the nation was pursuing such major projects as SDI and the national aerospace plane. The Air Force is heavily involved in Project Forecast II, which has identified seventy different technologies for further research and development. The potential advantages offered by nonlinear optics, antiproton, directed-energy, and other sophisticated technologies identified by Forecast II involve heavy investments of time and money before they can be proven.

Dr. Kulp maintained that there was a strong recognition from the outset that developing the technologies uncovered by Forecast II and applying them to military systems would be expensive. As part of the entire effort, therefore, project officials did a lot of sifting, he said, taking steps to guarantee that the technologies selected for development were workable and affordable.

Project officials were required to develop a computerized summary of the life-cycle engineering profile of a number of the technology candidates to understand the costs involved. Mr. Fowler, who served on Forecast II's senior advisory group, noted that the natural screening process will continue, leaving a core of projects that will provide the Air Force with a good basis for judging its research and development programs for some time to come.

Dr. Keyworth praised the effort as a "priceless exercise" in raising the attention of the military and industrial defense communities to the array of opportunities open to them. It has pointed out a number of areas in which the United States can achieve a force-multiplier effect through technology. He cited the idea of embedding sensors in an aircraft's skin as one example.



Secretary Cooper maintained that pursuing SDI and the national aerospace plane project while exploring the technologies identified by Forecast II was financially possible. "I think there is enough money in our budget if we manage it intelligently," he said. "I think they are all complementary."

"If we don't do it, nobody will," argued Dr. Kulp. "The point is there is little commercial market for many of the products that we use in defense. There is no commercial drive for private investment in research in these areas."

Government, Industry, and Academia

The experts were unanimous in their belief that the federal government must sponsor science and technology research, but they differed on how much of that research work should be accomplished in government laboratories and how much should be farmed out to private industry and universities.

At present, about twenty-five percent of federally funded research and development is accomplished by government laboratories. Another fifty percent is done by private industry, thirteen percent by universities, and about twelve percent by federally funded research and development centers.

Dr. Keyworth argued that, historically, educational institutions have contributed the greatest percentage of new ideas to the industrial, economic, and military capability of the country. He said government laboratories had a more difficult time adapting to changing missions and tended to move "very, very slowly."

But Dr. Kulp questioned the stability of university-oriented research, noting the tendency of such political and social issues as the Vietnam War and divestiture in South Africa to create major problems. He pointed to the beginnings of a similar crisis over SDI as more and more university scientists decline research funding to work on the project. "I am not sure I can live with this instability in a research program, and so I have to be very careful about how much money I put into those programs relative to what I do in-house and relative to what I do in corporations," said Dr. Kulp.

Secretary Cooper agreed that there were pitfalls attached to university research, but said the government should not turn its back on the universities. "We have got to work with them," he said. The Pentagon's University Research Initiative, which is providing funds to upgrade university laboratories, is one step in this direction.

"We have got to bring young people back to support what we are doing now and what we will be doing twenty years from now in national security," Dr. Keyworth said.

Mr. Fowler agreed that diversity was the key, noting that many of the innovations in weapon systems have come from outside the normal channel of in-house military laboratories. He cited the development of stealth technology by the Defense Advanced Research Projects Agency in association with industry as one example. More nontraditional defense contractors must also be lured into the research and development game, argued Dr. Keyworth.

"The real key to our overall research effort is to make sure we get everybody in our society involved," said Secretary Cooper. "I think that offers the best hope." ■

With the rollout of the E model, the F-15 adds deep interdiction to its repertoire.

THE NEWEST EAGLE

BY JEFFREY P. RHODES
DEFENSE EDITOR

Flying over the Missouri countryside, the first F-15E Eagle is put through its paces over the McDonnell Douglas plant in St. Louis. The dual-role fighter's first flight took place in December, and this second flight on January 2 was the first with two crew members. E-1 will soon start its test program at Edwards AFB, Calif.

SINCE its introduction in the Air Force inventory in 1974, the McDonnell Douglas F-15 Eagle has been regarded as the finest air-superiority fighter flying. The newest Eagle, the F-15E, rolled out in St. Louis, Mo., last December 18, and it will likely add a new superlative to the F-15's long list. It promises to be the finest deep-interdiction aircraft flying.

Secretary of the Air Force Edward C. Aldridge, Jr., a principal speaker at the rollout ceremony, called the E model "the newest element in the tactical air forces—it is a true contribution of aerospace power to peace. The rollout of the E is a landmark event in the modernization of the tactical air forces." More than 2,000 people, including numerous officials from the Air Force and the contractor and laborers and technicians who actually built the F-15E, were present as the charcoal-gray airplane (serial number 86-183) was unveiled.

The latest in the evolutionary line of Eagles will augment and eventually replace the Air Force's only deep-interdiction fighter, the General Dynamics F-111. The F-15E will be able to carry 24,500 pounds of various types of ordnance. This is 500 pounds less than the F-111F can carry, but still one-third of the conventional capability of the B-1 bomber and three times the bomb load of a World War II B-24. It can go in on the deck in all types of weather and at night to strike targets as far as 500 miles behind enemy lines.

But that's not all. The F-15E will be able to carry this load without sacrificing any of the air-to-air talents the Eagle is famous for. As Col. Michael Butchko, the F-15 system

program office (SPO) manager, said after the ceremony, "The E can fight its way to the target."

The F-15E resulted from the Air Force's dual-role fighter (DRF) competition held with the General Dynamics F-16XL. The proposal submitted by McDonnell Douglas, which was for a derivative of the F-15D, won, and a full-scale development contract for more than $373 million was awarded in February 1984. The Air Force, especially Air Force Systems Command's Aeronautical Systems Division at Wright-Patterson AFB, Ohio, worked closely with McDonnell Douglas in the development to ensure that the F-15E would perform as advertised.

Larger Loads, Greater Range

At first glance, it is hard to tell the F-15E from an F-15D. While most of the significant differences are internal, there are a number of external changes.

One of the main distinctions of the F-15E is a larger aft end. The engine bay has been modified to accept Pratt & Whitney F100-PW-220 engines (which are standard on most F-15s), longer, larger-diameter, more powerful General Electric F110-GE-100 engines, and other future engines. To meet the production schedule, the F-15E that rolled out—aircraft E-1—did not get the enlarged bay, which, at the time, was still undergoing development. E-2 and the remainder of the F-15Es will have the bigger bay, though. As with all F-15s, the E's aft end is made of titanium.

The E's aft end is not only larger; it is produced differently as well. As part of a process called superplastic forming, titanium, strong but lightweight, is fed into a 1,000-ton gantry press and heated to 1,650 degrees Fahrenheit. At that temperature, the titanium becomes pliable and can be pumped into its forms by argon gas.

The gas, which is inert and will not react with the metal, forces the titanium into the shape of the tool and then is removed. This process allows large, complex parts—such as the engine bay doors—to be manufactured easily and relatively inexpensively.

Most of the F-15E's load of ordnance is mounted on stub pylons on the low-drag conformal fuel tanks (CFTs) that hug the plane's fuselage. Because the weapons will be carried tangentially to these tanks (which together hold 9,000 pounds of fuel), drag will be reduced, thus increasing the F-15E's range. Even on some heavy payload missions, the E will be able to fly much farther than earlier Eagles.

The main landing gear doors and wheel wells of the E model had to be modified slightly to accommodate the switch to radial tires. With these low-pressure Michelin tires, which bulge slightly when the airplane is on the ground, the Air Force expects to get fifty percent more landings than from a regular set of aircraft tires. These tires are to be standard on all new Air Force airplanes and were especially designed to prevent disintegration at high speeds, unlike standard automobile tires.

One change to the F-15E that isn't apparent is the strengthened airframe. About sixty percent of the F-15E's airframe has been toughened, enabling it to withstand stresses up to nine Gs throughout its flight envelope. The E can even pull an instantaneous load factor of nine Gs with twelve BSU-49 500-pound bombs attached. That is two more Gs than a similarly equipped F-111F can pull. Sustained G-loading for the F-15E with the same bomb load (3.3-G) is nearly twice that of the F-111. Gross takeoff weight is 81,000 pounds—19,000 pounds less than the weight of an F-111F, but almost 10,000 pounds more than an F-15D.

Service life of F-15Cs and Ds is anticipated to be about 8,000 hours. By contrast, the 16,000-hour service life of the E model is specified in the contract. Even with an abnormally high usage rate of 500 hours per year, the F-15Es should last more than thirty years. The fully mission-capable rate for the F-15E is expected to be eighty-five percent. The rate for the F-111F, which went out of production in 1976, was fifty-three percent in 1985.

Survivability for the F-15E is enhanced by self-sealing feed tanks and fuel lines, fire-retardant foam in fuel tanks and voids, and the absence of fuel storage over the engines. There are three hydraulic systems and four pumps.

The Avionics Suite

E-1 is a test airplane, basically. A good part of its work will be checking out the operation and integration of the various systems, especially the avionics suite.

The F-15E will operate on a Honeywell-developed inertial navigational system (INS) that uses a ring-laser gyroscope to provide information about the aircraft's position. A digital moving map will then display that position to the pilot or the weapon systems officer (WSO) in the backseat.

The high resolution of the Hughes APG-70 radar will allow the crew to pick out such targets as bridges and airfields from low altitudes at ranges greater than eighty miles. Resolution improves closer to the target area, and specific small targets, such as vehicles, can be discerned. Another feature is the radar's ability to "freeze" images of a particular area after very quick sweeps. The radar can then be turned off to allow the aircraft to penetrate without tell-tale radar emissions.

The F-15E will be the first aircraft to get production Martin Marietta LANTIRN (Low-Altitude Navigation and Targeting Infrared for Night) system pods that will allow around-the-clock operations in bad weather.

The navigation pod contains a forward-looking infrared (FLIR) sensor to create daylight-quality video images of the terrain in the pilot's wide-field-of-view, holographic head-up display (HUD). The nav pod also contains a terrain-following radar for low-level, high-speed flying. The targeting pod contains a high-resolution FLIR, a missile boresight correlator, and a laser designator that will allow the crew to acquire the target and aim weapons from as far away as ten miles.

The rear cockpit of the F-15E looks a bit like the control room in a television studio. The WSO has four displays (two color and two monochromatic) and two hand controllers, one on each side of the cockpit. The WSO can "call up" the moving map, the radar map, the FLIR, or the tactical electronic warfare system (TEWS), along with assorted information about altitude, airspeed and weapons, on any of the display screens. He can then move the display images from one screen

to another. He can operate the controllers simultaneously or use them separately to move the display cursor from screen to screen. A single button on the controller makes all of the screen switching possible.

In the front seat, the pilot flies the plane with the assistance of the HUD and can use his display screens (one color, two monochromatic) to call up anything the WSO is watching. While it may seem as if the pilot would be too busy reaching around the cockpit to fly the plane, quite the opposite is true. The display switches are mounted handily on the stick and throttle, and the controls around the displays are simplified. Twenty-two panel controls present in the F-15C and D were not needed for the E's cockpit.

All of the sensors and equipment are easily switched from an air-to-ground mode to an air-to-air scenario and back down to the air-to-mud environment again. In a normal situation, the WSO will find the target, and the pilot will release weapons.

Multistage improvement program (MSIP) provisions on the F-15C/D production line have made it easier to incorporate E model avionics hardware, such as the improved central computer system.

The avionics hardware for the F-15E weighs 2,558 pounds, or 400 pounds more than in the F-15D. Half of what had been the ammunition bay for the M61A1 20-mm cannon is taken up by avionics equipment and instrumentation for the cockpit. The F-15E's gun, however, will still have 470 rounds of ammunition.

As can be imagined, the F-15E and its avionics are very software-intensive. The aircraft's computers have a total capacity of about 4,000,000 words of memory, with roughly 1,000,000 words going to the radar and 500,000 words going to the TEWS. Software integration has been a challenge, but both the Air Force and McDonnell Douglas report that the process is going smoothly.

At the rollout ceremony on December 18, Secretary of the Air Force Edward C. Aldridge, Jr. (in dark suit), gets briefed on the F-15E's cockpit by Gary Jennings (second from left), the F-15 Project Test Pilot, as McDonnell Douglas Chief Executive Officer Sandy McDonnell (in light suit) and weapon systems officer Maj. Mike Deloney look on.

Testing the F-15E

Aircraft E-1 actually flew seven days before the rollout ceremony and one day ahead of schedule. After a number of company flights around St. Louis to certify airworthiness, it will be taken to Edwards AFB, Calif., to begin flight test in earnest. For the remainder of this year, E-1 will be used to fully develop and test the triple-redundant digital flight system. In April, tests with the LANTIRN navigation pod begin, and crew station integration with the INS and APG-70 radar will continue through May. First testing with the LANTIRN targeting pod is scheduled for October.

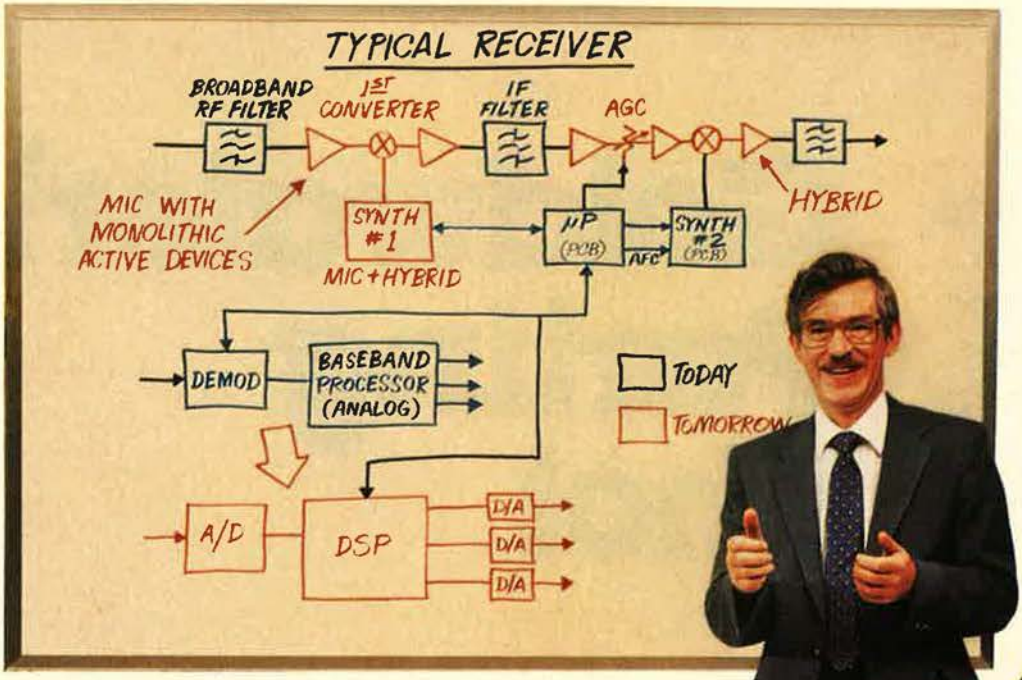
The second E, which will have the modified aft end, will be finished in May and will be used for loads and structural testing. For about five months, E-2 will test the terrain-following radar in a manual mode, then work on automatic terrain-following coupled with the LANTIRN pods until the end of December. E-1 and E-2 will be heavily instrumented for development work, and it is doubtful that either aircraft will be refitted as combat-coded aircraft.

E-3, which will be finished in November, will be the first full-up production aircraft. It will feature the Dash-4 conformal fuel tanks with the ordnance pylons and will be sent to Eglin AFB, Fla., for stores certification and stores separation tests. E-3 will be joined by E-6, and the two aircraft will continue the weapons tests and begin testing of the F-15E's electronic warfare suite, as well as the chaff and flare dispensers, in June 1988.

The F-15E is wired to carry the AIM-7F and M Sparrow, the AIM-9J, L, M, and P Sidewinder, and the AIM-120A Advanced Medium-Range Air-to-Air Missile (AMRAAM), none of which the F-111F can carry. The F-15E can carry all versions of the AGM-65 Maverick missile in the Air Force inventory (A, B, and D models) as well as two versions of the GBU-10, the GBU-12, and the GBU-24 Paveway II and III laser-guided bombs. The E will also be able to carry the GBU-15 glide bomb. The F-15E can carry more of all of these types of weapons, except for the GBU-15, than can the F-111.

The F-15E does not have the capability to carry such standoff weapons as the AGM-130 or the AGM-84 Harpoon, but that capability can be added. The E can't carry AGM-88 High-speed Antiradiation Missiles (HARMs) either, but could be modified if USAF wanted to use the aircraft for radar suppression.

The E-4 and E-5 aircraft are scheduled to go to Tactical Air Command for tech-order verification in mid-1988. In early 1988, the Air Force will begin formation of the first operational training squadron for the F-15E at Luke AFB, Ariz., while testing continues. Current plans call for the delivery of 392 F-15Es to four operational wings, and the first operational wing will be formed at Seymour Johnson AFB, N. C. Assuming budgets stay on track, F-15Es, which will cost approximately $32 million each, will be delivered at the rate of forty-two a year until 1997. ■



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As he heads into retirement, Sen. Barry Goldwater blasts congressmen who vote for pork in the barrel rather than defense on the line.

Goldwater's Parting Shot

BY EDGAR ULSAMER
SENIOR EDITOR (POLICY & TECHNOLOGY)

SEN. Barry Goldwater, the iconoclastic outgoing Chairman of the Senate Armed Services Committee and Republican standard-bearer in the 1964 Presidential election, leaves office with grave concerns about America's national security posture in the years ahead. "We have," he told this writer, "a major problem, and it is getting worse." The problem, he points out with a stark sense of déjà vu, "is the same we had in the 1930s."

Half a century ago, as a young reserve officer, he was deeply worried about the country being drawn into global war without being ready for it. Today, the seventy-eight-year-old Arizonan, who chose not to seek reelection, worries because "we have the same kind of forces working in Congress as then." The symptoms that he finds so alarming, so reminiscent of the hapless, heedless years just prior to World War II, manifest themselves in a lack of statesmanship and in rampant pork-barreling on the part of the new guard in Congress: "They don't think of national defense; that is not an important item to them. They think only of getting reelected, of what they can get to be built in their own state or district."

Sitting in the Committee Chairman's office that will soon be occupied by his Democratic successor and close associate, Sen. Sam Nunn of Georgia, he, at times, comes across as exasperated: "I don't know what it's going to take to get this Congress out of its mood about defense. We simply can't take any more cuts. If defense has to take another cut this year like it did [in FY '86 and FY '87], then there will be only one place left [for

Secretary of the Air Force Edward C. Aldridge, Jr., pins the Distinguished Flying Cross on Sen. Barry Goldwater (R-Ariz.) at the Aerospace Education Foundation's "Salute to Jimmy Doolittle" dinner last December. Senator Goldwater was honored on the eve of his retirement from the Senate as Chairman of the Armed Services Committee, capping a distinguished military and public career.

economizing], and that's the troops. And once you start letting the troops go, you are through."

The Fundamental Problem

The fundamental problem with contemporary Congresses has been that most members tend to forget the basic commitment they make on assuming office. "They put their hands on the Bible and swear that they will defend the Constitution against all enemies, foreign and domestic." But instead of living up to these high principles, many members, he feels, deal with defense issues mainly in terms of currying favor with their constituents. As a consequence, Congress, in the aggregate, siphons off many billions of dollars each year from modernization programs and the military payroll by keeping open no-longer-needed bases and facilities and by foisting unneeded and unwanted weapon systems on the Pentagon, he believes.

Senator Goldwater buttresses this contention with a series of recent examples, including the case of the T-46. "The Air Force Chief of Staff came over personally to tell [the Senate that the Air Force] did not want the aircraft, yet the senators from New York [where the contractor is located] insisted that we buy an aircraft that is unneeded and unwanted."

Senator Goldwater is equally vocal in his criticism of the US Navy's "home-porting," which he portrays as a political gambit. "It's the fault of the Secretary of the Navy, who cleverly saw a way to get about fourteen senators and a number of representatives indebted to the Navy in perpetuity." He suggested that, from now on, whenever the Secretary of the Navy "wants something, he has got a base of fourteen senators to go to because of home-porting, which I would say is going to cost this country $12 billion before we get through with it."

In a reverse twist of congressional pork-barreling, parochial interests are stymieing a pressing Army requirement: "We haven't had a new 120-mm mortar for our ground forces, I would guess, in [some] twenty years. We could buy [such mortars] in the next fifteen minutes from Israel, France, or Italy. [But the political reality] is that we can't, because there is an old firearms factory somewhere in New York that some congressmen say could make them. I think this old factory hasn't made anything but flintlocks."

He bemoaned the travesty of Congress's largess in satisfying narrow constituent interests at a time when "we had to take $30 billion out of defense this year and $20 billion last year—and when we haven't seen the end [of the downward trend] yet." At the root of the problem, he suggested, is the fact that most of the voters who "are patriotic, country-loving Americans just don't know what the boys in Washington are doing to their defense."

The Legislative Track Record

The retiring Senate Armed Services Committee Chairman doesn't mince words either when it comes to Congress's legislative track record. "Since the creation of the budget committees [in 1974], the procurement efforts of the SASC have about disappeared." He ex-

plained that "I had my [Committee's] authorization [bill] ready to go by [the mandated deadline of] May 15, but the Budget Committee said 'no,' [even though] we had worked like the devil from the moment we got into session." Because the Budget Committees came up with ceilings that differed from those that the SASC had to work against, "we had to redo the whole job, [including holding] a new set of hearings. We had to write a new authorization, but by then, we ran into the summer recess and thus, because [of the need for] a conference with the House, we never got out an authorization bill."

For four years in a row, the Senator complains, "the military had to live under a CR [continuing resolution, a makeshift arrangement to compensate for Congress's inability to pass authorization and appropriation bills], which is no way to run any part of the government."

Exacerbating the problem, in his view, is that the House Armed Services Committee "has done as much to destroy the effectiveness of the armed services committees as anything we have done in the Senate." The outgoing Speaker of the House, Rep. Thomas P. "Tip" O'Neill, Jr., he complains, "ruled" that any issue before the conferees of the two armed services committees that even remotely affects nondefense areas warrants inclusion in the conference of members of other committees with oversight responsibilities for these areas. The purpose of the joint Senate/House armed services committees conference is to reconcile differences between the panels' proposed bills. The unprecedented inclusion of members from other committees bloated the joint conference and enabled them "to vote for their own selfish interests," the SASC Chairman charges.

Because of this ruling by the Speaker, the number of House conferees increased sharply from previous years, reaching about ninety in 1985 and some seventy in 1986, Senator Goldwater points out with obvious dismay. "Now mind you, that means [the House brings in voting conferees] from [the] Agriculture [Committee] because we might talk about the foraging of animals [on military land] or from Housing and Urban Development" because the conference might touch on housing issues involving military personnel.

Senator Goldwater takes a somewhat jaundiced view of halfhearted efforts to streamline the process by which Congress funds national security requirements, especially the duplicative and, at times, internecine relationship between the budget, authorization, and appropriation committees of both chambers. The widely held view that a more cohesive, centralized mechanism should be substituted, Senator Goldwater asserts, is correct: "We could come up with [an efficient approach that combines the budgeting, authorizing, and appropriating functions] in an hour or two," but entrenched parochialism and vested interests militate against such remedies.

He has, the Senator explains, brought the need for reorganizing the committee structure "very forcefully to the attention of the majority and minority leaders" by pointing out "that we are not creating a good condition in this body when we appropriate money by continuing resolutions." CRs, he says, lead to "Christmas-tree legislation whereby [members] hang billions of dollars worth of junk that we don't need on a bill that ought to provide only for the defense of our country."

Moreover, this intertwining of money appropriations for crucial defense needs with frivolous expenditures, in practice, makes it impossible for the President to veto such a defense bill. In order to excise unneeded, unrelated appropriations, the President would have to put at risk indispensable defense funds. In this context, Senator Goldwater reiterates his strong support for legislation that would provide the President with a line-item veto, meaning the ability to seek deletion of specific appropriations without need to gut whole defense bills. Recent attempts at passing line-item veto legislation have been unsuccessful, however.

One of the quirks in the legislative process that visibly irks Senator Goldwater is the increasing tendency by the appropriations committee's defense subcommittee to usurp the functions of the SASC—by authorizing as well as appropriating defense funds. Last year, for instance, when his committee came back from summer recess, its members discovered that the Senate Appropriations Committee's defense subcommittee had added about $8 billion for items that the SASC had not authorized, "on things like a marine fleet to be used in Alaska [the home state of the subcommittee's chairman]."

Growing Personal Staffs

While he defends the size of the small, highly expert staff of the Senate Armed Services Committee, Senator Goldwater is outraged by senators and representatives who have as many as 100 individuals on their personal staffs. The size of the congressional staff, he points out, has grown since he first came to the Senate in 1952 from about 1,500 to almost 20,000 at present. Worse yet, "these people have nothing to do, so they write amendments and bills all day long." As a consequence, he fumes, "we are bogged down on the floor of the Senate and the House voting legislation we don't need and shouldn't even talk about." Congress, therefore has to stay in session longer and votes on more bills than ever before. "When I first came to the Senate, we had fewer than 200 votes [a session]; now that number is above 1,000. This is just another addition to the growing impossibility of Congress acting in a way that's in the best interest of the country, whether this involves military matters or something else."

Solutions to Congress's organizational and procedural problems have so far been elusive, even though "one major reform could be done almost immediately, [and that] is for the joint leadership to get together and say, 'We have too many staff members allowed—we simply have to start cutting down.' "

Senator Goldwater finds fault with the Senate's seniority system, because it tends to keep younger members off committees that they may be most qualified for. "The system simply doesn't pick up the expertise that is available by making [candidates for critically important committee assignments] wait and wait until they have gone into something else and their expertise is diminished."

This problem is especially acute in the case of committees responsible for defense oversight, with the result that many of the committee members were picked strictly on the basis of seniority, even though they had never themselves served in the armed forces.

In the case of the Senate Armed Services Committee

of the Ninety-ninth (the most recent) Congress, of the nineteen members, "we had ten who never served in uniform." He hastens to point out that "we were lucky because [these ten] were good people." Senator Goldwater makes clear that "in my view, there should not be any members of the armed services committees in [either chamber] who have not worn the uniform." He acknowledges that meeting this standard is becoming more difficult as fewer and fewer members of Congress are veterans.

The Draft and Other Issues

The retiring SASC Chairman sees no compelling military reason for returning to a draft system. "I am not opposed to the draft, but we haven't had the need for it in the past ten years. [The quality of the force] is a lot better than what we had in World War II. We have today the finest enlisted and officer force that I have seen in my life."

Precipitous cuts of the defense budget, on the other hand, he warns, might make it necessary to reinstitute the draft system. Cutting troop strength is the "first step" toward conditions that might require a draft system, he keeps warning the Pentagon. So long as there is no military need for a return to the draft, Senator Goldwater favors a system of two years of national service for all eighteen-year-olds, male as well as female. The choice of type of service, he believes, should be left to the individual, so long as the activity benefits the common good.

Senator Goldwater's relatively ambivalent position on the draft is in marked contrast to how he feels about arms control: "You are talking to a man who doesn't believe in arms control." His rationale is categoric. Arms control, theoretically, is "desirable, but so is the elimination of crime or dope. It will never happen." His fist came down hard on the table when he averred that "the control of arms should be [governed by] what is required to defend the freedom of America, and that's all. I don't give a damn what the Russians say, or the Chinese, or anybody else. If I feel—and our President feels—that we need 3,000,000 men [under arms], by God, that's what I want—and I don't want to have to talk to anybody else about it." His bottom line on the issue is that "the sincerity behind arms control is not really there."

The blunt champion of US aerospace power (who was awarded a Distinguished Flying Cross by Air Force Secretary Edward C. Aldridge, Jr., at a gala tribute hosted by the Air Force Association's Aerospace Education Foundation on December 2, 1986) is also not enthusiastic about legislation that seeks to boost the military's role in drug interdiction. He cites two reasons.

First, the US military—except for the Coast Guard—is not legally empowered to arrest civilian citizens. Pointing out that he remembers the heyday of Hitler and Mussolini, he avows "I will fight until my dying day to deny the military man the right to knock on our doors." Second, as an Arizonan who has spent most of his life near the border with Mexico, Senator Goldwater doubts that even the military and its sophisticated equipment could seal the border and stamp out drug smuggling. Even though he believes that the current level of radar surveillance and similar support by the military to law enforcement agencies is basically futile, he is not opposed to such limited show of force.

"Father" of Defense Reorganization Act

"I tell you this very happily—the terrific opposition we experienced at the outset isn't there any more. . . . I think the Joint Chiefs and the services are resigned to the reorganization and will do their level best to make it work," Senator Goldwater, the driving force behind the 1986 Defense Reorganization Act, told AIR FORCE Magazine. He concedes readily that "as in the case of any legislation, there will be need for improvements in some places. In some cases, we may have gone too far, but as we live with it year after year, we'll find these places, and Congress will make the corrections."

He is adamant that the reorganization act did what was needed by creating the new post of Vice Chairman of the Joint Chiefs of Staff, and he is extremely pleased that Gen. Robert Herres, at this writing Commander in Chief of NORAD and US Space Command, will be the first officer to fill this newly created slot.

One of the big problems the Committee unearthed "in our study of the Pentagon structure is that the Joint Chiefs don't act to help their nation in a joint way. It gets down to 'I am Air Force, and you are Navy. I want something, and you want something, so we scratch each other's back.' " As a result, he charges, the Chiefs "were getting too parochial and were defending their turf instead of that of the military [in a joint fashion]."

Senator Goldwater is impatient with the contention that the Vice Chairman, an Air Force officer, "might work in collusion with the [sitting] Air Force Chief and, thus, have a leg up on everything we do." The answer is, "No. That man has no veto, has nothing until the Chairman is out of town or is performing the new duty we handed him." The new duty assigned to the Chairman by the 1986 reorganization is that of "military advisor to the President," which, during a crisis, he suggested, becomes a full-time job.

Senator Goldwater also rejects the widely held view that the legislation entails a diminution of the role of the service chiefs while building up the civilian service Secretaries: "We have been [functioning] under the civilian superiority concept for 200 years, [and] I don't think the [new arrangement] is any different from what we had." The service Secretaries, "when they are any good—and most of them have been pretty good—actually help the Chief more than they hinder him. I can't remember, offhand, any Secretary, regardless of administration, that didn't try to have good relations" with his service chief.

Turning to the Office of Under Secretary of Defense for Acquisition (USDA) that the 1986 Defense Reorganization Act creates and the official, Richard P. Godwin, who is its first occupant, Senator Goldwater pointed out that he "comes from the same corporation [Bechtel] that the Secretaries of State and Defense come from. But he happens to be a man of whose work I have known, and I think he is well adapted to this particular phase." In a generic sense, the Under Secretary of Defense for Acquisition "has to have an industrial background to understand general procurement practices, to understand the determination of [product] quality, and to constantly promote competition." These traits, he pointed out,

"are the basics that we worked into the legislation. Eventually, we might have to come up with some other ideas."

Dealing With Duplication

Another key purpose of the reorganization act is to eliminate duplication in what the services do and buy. While he emphasizes that the military does not "succumb" to pressures from industry, they are exposed "to people who want to sell them something." The legislation creates the position of USDA in part to provide a central authority to determine why, if one service has developed a given weapon system, another one needs to invent a similar system that does essentially the same job. "If we learn to think along practical rather than political lines, then we will see some sense coming into the Pentagon."

The outspoken retiring SASC Chairman, in this context, calls attention to "my fetish," meaning his perception "that we have four tactical air forces, three navies, and two armies and that we are training pilots in the Air Force, the Navy, the Army, and the Marine Corps." He considers it a plus that the Army and the Air Force train their helicopter pilots in a joint program at Fort Rucker, Ala., but is vexed that the Navy won't join in this training effort on grounds that "we fly over water." As a seasoned helicopter pilot, Senator Goldwater suggests that the Navy's argument is not sound: "It doesn't make any difference what you fly over so long as those things [the rotor blades] keep turning."

He is not sanguine about the services' willingness to change what he considers wasteful duplication, because "this has become a matter of pride—of defending one's turf, if you will."

While Senator Goldwater is concerned about industry at times fostering parochialism on the part of the services, he rejects the notion of a collusive military-industrial complex, including the validity of the term itself. "Ike's [President Eisenhower's] ghostwriter created [that term], and I got onto Ike on the first day about it. He said he didn't write the term and did not believe in it. Still, it's being thrown at us all the time." He suggests that it is fully consonant with the American enterprise system for industry to try to sell "instruments of war, [which entails] talking to the services" and possibly getting advice from retired military experts on how to succeed in such sales efforts. But he cautions that such sales campaigns must not degrade to industry "buying presents for members [of Congress], sending them on long trips, or entertaining them lavishly. That, I think, is going too far."

The Pentagon, however, should maintain a closer rapport with industry as well as Congress to get as precise a picture as possible of what a proposed weapon system can and can't do. "For example, is the M1 tank capable of [going to war] in sandy terrain? We do know that it's going to do well on the grassy plains of Europe. We have already found out that the C-5 will not land just anyplace, even though that was one of its [selling] points." He harkens back to the importance of the new USDA position: "If he does his job right . . . Congress ought to be able to depend [on his recommendations] for what the armed services really need."

As he passes the reins of the Senate Armed Services Committee to his Democratic successor, Senator Goldwater is surprisingly optimistic about one central area—the prospects for a steady, bipartisan defense strategy. "We are far closer to that than most people realize." During his tenure as Chairman, he asserts, politics "practically never" entered into the debates of the Committee, even though "real political people," such as Sens. Edward M. Kennedy (D-Mass.), Alan J. Dixon (D-Ill.), and Carl Levin (D-Mich.), were among them: "When it comes to the defense of the country, they are all right." On the House side, he suggests that his opposite number, Rep. Les Aspin (D-Wis.), the Chairman of the House Armed Services Committee, "has the same desires I have—to get decent defense for this country at the best cost."

Line-Item Management

One of the most vexing, hoary questions that plagues the relationship between Congress and the Pentagon is "line-item management," meaning the tendency of the legislative body to take over the Pentagon's management function under certain conditions, both in a budgetary and programmatic sense. Here, too, Senator Goldwater believes that the reorganization act will go a long way toward removing Congress's incentive to manage individual elements of the Five-Year Defense Program. "The last thing we [ought] to do is to micromanage. That is the job of the Pentagon." But if the Pentagon does "such a bad job that they invite our oversight, that is their fault," Senator Goldwater points out. He also concedes that "you can never stop members of the armed services committee from [probing specific programs or] inspecting specific [facilities]."

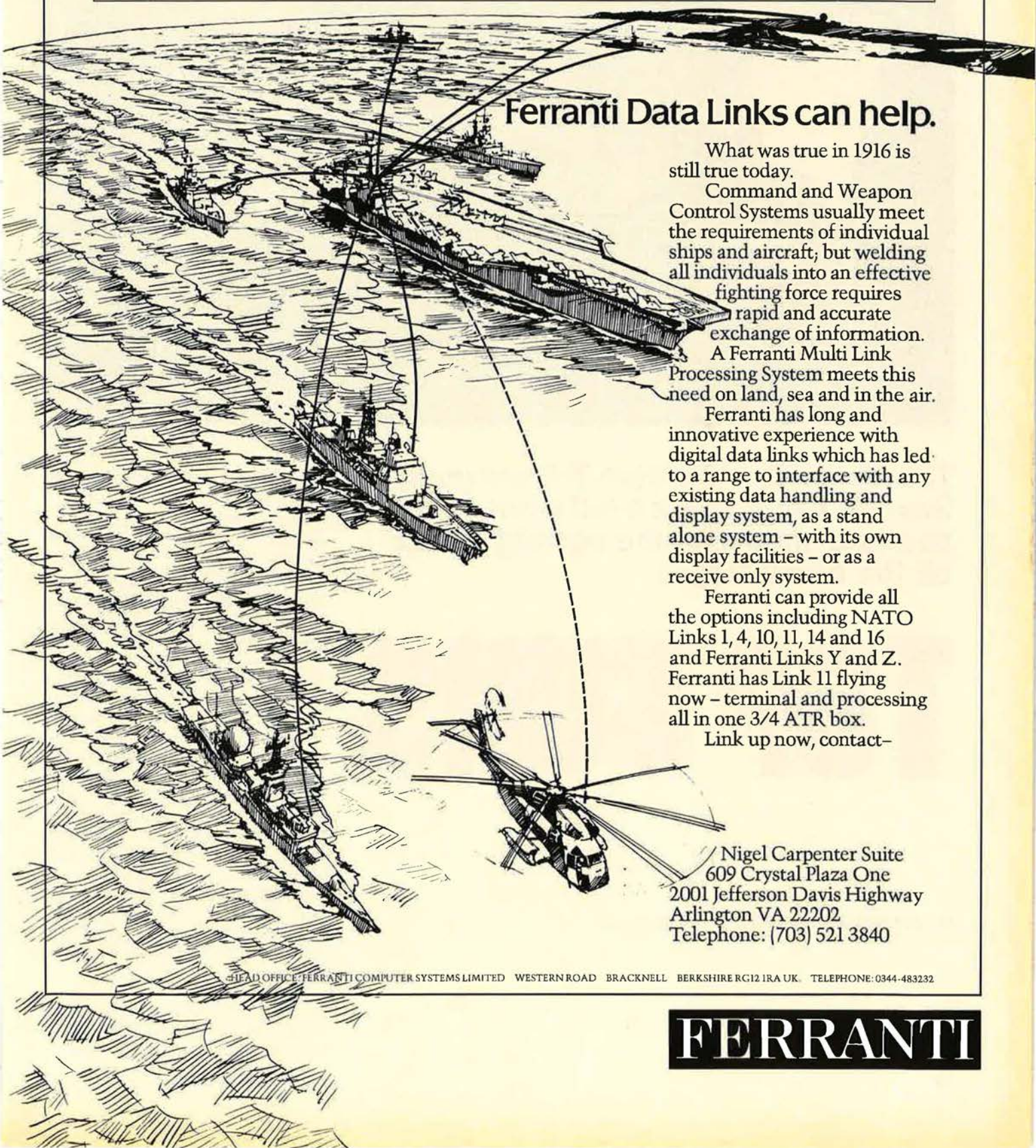
One way by which the Pentagon could forestall congressional micromanagement is to improve program management by making this function a separate career field. "Procurement of weapon systems today is almost as important as operations. We have to have people who are experts and who like this field [rather than] picking pilots who love their job, bringing them into the Pentagon for three or four years where they can't wait to get back into the field, and by the time they have become proficient in program management, [then sending them] back to an operational assignment. I think we can find a sufficient number of operational people who would like to come back to the Pentagon [or another headquarters] and spend their careers in management," Senator Goldwater says.

The retiring SASC Chairman, for more than thirty years one of the most stalwart supporters of the Air Force on Capitol Hill, distilled the lessons he learned in a pithy message to the new members of the Senate Armed Services Committee: "Maintain a constant, informal liaison with the Pentagon. In other words, keep in touch, make field trips, get to know the enlisted people and the junior officers."

The Senator leaves Congress with the same uncompromising, unabashedly exuberant commitment to old-fashioned values that marked his proud and brilliant career. As he so ringingly put it in his campaign for the Presidency: "Extremism in the defense of liberty is no vice. And . . . moderation in the pursuit of justice is no virtue." His creed will not be soon forgotten; the void he leaves will not soon be filled. ■

"We must have a navy so strong and so well proportioned and equipped, so thoroughly ready and prepared, that no enemy can gain command of the sea and effect a landing in force on either our western or our eastern coast."

REPUBLICAN NATIONAL PLATFORM, 1916.



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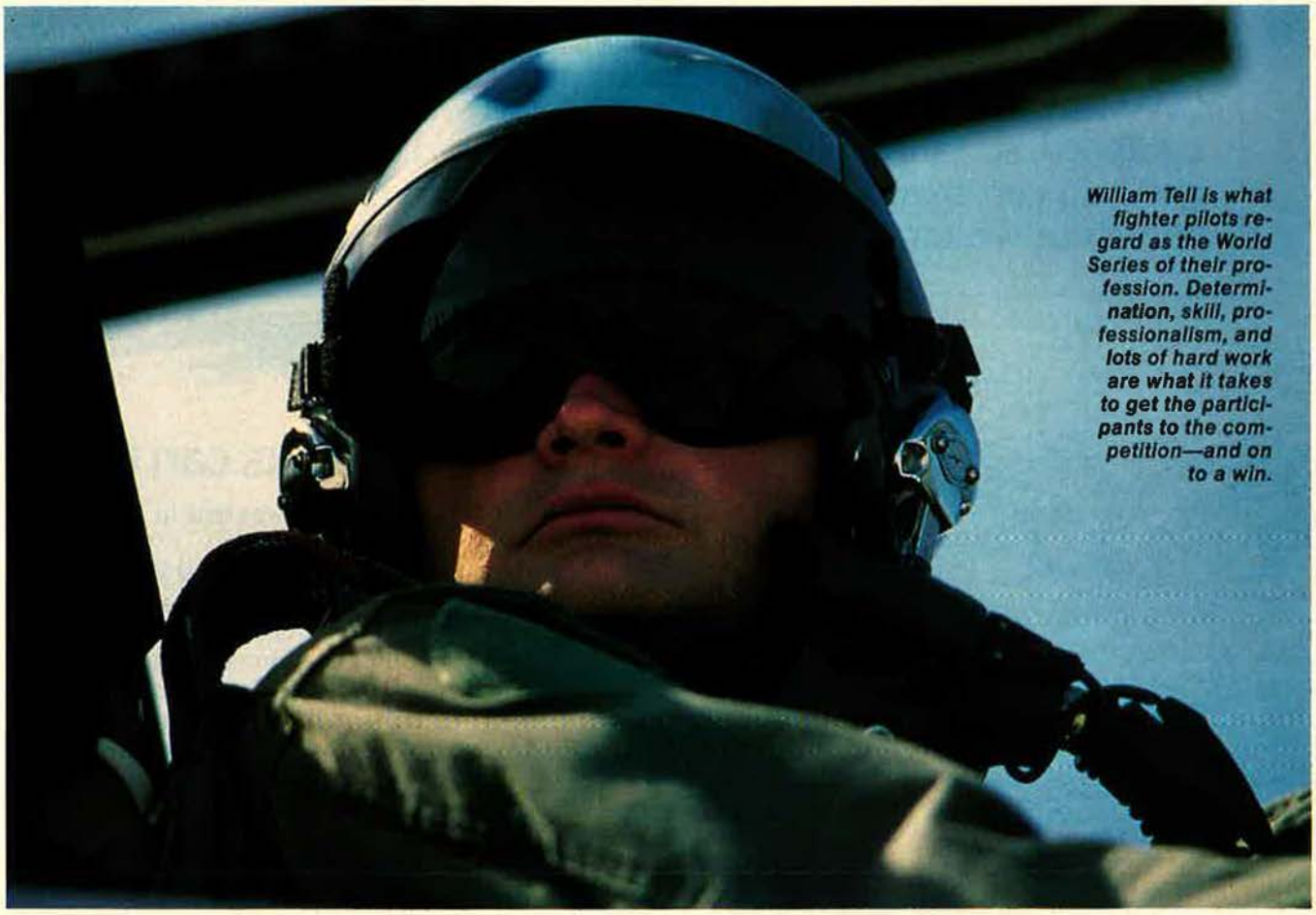


William Tell is what fighter pilots regard as the World Series of their profession. Determination, skill, professionalism, and lots of hard work are what it takes to get the participants to the competition—and on to a win.

The aircrews at William Tell are good. Several flyers missed full point credit because they shot the scoring device off the aerial target.

TOP GUNS

BY JEFFREY P. RHODES, DEFENSE EDITOR

FLYING at 30,000 feet over the Gulf of Mexico last fall, Capt. John D. Reed heard the unmistakable, prolonged tone sounded by his aircraft's fire-control system when the radar locks on to a target. Captain Reed fired an AIM-7 Sparrow missile at the bogey, a maneuvering QF-100 drone. He turned, repositioned his aircraft for a tail-aspect shot, and then launched an AIM-9L Sidewinder missile at the drone. The AIM-7 had come close, but the Sidewinder nicked one of the target's wing-mounted heat enhancers.

This was a live-fire engagement, not the usual training sortie simulation. It was a special moment for Reed, who had never before launched a missile of any kind. And Captain Reed was taking on more than a target drone. This was the early innings of what fighter pilots regard as the "World Series" of their profession, and the competition was fierce.

Captain Reed was flying the Profile I and II missions at Tactical Air Command's biennial William Tell air-to-air weapons meet at Tyndall

AFB, Fla. His success with these missile shots propelled him on his way to winning the "top gun" trophy as the highest-scoring individual in the competition.

While John Reed is a captain in the US Air Force, he was flying this time as an exchange pilot for 425 Squadron, a Canadian unit from CFB Bagotville, Quebec. William Tell '86 marked the first time the Canadians had flown their McDonnell Douglas CF-18s, a close derivative of the US Navy's F/A-18 Hornet, in the competition. Yet another first was an American pilot winning the event while flying for another country.

"I'm the one who is getting all of the credit, but I was only one part of the team getting it up there," said Captain Reed, who has become somewhat of a media celebrity since the win, having appeared on ABC's "Nightline" program and also on "Canada A.M." "All I had to do was put up with the pressure of the competition. My ground crew, Cpl. Randy Robert and Cpl. Bob Roy, had to put in the long hours to make sure I could fly."

Even though Captain Reed claimed the individual crown, the Canadians were outpointed by the F-15 pilots of the 33d Tactical Fighter Wing from Eglin AFB, Fla., for the Gen. Daniel "Chappie" James, Jr., Trophy, which goes to the overall team champion. The "Nomads," as the members of the 33d TFW are known, accumulated 40,835 points (out of a possible 50,000) to defend their title and edge the Canadian "Alouette" Squadron, whose four pilots racked up 38,295 points. Third place went to the "Shoguns" of the 18th TFW from Kadena AB, Okinawa, who totaled 38,157 points.

Hot Competition

The air-to-air events claimed most of the attention at William Tell, but there was also competition on the ground. The maintenance crews were judged in areas ranging from aircraft appearance and performance to sortie-generation techniques. Weapons loading crews were graded on mating missiles to aircraft quickly, safely, and correctly. And finally, weapons control teams were pitted against each other to see how effectively they guided pilots to intercepts in four of the five Profile flights.

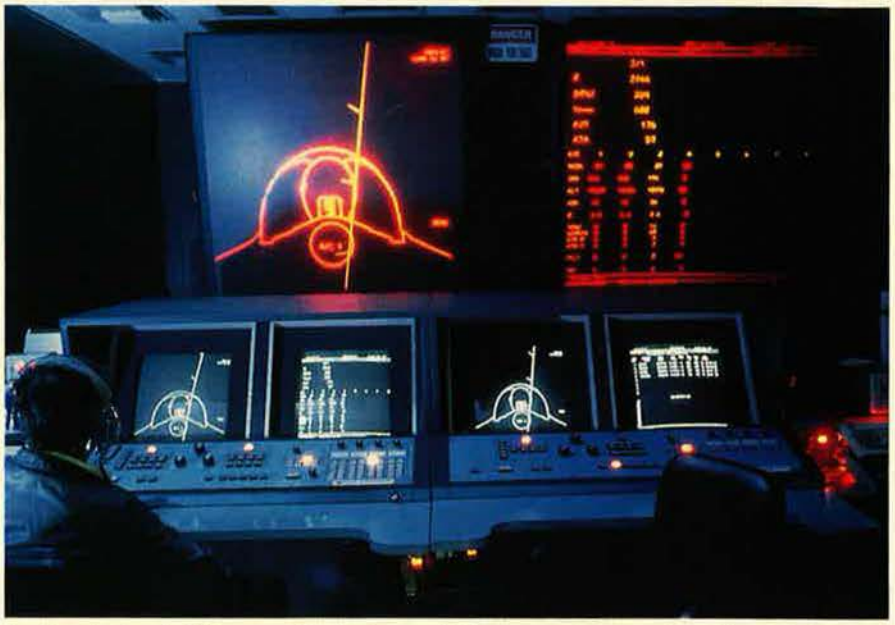
The Profile flights were the glamour events. Profiles I and II were combined into one flight during which the pilot is guided by the ground controllers to intercept the QF-100 and fire Sparrow and Sidewinder missiles. This competition emphasizes systems and radar function rather than pilot proficiency alone. Capt. Richard "Bear" Gibbs from the 36th TFW, Bitburg AB, West Germany, was the only pilot actually to shoot down a drone. His AIM-7 clipped the drone, and his AIM-9 scored a direct hit.

Profile III involved scrambling two fighters to fly against two "intruders." The two competition pilots had ten minutes to get airborne, then an additional five and a half minutes to find and visually identify the targets. They had to pass close enough to distinguish the colors painted on the tails and wingtips of the F-16 or F-106 "intruders." Each of the two competition aircraft simulated firing two missiles at the bogeys.

Entire teams participate in Profile IV. As an air defense exercise, the four competitors had to defend their allotted airspace for forty-five minutes against twelve "intruders." Each defending aircraft was limited to three simulated missile shots. To confuse matters, assorted "friendlies" were also in the air, and the "intruders" employed electronic countermeasures, chaff, and jamming. The "intruders" included F-16s, F-4s, and F-111s from four TAC units, F-106s from two ANG groups, and B-52s from Strategic Air Command.

Profile V evaluated the marksmanship of the pilots with the plane's 20-mm cannon. Capt. Ed Kresge, the 33d TFW pilot who finished second in the individual competition, won the gun profile with 1,250 points out of a possible 2,500. This part of the competition proved to be the most difficult, as eight of the ten teams recorded two or more zeros. Four pilots shot for each team.

"The other three guys on my team lost points because they shot so accurately they physically broke the scoring device," noted Captain Kresge. Fifty rounds were scored for maximum points, and only those rounds that scored before breaking the device counted. "I attribute my success to shooting close enough, but not close enough to break the device. If the tracking works well, the sight works well, the gun works well, and you don't break the device, you are going to get a pretty good score on it."



In the Air Combat Maneuvering Instrumentation operations center at Tyndall AFB, Fla., a technician monitors the action out on the missile firing range over the Gulf of Mexico. The ACMI system was used to score the missile profiles.

High-Tech Arena

William Tell was scored with the

latest in high-tech equipment. The scoring device in the gun-profile flight was acoustically operated. The sound of the projectiles striking the fifteen-inch-wide, seventeen-foot-long, orange Low-Cost Tow Target (LCTT) registered the points. The LCTT is foam-filled and is covered by thin sheet metal. During the competition, it trailed 2,000 feet behind an F-4 that flew at speeds up to 500 knots.

The Canadians of 425 Squadron scored better in the gun profile than did any other team. Surprisingly, they had not practiced for this event at all because of the unavailability of targets. "I feel the CF-18 turns a little better than the F-15 because it is a little smaller," said Captain Reed. "We also had a good team strategy. We wanted everybody scoring well to be in a good position. If it came down to guns, we figured we could do as well as anybody because of the airplane, even without practice." Captain Reed had previously flown Phantoms in Korea and had much experience firing the M61A1 20-mm cannon common to both the F-4 and CF-18. The Canadians' performance in the gun profile secured second place overall for 425 Squadron.

The missile profiles were scored on Tyndall's Air Combat Maneuvering Instrumentation (ACMI) range in the Gulf of Mexico. The ACMI system consists of pods mounted on the aircraft's AIM-9 rails and on the "intruder" aircraft. Seven solar-powered towers (five semisubmerged towers in the Gulf and two on land) are arranged in a thirty-mile-diameter circle to relay the data from the range. During the competition as well as in routine range work, information is sent from the towers by microwave transmission to the Master Tracking Station at Carabelle, Fla., and is relayed from there to Tyndall.

The information is displayed on two screens that give a computer-projected three-dimensional view of the aerial engagement. The flight data is updated every one-tenth of a second, so the recreation of the air battle is current as well as complete. The ACMI data is stored and can be used later in training. ACMI operations staffers were judges for the competition.

—Rudy Vonack—Hughes Aircraft

Matching the aerial competition is the rivalry between ground crews. Maintenance crews are judged in categories that range from aircraft appearance to weapons loading. Here, personnel from Canada's 425 Squadron check a CF-18's systems.

The microwave system was also used to telecast pictures taken from a chase plane back to the flight line. This was the first time at William Tell that the ground crews could actually see how their pilots were doing.

Best of the Best

There were forty pilots and ten alternates on the ten teams invited to William Tell '86. They are among the world's best fighter pilots.

"At this level, the flyers are all closely matched," noted Captain Reed. "Their skills are all sound, and it is a race to see who is best. That's what the competition is all about."

Captain Kresge echoed those statements. "If I had to pick one thing that will stand out, it is the experience and proficiency of the pilot. He's going to make the biggest difference, and then right after that comes his airplane—how good the avionics and radar are and what ordnance it is carrying."

Pilot skills are the result of hard work, according to Captain Reed, who hopes to fly F-15s in Europe when his tour as an exchange pilot is over later this year. "There is no substitute for hard work. Even General [Chuck] Yeager said it—'There are no natural-born pilots.' Good pilot skills are a function of working hard to get better. With the complex aircraft we have now, it takes a long time before you are really proficient."

Both Captain Reed and Captain Kresge feel that simulators are more important in training than they used to be. "Shooting missiles at drones is not something you do very much," said Captain Kresge, who serves as the 33d TFW's weapons officer. "In fact, most F-15 pilots only shoot one or two missiles in the course of a career. That's why the simulator is important for building basic habit patterns. Working in the simulator gives a pretty good feel for what you are doing. Then, when it counts, the habit patterns are there."

Simulators also help the pilots get the most out of their actual flying hours. This combination of simulator time and cockpit experience is what keeps pilots proficient.

"The F-111 guys in England showed why we need a constant state of readiness," noted Captain Reed. "They had to be proficient, because I'd bet they didn't get a whole lot of warning before they had to go to Libya [last April]. You train like you fight."

Both men agreed that today's pilots are thoroughly professional, but one area about which they disagreed slightly was the image and

William Tell '86 Boxscore

Unit	Base	Points (of possible 50,000)
	F-15/CF-18 Category	
[1]33d TFW	Eglin AFB, Fla.	40,835
[2]425 Squadron	CFB Bagotville, Canada	38,295
18th TFW	Kadena AB, Okinawa	38,157
1st TFW	Langley AFB, Va.	36,697
48th FIS	Langley AFB, Va.	36,585
36th TFW	Bitburg AB, West Germany	34,964
49th TFW	Holloman AFB, N. M.	31,306
	F-4 Category	
[1]119th FIG	Fargo IAP, N. D.	27,434
142d FIG	Portland IAP, Ore.	25,367
107th FIG	Niagara Falls IAP, N. Y.	22,114

[1]Both units awarded the Maj. Richard I. Bong Trophy for best team.
[2]Only CF-18 unit participating.

personality of today's fighter pilots.

"I think we try to maintain the 'image,' if you will, as much as we can," said Captain Kresge. "But I do think pilots as a group are a little more by the book. There is no excuse for me to take out a $25 million aircraft and be careless with it. Nobody is going to build me another one if I do. There are a lot more rules, and somebody is going to get real upset with me if I break them."

Captain Reed agreed that the aircraft were too expensive to "go plunking them around," but he also said that "I think the individuals haven't changed a bit. The attitudes that were important and successful in all earlier air wars—not swashbuckling, but aggressiveness—are still viable. We're not giving those gentlemen credit for being on top of the state of the art of their technological times. Those guys were every bit as professional as we are. We may be a little more technology-oriented, but the things that make a fighter pilot good—dedication, skill, and practice—are still important." ■

William Tell '86 Trophies

- Gen. Daniel "Chappie" James, Jr., Trophy—(best overall team) 33d TFW.
- Maj. Gen. James L. Price Trophy—("top gun" award for highest scoring individual—12,500 possible points): 1. Capt. John D. Reed, 425 Squadron (11,030); 2. Capt. Ed Kresge, 33d TFW (11,005); 3. Lt. Col. George Booth, 48th FIS (11,000).
- Top Shooter Award—(F-15/CF-18) Capt. Ed Kresge, 33d TFW (1,250 of 2,500 possible); (F-4) Maj. Roland M. Moore and Maj. William DeJager (tie), 142d FIG (870 of 2,500 possible).
- Top Gun Team Award—425 Squadron (4,050 of 12,500 possible).
- Lt. Col. Robert "Dad" Friendly Trophy—(top F-15/CF-18 weapons control team) 18th TFW (8,670 of 10,000 possible); Best Weapons Control Team Award—(F-4) 107th FIG (7,675 of 10,000 possible).
- CMSgt. Arvol "Pete" Lusse Trophy—(top F-15/CF-18 maintenance team) 1st TFW (3,750 of 4,000 possible); Best Maintenance Team Award—(F-4) 142d FIG (3,600 of 4,000 possible).
- Best Weapons Load Team Award—(F-15/CF-18) 425 Squadron (2,910 of 3,500 possible); (F-4) 119th FIG (2,865 of 3,500 possible).

"And the winners are . . ." Smiles and applause round out the endless days of work and waiting as the winners are announced. Here, members of the 48th FIS celebrate.

VIEWPOINT

The Bay of Piglets

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

The Iranagua flap has breathed new life into the Nicaraguan revolution. The US will find it more difficult now to stand firm against Marxist expansionism in this hemisphere.

Back in the early 1950s, I was plucked out of a comfortably obscure nook in the Pentagon's D Ring for duty in the office of the Secretary of the Air Force. Before I reported, however, Gen. Thomas D. White, the Chief of Staff, asked me around for a chat. Like most such conversations between colonels and Chiefs of Staff, this one was brief and to the point. The Secretary, General White said, was not only a personal friend but a greatly admired friend of the Air Force. It was, therefore, a distinct privilege for me to serve as his military assistant. General White then went on to say that I was to remember what uniform I wore and where I came from, and if that caused me any problems, I could return to my former job.

In explanation of these instructions, General White said he had had a few experiences with military officers who had confused their role with that of their civilian bosses, even to the point of usurpation of authority. The results were unhappy ones, both for the military and, in the long run, for the civilian being served.

As I write this, "Iranagua" is the focus of all attention. The special Senate and House committees have been announced to a full battery of microphones, and the investigative press, dormant since Watergate, is in full cry.

By the time this appears, our latter-day Watergate or perhaps more aptly Bay of Piglets either may have been filed away or have done lasting damage to the Administration. Whatever comes of it, the senior military, including the Chairman of the Joint Chiefs of Staff, appears to have been sidelined in favor of a few men in uniform who could have benefited from General White's advice.

Although it was not a part of his mea culpa after the Bay of Pigs debacle, President Kennedy had also chosen to sideline the Joint Chiefs prior to that venture. Thus, their warnings that US air support would be necessary unless the invasion sparked an immediate and massive uprising went unheeded. The last-minute change of a landing site to the remote Bay of Pigs ruled out a mass uprising. The carrier *Essex* lying just over the horizon, its airplanes unmarked, was never called on. As a consequence, Castro's few jets had a field day with the vulnerable little invading force.

All that, however, is history, and so—sooner or later—will this latest fiasco be. We can hope the harm inside the Washington Beltway will be transient, as are most such Washington crises. The real worry is what this may do to our policies in areas where we have much at stake.

Of particular interest, in this regard, is the Caribbean and those nations we call Central America. The Bay of Pigs left as its principal legacy a Soviet client state in Cuba—insured, it seems, after the Cuban missile confrontation, against further US intervention. The missile confrontation itself was a direct result of the Bay of Pigs.

The years that followed these events saw a growing Soviet influence in our backyard, with Grenada destined to become a staging point for Soviet penetration of the countries bordering the Caribbean and the rest of Central America. Nicaragua, its revolution gone wrong, was the first opportunity to be exploited. President Reagan's Caribbean Initiative, climaxed by the Grenada coup, then put a severe crimp in Cuban/Soviet plans for the area. In the meantime, El Salvador pulled back from the edge of its own Marxist takeover, and the Nicaraguan Marxists were kept too busy with the Contras to attempt serious mischief abroad.

One has only to leaf through the press reports of a few years ago to appreciate the relative stability El Salvador has attained. It has not been easy, nor is it necessarily permanent. President Duarte has confounded conservatives and left-wingers alike by his firm stand against the Marxist revolt, and General Vidas Casanova, the armed forces chief, has evidently rejuvenated the Salvadoran Army. The small Salvadoran air force, under the fiery General Bustillo, needed no rejuvenation, just logistic help. The United States program for El Salvador has been so successful, in fact, that the war in that country is no longer news. Should the US back away, it could be again.

Iranagua has breathed new life into the exporters of the Nicaraguan revolution, as evidenced by the December foray into Honduras. The tough reaction of the Hondurans may have surprised Daniel Ortega and his comrades, but it was only a test. There will be others, certainly if the United States appears aimless and divided over its Central American policy. Without the United States as a backup, none of these countries is a credible match for the formidable Soviet-equipped Nicaraguans.

For reasons that remain unfathomable to simple souls like me, the Sandinistas have a substantial constituency in this country. There can be no question, even among the wide-eyed innocent, of Managua's political orientation, nor can there be any question about the alarming amount of Soviet military hardware funneling into that impoverished land. The release of Eugene Hasenfus in time for Christmas shows a distinct improvement in Sandinista public relations, an area that has been weak in the past.

All in all, the continuation of a firm policy against the expansion of Marxist revolution in this hemisphere is not going to be any easier. It will be a sad prospect for Latin America, and for ourselves not too much later, if the current Washington flap leads to a collapse of that firm stand. ■

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Top officials talk about reducing our vulnerability in nuclear conflict, improving our tactical staying power, and preparing to operate in space.

Three Battle Arenas:

A Situation Report

BY EDGAR ULSAMER
SENIOR EDITOR (POLICY & TECHNOLOGY)

THE goal for the Defense Nuclear Agency (DNA) over the next five years is "to be able to reduce casualties due to radiation [caused by nuclear weapons] in a fallout environment from ninety percent to as low as ten percent," disclosed DNA Director Lt. Gen. John L. Pickitt at AFA's national symposium "The US Air Force—Today and Tomorrow" held in Los Angeles, Calif., October 30–31, 1986. Underscoring that the US was making significant progress in reducing the effects of nuclear radiation on humans, General Pickitt said that "force readiness and combat capability would obviously be improved dramatically, and the impact on civil defense would be equally positive" if DNA's objective can be realized.

DNA's approach to the question of how to "radiation-harden" the human physiology is being developed in concert with the Armed Forces Radiobiology Research Institute and involves a number of steps. After a fashion, he explained, it is possible to "harden" personnel through prophylactic measures that preclude radiation having an effect on the body. "Radiation affects the human cell in a way that causes chemical change. If it is possible to inhibit that impact, then it becomes possible

to preclude a chemical change," he added. DNA's "hardening" program, therefore, starts with "body supplements, [including diets rich in] leafy green vegetables, as well as vitamins A and E that [in combination] give about a thirty percent reduction of the impact on the human body caused by [nuclear] radiation."

The other element of DNA's plan for reducing the effects of nuclear radiation, the Agency's Director declared, concentrates on a two- or three-phased approach to safeguarding cell chemical balances by means "not too dissimilar from what we use today in chemical warfare [protection] with atropine injections." Once the human body has gone through major cell chemical change, he acknowledged, the effects of nuclear radiation must be treated as a major illness. Such treatment includes intravenous feeding, the purging of toxic chemicals from the cells, and the repair of damage to the immune system in order to restore its resistance to infection.

The Importance of Nuclear Testing

Turning to the hardware side of nuclear war and its deterrence, the DNA Director stressed the importance

PICKITT: Radiation hardening for humans.

of the US underground nuclear test program by disclosing that with the exception of one nuclear warhead, the Mk 11, every major new nuclear weapon program over the past twenty-one years "has produced unexpected results when exposed to a full-scale test underground. Some of these failures have been catastrophic." In spite of detailed and complex analysis coupled with an extensive above-ground test program, "we have been surprised virtually every time we test a full system in an underground nuclear environment."

General Pickitt unveiled a chart at the AFA symposium that listed several major systems that required various levels of changes, including changed spacing of the warhead's stages or component replacement, following initial underground tests. Among such systems were the Mk 4 warhead for the Trident C-4 SLBM, the Minuteman III's Mk 12A, and the Mk 21 of the Peacekeeper ICBM (which did not involve a full-fledged systems failure).

General Pickitt used a recently unclassified photograph of a reentry vehicle (RV) after exposure in an underground test to show that "a major portion of the heatshield has been blown away as a result of the radiation energy that was deposited in the system. I want to emphasize that this damage was caused [exclusively] by radiation. This failure, if undetected, could have compromised the force if the Soviets were to deploy a comprehensive ABM system. Fortunately, a rather modest redesign corrected this problem." He added that the paramount lesson from this test surprise "is that this failure mechanism was not predicted prior to the test; in this case, the physics of the failure were not even understood at the time of the test."

Stealth in a Nuclear Environment

One of the key concerns that the Defense Nuclear Agency is grappling with, according to General Pickitt, revolves around the nuclear survivability and mission capability of stealthy air-breathing systems: "The effects of the nuclear environment on advanced composites and other new materials had to be evaluated quickly and [comprehensively] to provide a useful data base for the aircraft designers." Not only was DNA concerned about the "structural integrity of aircraft, but we also had to evaluate the potential changes in the radar cross section that might result from a nuclear detonation in the vicinity of an aircraft." He hinted that DNA's analyses led to the rejection of some advanced composites and the substitution of others in the design of stealthy vehicles.

The Air Force's work on a survivable Small ICBM (SICBM)—which is expected to receive close scrutiny from the 100th Congress—is being carried out in concert with DNA. Key here, he said, "is definition of the airblast environment for the Hardened Mobile Launcher design. . . . This issue is particularly complicated because the airblast pressure wave is significantly affected by the thermal radiation from the nuclear fireball, an effect that is difficult to simulate without an atmospheric nuclear explosion."

DNA, working with Air Force Systems Command's Ballistic Missile Office, however, was able to come up with an innovative testing approach that involves the use of helium to simulate the effect of the nuclear fireball. General Pickitt disclosed that "an eight-kiloton, nonnuclear test has been conducted that was the first of its kind in successfully simulating this airblast environment." He added that another test of this type is imminent and is counted on to generate information confirming "the earlier results [with regard to] Hardened Mobile Launcher hardness" as well as to gauge the vulnerability of RVs to dust erosion.

The survivability as well as the basic ability of major weapon systems to function in a nuclear war environment remain in the forefront of DNA's concerns, according to General Pickitt. In this context, he reported significant advances in the agency's Electromagnetic Pulse Technology Development Program. Many different air-breathing weapon systems, ranging from cruise missiles to the EC-135 Worldwide Airborne Command Post and the A-7F, have been modified following DNA's evaluation of their resistance to EMP. The Air Force and the other services, General Pickitt added, benefit fur-

ther from this program because it provides a data base for "system designers to use in planning the development of more survivable aircraft in the future."

Similar work by DNA is paying off by increasing the survivability and operational reliability of microcircuitry in intense nuclear radiation environments. The DNA Director reported that "we now have the capability of mass-producing, [for instance,] a 64-kilobit memory chip that can withstand more than 1,000,000 'rads' of ionizing radiation."

In a team effort with the Air Force, he reported, DNA has pioneered new concepts for nuclear weapon storage vaults that boost security, survivability, and combat effectiveness and that enhance the prospect of significant reductions in the number of personnel required to guard these facilities. Recent tests by DNA, carried out under the code name of "Distant Runner," showed that these new designs are "so strong that even a major explosion will not damage the vault or endanger a weapon," according to General Pickitt.

The design and testing of superhard missile silos is another DNA endeavor involving close cooperation with the Air Force. "Only five years ago, 5,000 psi [pounds per square inch] overpressure was pushing the state of the art in silo design. Yet, today, thanks to our testing program, we are . . . designing and evaluating superhard silo designs . . . that can survive near the edge of a nuclear crater at overpressures far exceeding 5,000 psi."

Because of recent advances by DNA, the cratering effects produced by nuclear ground bursts are no longer the mystery they once were. "For decades we have relied on early observations from the atmospheric tests in the Pacific Proving Ground and the Nevada Test Site. In support of the Air Force's superhard silo program, we have just completed an extensive physical survey of the Pacific craters—our only data base for cratering [caused by] high-yield weapons." The findings from this survey—augmented by DNA's underground nuclear experiments illuminating the high-pressure physics encountered within close range of a nuclear explosion—have been "incorporated into the computer codes and supporting simulations that support Air Force facility designs and targeting requirements over a wide range of weapon yields and geologies," the DNA Director told the AFA meeting.

DoD Reorganization's Effects on MAC

Both the Packard Commission—a high-powered panel convened by the President to probe the organizational structure of the Pentagon—and the Ninety-ninth Congress have mandated changes that affect the way that Military Airlift Command does business. These changes, MAC Commander in Chief Gen. Duane H. Cassidy told the AFA symposium, affect the command's airlift as well as special operations functions.

The advent of "some kind of a National Transportation Organization" will entail major organizational change for MAC and "is probably an idea whose time has come," General Cassidy said. The purpose of this mandated change is to create "a single unified command to integrate global air, land, and sea transportation. The present system for coordinating several modes of transportation has reached a critical point." While the creation of the Joint Deployment System and Joint Deployment Agency several years ago has eased the coordination problem, the system "can go no further in its present format," in General Cassidy's view.

CASSIDY: Providing for joint transportation needs.

By overturning a long-standing prohibition of the merger of the three transportation modes, Congress opened the door late in 1986 to unification and centralization of all military transportation systems. At the direction of the President, the Chairman of the Joint Chiefs of Staff is now "organizing these three very different modes so they can support the warfighting CINCs as they should," General Cassidy reported. As a result, the Joint Chiefs of Staff will soon make specific recommendations to the Secretary of Defense about a National Transportation System designed to "provide the best service for those being deployed and for those who will employ those being deployed," MAC's Commander in Chief told the AFA meeting. "And certainly, the Air Force and MAC will be a major element in all this," he added.

The other major organizational change facing MAC stems from the creation of the unified Special Operations Command. This restructuring, General Cassidy said, "is not being made as deliberately [as the centralization of the transportation system and] comes to us as a creation of Congress by the expedient of amending section 136(b) of Title 10, United States Code." This congressional action establishes an Assistant Secretary of Defense for Special Operations and Low-Intensity Conflict, assigns all active and reserve special operations forces to this command (unless otherwise directed by the Secretary of Defense), and prescribes that the Commander of the Special Operations Command will hold the grade of a four-star general or admiral.

General Cassidy asserted that he had "no quarrel" with the need for change, but expressed concern "with the construction process." Special operations, he explained, "has been fraught with as many ideas as there are people who work in special ops." This diversity of views is evidenced by the fact that Congress came up with two somewhat contradictory pieces of legislation to address the issue. One of these bills, he said, is "from the Senate, and [the other is] from the House, [with the

latter suggesting] a fourth service. So what we got was a compromise." While he underscored the need for emphasizing special operations, he warned "we must never forget that fighting organizations must be constructed not by a process of chopping and stretching but in a way they can fight."

USAF's special operations force "has grown and become stronger in the three years it's been with MAC," General Cassidy asserted, adding that there is "much more to special ops than simply equipment and organization: It's people who train together, who apply innovative thinking, [and] who have adequate command and control."

In assessing the rapid growth of Transport Aviation, MAC's Soviet counterpart, General Cassidy reported that they copied "our airplanes" and are outstripping the US by building more transport aircraft "than we have." Transport Aviation now has 270 Il-76s, compared to MAC's 267 C-141s, which were copied by the Soviets. Additional numbers of Il-76s are assigned to Soviet satellite countries, and new ones are being produced at the rate of about thirty a year, he said. The Soviet equivalent to the C-5, the Condor, is now in production. The Condor, he pointed out, "set twenty-one official records by lifting a payload that exceeded the previous record set by the C-5."

MAC is countering the growing Soviet force-projection capabilities through its own vigorous modernization programs. The rewinging of the C-5As is expected to be completed by July of this year, the last of the fifty new C-5Bs should be in the inventory in FY '89, and the C-17 program, "from all indications, is a go," the MAC Commander in Chief told the AFA meeting.

CUNNINGHAM: Forty wings are imperative.

Status of the Tactical Air Forces

At a conference held just prior to the AFA symposium, the commanders of USAF's tactical air forces (TAFs) concluded that "fiscal reality has slowed our momentum, but [we also reaffirmed] the need to modernize in concert with a reasonable expansion," Twelfth Air Force Commander Lt. Gen. Charles J. Cunningham, Jr., told the AFA symposium. In the hardware arena, the TAF commanders stressed the need to reach a production decision concerning the so-called "A-7 Plus" by 1989 and to start R&D on the A-16 follow-on close support aircraft in 1988, with the expectation that procurement of that aircraft will begin in 1990, he reported.

There was consensus also on the need to build the forward air control force around airborne systems. General Cunningham explained that various FAC aircraft are available, depending on the intensity of the anticipated conflict. The TAFs are in the midst of drawing up a FAC roadmap that will be submitted to the Chief of Staff for implementation, he said.

The TAF commanders also singled out several key requirements for top-priority attention, according to General Cunningham. These include the advanced medium-range air-to-air missile (AMRAAM), which is faring well in current test flights; LANTIRN, whose targeting pod ought to be ready next year for full-up production of at least forty-two units a year; expeditious development of the advanced tactical fighter (ATF); and the development and retrofit of an on-board loading system for the KC-10. The commanders also recommended that the multistage improvement program for the F-15Cs and Ds be extended to cover all of these models, he said.

In broad terms, the TAF commanders feel that their forces "look quite good today and that the Soviet threat is not ten feet tall." Nevertheless, there is a consensus, according to General Cunningham, that the Soviet threat as well as the whole world situation is becoming more formidable and complex.

But while the challenges facing USAF's tactical forces are growing, there is the ameliorating factor "that we don't operate in a vacuum" and that the capabilities of the aviation arms of the US Navy, US Army, and Marine Corps also are increasing. By way of an example, he cited the "long way the Army has come with the AH 64s that they call fighters. These are $16 million aircraft equipped with laser ranging, 30-mm guns slaved to [the pilot's] head movements, and helmet-mounted [sights and that boast] a ferry range of 1,200 miles." Cooperation with the other services and joint training are at unprecedentedly high levels, including in the areas of low-intensity conflict and combating terrorism, the Twelfth Air Force Commander said.

The commanders expressed satisfaction with the steady gains by the TAFs in the crucially important "fully mission-capable rate that not long ago was in the fifty-five percent to sixty percent range and [that] is now consistently at or above eighty percent. Our equipment is ready, and the spares are out there." The utilization rate per possessed aircraft is in excess of twenty per month in the case of the F-16, for instance, while the monthly sortie rate per aircrew is a "very healthy fourteen," according to General Cunningham.

The TAF commanders consider the goal of forty fighter wings "an article of faith," the Twelfth Air Force Commander told the AFA meeting. He pointed out that the original objective was to build up to a force of seventy tactical fighter wings. Coming down to forty wings "was a big compromise. To be told that we can't get to [that lowered objective] until the 1990s borders on the ludicrous." He added that, over the longer term, the Air Force considers it imperative to build up to a forty-four-wing force.

PADDEN: Space is not an experiment.

The Challenge of the High Ground

"Soviet doctrine, Soviet systems, and Soviet behavior all point to their clear intention to dominate space," declared Maj. Gen. Maurice C. Padden, Commander of Air Force Space Command, at the AFA symposium. Two pivotal challenges to his command ensue from this premise. "In order to use space to continue to deter aggression, we must, first, accept [the fact] that space is no longer an 'experimental' medium—that it is, in fact, a bona fide operational environment—and second, that we must acquire a full range of capabilities required to fulfill our charter in supporting and directing Air Force operational space activities."

Even though the Air Force and other services have operated space systems in a routine fashion for more than two decades, these "operations," in an almost anachronistic fashion, have been carried out under a "development umbrella." The concomitant military space infrastructure "grew up in a relatively unstressed environment. . . . Space activities were [viewed] as experimental, and the medium of space [was considered] a kind of laboratory, [even though] it has become abundantly clear that the threat mandated a different approach." With the recent creation of the Air Force Space Command and the unified US Space Command—both "fully endorsed" by the Air Force—a shift in emphasis toward the operational character of space occurred and "will continue."

In the coming decade, General Padden pointed out, "we'll be challenged to make our space systems and ground segments as hardened and survivable as the threat dictates . . . [in order to achieve] functional survivability." This translates into "increasing the number of on-orbit spares, having just the right number of multimission spacecraft, acquiring a rapid replenishment capability, and—in the case of ground segments—[ensuring] mobility and redundancy."

Further, if "more and simpler" is the answer, General Padden pointed out, "spacecraft production rates must increase. We must then consider developing the capability to adapt a simple, perhaps 'standard issue' satellite, with a number of specific modules." He explained that these modules should include individual designs dedicated to communications, surveillance, nuclear detonation detection, and other key functions.

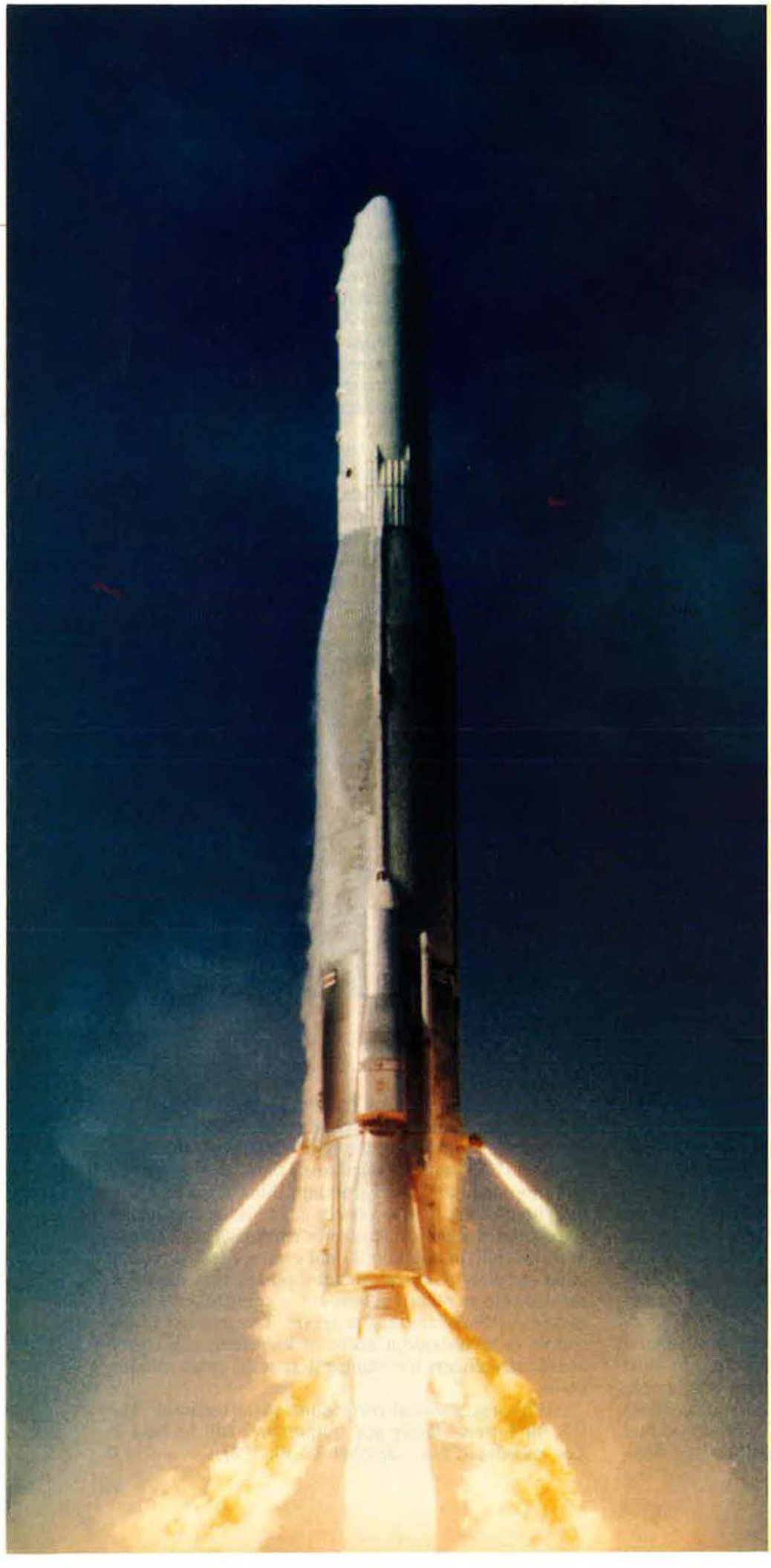
In line with the "standard issue" approach to satellites, General Padden added, is the Air Force Space Command's notion of a "standard issue" booster, which he defined as a "core launch vehicle to which modular boosters could be added, depending on the weight and destination of the spacecraft." Such a common booster approach would also increase operational flexibility by allowing US forces to "divorce ourselves from the reliance on a specific launch location for a specific booster," according to General Padden.

Another major challenge facing the new Air Force Space Command, its commander pointed out, is in the personnel sector. The first objective, in a chronological sense, is to build a "space operations career progression model [that can] identify the milestones required to develop space operations leaders." Ancillary initiatives, he added, include the creation of a "space chair" at the Air War College, expanded space curricula in professional military education courses, and creation of a senior officer management seminar on space. In addition, "we would also like to establish a special rating for space operations and award a distinctive space operations badge, just as we issue pilot wings now."

SHAUD: Toward undergraduate space training.

The Commander of Air Training Command, Lt. Gen. John A. Shaud, discussed specific space-oriented training programs, including the new Undergraduate Space Training (UST) program that, over time, will become as commonplace as Undergraduate Pilot Training. This five-month-long course covers calculus, vector analysis, orbital mechanics, space system design and acquisition, spaceflight operations, and even space law, among other subjects. General Shaud reported that the other services are on record in terms of wanting to participate in this Air Force training program. The purpose of the course is to provide a cadre of knowledgeable space operations officers for training in specific space mission areas.

(AFA's next national symposium on the theme of "The US Air Force—Today and Tomorrow" will be held in Los Angeles, Calif., October 29–30, 1987.) ■



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General Dynamics F-16C Fighting Falcon of the Egyptian Air Force

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GENERAL DYNAMICS F-16 FIGHTING FALCON

The F-16 had its origin in the US Air Force's Lightweight Fighter (LWF) prototype programme, in 1972. The first of two YF-16 prototypes (72-01567) made its official first flight on 2 February 1974, and was followed by the second YF-16 on 9 May 1974. On 13 January 1975 the Secretary of the US Air Force announced that the F-16 had been selected for full-scale engineering development. Manufacture of eight pre-production aircraft, comprising six single-seat F-16As and two two-seat F-16Bs, began in July 1975. The first FSD F-16A made its first flight on 8 December 1976, and the first F-16B on 8 August 1977.

Initially, the US Air Force planned to procure a total of 1,388 F-16s, including 204 two-seaters, to replace McDonnell Douglas F-4s in the active force and to modernise the Air Force Reserve and Air National Guard. This has since been increased to a planned total of 3,047, of which 1,859 had been contracted and more than 1,000 delivered by September 1986. In addition, fifteen other air forces have ordered a total of 1,106 F-16s (for details see 1986–87 *Jane's*). Production at Fort Worth for the USAF continues at the rate of 180 a year for FY 1987, with a contract option to increase this to 216 a year in FYs 1987, 1988, and 1989. By December 1986 deliveries to all customers from Fort Worth totalled 1,261, with a further 401 delivered from European assembly lines in Belgium and the Netherlands.

Operational, experimental, and planned versions of the F-16 are as follows:

F-16A. First production version, for air-to-air and air-to-surface roles. Production for USAF completed in March 1985, but still available to other customers. Pratt & Whitney F100-PW-200 turbofan engine, rated at approx 111.2 kN (25,000 lb st) with afterburning. Westinghouse APG-66 pulse-Doppler range and angle track radar. First aircraft (78-0001) flew for the first time on 7 August 1978. Entered service with USAF's 388th Tactical Fighter Wing at Hill AFB, Utah, on 6 January 1979, and achieved combat-ready status in October 1980, in which year the name **Fighting Falcon** was adopted. Standard equipment in TAC, USAFE, PACAF, ANG, and AFRES, and with the Thunderbirds air demonstration squadron. Operated also by air forces of Belgium, Denmark, Egypt, Israel, the Nether-

F-16D two-seat fighter/trainer of the Republic of Korea Air Force

lands, Norway, Pakistan, and Venezuela; ordered by Indonesia, Singapore, and Thailand. Extension of fin root fairing houses Loral Rapport ECM equipment in Belgian F-16As and F-16Bs, a braking parachute in aircraft for Norway and Venezuela. F-16s of the Pakistan Air Force carry Thomson-CSF Atlis laser target designation pods. For further details of service history see 1986–87 *Jane's*.

USAF and NATO operators are co-operating in an operational capabilities upgrade (OCU) programme to enable F-16A/Bs to utilise next-generation air-to-air and air-to-surface weapons systems. Changes will be made to existing radar systems and software, and the aircraft's fire control computer and central interface will be improved. A data transfer unit and combined altitude radar altimeter will be installed.

F-16A (ADF). During October 1986 the USAF awarded General Dynamics a $633 million contract to modify a total of 270 F-16As as air defence fighters (ADF) to replace F-4s and F-106s in eleven Air National Guard continental air defence squadrons. The aircraft will be equipped with upgraded avionics to improve their capability against cruise missiles, and pylons for two 2,271 litre (600 US gallon) drop tanks plus two or four AIM-7 Sparrow/AIM-120 AMRAAM air-to-air missiles in addition to the standard pair of Sidewinders and a 20 mm gun. No provision for AN/ALR-69 radar warning receivers or AN/ALE-40 chaff dispensers. Programme completion scheduled for FY 1992.

F-16B. Two-seat variant of F-16A with two cockpits in tandem, each fully systems-operational. Service use as for F-16A. Length unchanged.

F-16C/D. Single-seat (F-16C) and two-seat (F-16D) versions embodying results of USAF Multinational Staged Improvement Programme (MSIP) implemented in February 1980. MSIP expands the aircraft's ability to perform precision strike, attack, and beyond-visual-range intercept missions by day and night in all weathers, and assures its ability to accept future systems such as the AIM-120A AMRAAM air-to-air missile, LANTIRN nav/attack system, and ALQ-165 ASPJ jamming system. Stage I of the programme, introduced on Block 15 F-16A and F-16B aircraft delivered from November 1981, was limited to wiring and airframe provisions for emerging systems. Stage II, applicable to production deliveries of F-16C and F-16D aircraft from July 1984 (Block 25), incorporates core avionics, cockpit, and airframe changes. Stage III, scheduled to begin during 1987, will provide for advanced systems installation, as these become available.

Only external feature distinguishing the F-16C from an F-16A is a slightly expanded forward tail fin root fairing to house ASPJ when it becomes available. Internal changes include a Westinghouse APG-68 multi-mode radar offering increased range, sharper resolution, expanded operating modes, and advanced ECCM by comparison with the APG-66; an advanced cockpit with improved pilot/vehicle interface, including up-front controls, two multi-function displays, radar altimeter, GEC Avionics wide-angle HUD with FLIR video, and Fairchild mission data transfer equipment; avionics growth capability through increases in both the speed and memory of core computers, with solid-state cartridge system for loading mission data; increased capacity electrical power and cooling systems; structural changes for increased T-O weight and gross weight manoeuvring limits; and MIL-STD-1760 weapons interface to provide compatibility with advanced 'smart' systems, including AMRAAM, LANTIRN, and the Litton AN/ALR-74(V) radar threat warning receiver. In MSIP Stage III planned upgrades will include automatic terrain following, ASPJ, GPS, PLSS, and Enhanced JTIDS, improving further the F-16's multi-role capability and survivability, particularly for night/all-weather missions.

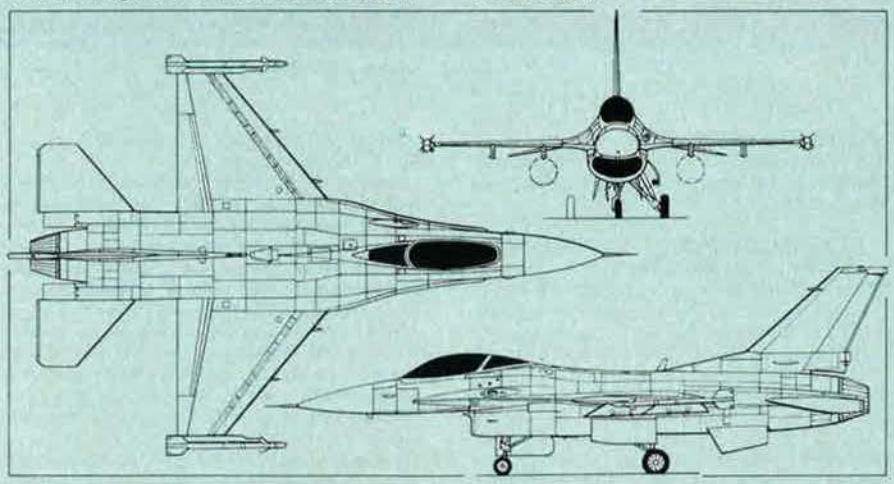
The first F-16C for the US Air Force (83-118) was delivered on 19 July 1984; the first F-16D was delivered in September 1984; first operational unit to equip with these models was the 33d TFS at Shaw AFB, S. C. F-16Cs and F-16Ds have been ordered also by Egypt (40, the first of which was handed over at Fort Worth on 15 August 1986, with plans for an additional 36); Greece (40, deliveries commencing in 1988); Israel (75, with plans for 30 more); South Korea (36, the first of which was delivered in 1986, with a planned force totalling 156); and Turkey (160, deliveries beginning in 1987).

Under the USAF's Alternate Engine Program, F-16C/Ds will be produced with both Pratt & Whitney F100-PW-220 and General Electric F110-GE-100 engines. The first Egyptian F-16C was the first production F-16 to have the F100-PW-220 engine, which will also power South Korean aircraft. Those for Israel, Greece, and Turkey will be powered by the General Electric engine.

F-16N. Selected in January 1985 as US Navy supersonic adversary aircraft (SAA). Initial $154.7 million contract is for 14 aircraft, with planned procurement of 26, deliveries to begin in April 1987 and continue at the rate of two per month. Essentially similar to F-16C, with minor structural modifications involving the substitution of titanium for aluminium in lower wing fittings and cold working the lower wing skin holes to meet the increased frequency of *g* loading in adversary roles. General Electric F110-GE-100 engine; APG-66 radar instead of APG-68; no M61 gun. Normally, the F-16N will have only wingtip launchers for practice AIM-9 missiles and ACMI AIS pods, but will be capable of carrying the full complement of F-16 external fuel tanks and other stores. The last four aircraft will be **TF-16N** two-seaters, similar to F-16D.

F-16R. Reconnaissance variant of F-16D intended as replacement for RF-4C. General Dynamics reconnaissance pod, incorporating a video camera system to provide display images for the aircraft's crew and high resolution near real-time transmission to end users, installed on centreline stores station of F-16B (75-0752) for flight demonstrations in late 1985/early 1986, and later on modified F-16D/F-16R test aircraft. The semi-conformal reconnaissance pod can also carry wide-angle and long-range Chicago Aerial KS-153 cameras, a Texas Instruments RS-710 infra-red linescanner, extendable data link antenna, and a Control Data Corporation imagery management system. Pod is 4.40 m (14 ft 5 in) long, weighs 454–567 kg (1,000–1,250 lb), and has a design load factor of 9*g*. Production deliveries of up to 410 reconnaissance pods for USAF could begin in FY 1991. Flight testing was continuing in late 1986.

F-16/79. Essentially an F-16 powered by a General Electric J79-GE-119 afterburning turbojet, rated at 80.1 kN (18,000 lb st). Produced for US government's FX programme, to develop aircraft for export to nations in which a first-line US fighter might not be required. Primarily an air defence fighter, but retaining multi-role capability. Prototype converted from second F-16B development aircraft (75-0752). First flew on 29 October 1980; company certification flight testing completed on 19 December 1980. Offered as single-seat F-16/79A and two-seat F-16/79B. No orders by December 1986. Details in 1986–87 *Jane's*.



Three-view drawing of the General Dynamics F-16C Fighting Falcon *(Pilot Press)*

F-16/AFTI. Modified F-16A testbed aircraft for Air Force Systems Command's Advanced Fighter Technology Integration (AFTI) programme; first flown on 10 July 1982. F-16/AFTI has an automated manoeuvring attack system (AMAS) permitting 'decoupled' or six degrees of freedom flight modes. AMAS provides a range of attack profiles unknown in conventional fighters, such as weapons firing while slipping sideways, without banking or flying over target. External changes include addition of twin fuselage mounted ventral foreplanes. Advanced technologies to be evaluated in the F-16/AFTI include a helmet-mounted sight for the pilot and interactive avionics which will provide aural warnings of impending or actual emergencies and respond to voice commands from the pilot. Information generated by the programme (further details in 1986–87 *Jane's*) will be made available generally to the US aircraft industry for application to future fighter aircraft designs.

F-16R test aircraft equipped with General Dynamics reconnaissance pod

General Dynamics F-16/AFTI technology testbed aircraft, now with a Westinghouse FLIR sensor/tracker pod mounted at its starboard wingroot leading-edge

F-16XL. Advanced development of F-16 with 'cranked arrow' wing, embodying 50°/70° compound leading-edge sweep and an area more than twice that of a standard F-16 wing. Internal fuel capacity increased by 85 per cent, plus extra space for avionics and sensors. Two prototypes built; first flight on 3 July 1982. Demonstrated 48 per cent increase in combat radius on internal fuel, and 87 per cent increase with external tanks, compared with F-16A. Under the designation **F-16E**, the F-16XL was proposed for USAF's dual-role air defence/ground attack fighter requirement, for which the F-15E was selected on 24 February 1984. The prototypes are held in flyable storage at General Dynamics' Fort Worth facility. Details in 1985–86 *Jane's*.

Development of the F-16 is continuing. Initial operational testing of the LANTIRN system began in mid-January 1986 on an F-16 from McChord AFB, Wash., as a result of which delivery of 700 of the navigation pods is scheduled to begin in April, with a production decision on the targeting pod pending. Flight testing of an infra-red system known as Falcon Eye FLIR is expected to begin in mid-1987. This utilises a helmet-mounted display and head-steered FLIR sensor forward of the aircraft's windscreen. Claimed advantages are night vision without need for an external pod, 24-hour capability for low-altitude high-speed navigation, off-boresight detection and recognition of tank size targets, and multi-role night attack capability with conventional weapons and AIM-9L Sidewinder missiles.

Other research and development subjects being investigated for the F-16 include artificial intelligence, modular avionics architecture, VHSIC, various weapons, sensors and cockpit displays, secure/anti-jam communications and data links, advanced navigation systems, chemical and electromagnetic pulse hardening, signature reduction, and vulnerability reduction. The F-16 airframe is a candidate for a defence suppression role in the Follow-On Weasel programme. A Falcon Century programme has been instituted to monitor and evaluate developments and maintain a master plan for F-16 developments into the next century.

The following description applies specifically to the F-16C and F-16D:

TYPE: Single-seat day/night multi-role fighter (F-16C) and two-seat fighter/trainer (F-16D).

WINGS: Cantilever mid-wing monoplane, of blended wing/body design and cropped delta planform. The blended wing/body concept is achieved by flaring the wing/body intersection, thus not only providing lift from the body at high angles of attack but also giving less wetted area and increased internal fuel volume. In addition, thickening of the wingroot gives a more rigid structure, with a weight saving of some 113 kg (250 lb). Basic wing is of NACA 64A-204 section, with 40° sweepback on leading-edges. Structure is mainly of aluminium alloy, with 11 spars, 5 ribs, and single upper and lower skins, and is attached to the fuselage by machined aluminium fittings. Leading-edge manoeuvring flaps are programmed automatically as a function of Mach number and angle of attack. The increased wing camber maintains effective lift coefficients at high angles of attack. These flaps are one-piece bonded aluminium honeycomb sandwich structures, and are driven by rotary actuators. The trailing-edges carry large flaperons (flaps/ailerons) which are interchangeable left with right and are actuated by integrated servo-actuators. The maximum rate of flaperon movement is 52°/s.

FUSELAGE: Semi-monocoque all-metal structure of frames and longerons, built in three main modules: forward (to just aft of cockpit), centre, and aft. Nose radome built by Brunswick Corporation. Highly swept vortex control strakes along the fuselage forebody increase lift and improve directional stability at high angles of attack.

TAIL UNIT: Cantilever structure with sweptback surfaces. Fin is multi-spar multi-rib aluminium structure with graphite epoxy skins, aluminium tip, and glassfibre dorsal fin and root fairing. Optional extension of rear root fairing to house brake-chute (standard in F-16Cs for Turkey) or Loral Rapport III ECM equipment. Interchangeable all-moving tailplane halves, constructed of graphite epoxy composite laminate skins mechanically attached to a corrugated aluminium substructure. Each tailplane half has an aluminium pivot shaft, and a removable full depth bonded honeycomb leading-edge. Ventral fins have bonded aluminium honeycomb core with aluminium skins. Split speed-brake inboard of rear portion of each horizontal tail surface to each side of nozzle, each deflecting 60° from the closed position.

LANDING GEAR: Menasco hydraulically retractable type, nose unit retracting rearward, main units forward into fuselage. Nosewheel is located aft of intake, to reduce the risk of foreign objects being thrown into engine during ground operation, and rotates 90° during retraction to lie horizontally under the engine air intake duct. Oleo-pneumatic struts in all units. Goodyear mainwheels and brakes; Goodrich mainwheel tyres, size 25.5 × 8.14, pressure 14.48–15.17 bars (210–220 lb/sq in) at T-O weights less than 11,340 kg (25,000 lb). Steerable nosewheel with Goodrich tyre, size 18 × 5.5-8, pressure 14.82–15.51 bars (215–225 lb/sq in) at T-O weights less than 11,340 kg (25,000 lb). All but two main unit components interchangeable. Brake by wire system on main landing gear, with Goodyear anti-skid units. Runway arrester hook under rear fuselage. Landing/taxying light on each main landing gear leg.

POWER PLANT: One General Electric F110-GE-100 or one Pratt & Whitney F100-PW-220 turbofan engine, each rated at approx 129.0 kN (29,000 lb st) with afterburning, as alternative standard engines, mounted in rear fuselage. Fixed geometry intake, with boundary layer splitter plate, beneath fuselage. Standard fuel contained in wing and five seal-bonded fuselage cells which function as two tanks; internal fuel weight is 3,162 kg (6,972 lb) in F-16C, and approx 17 per cent less in F-16D. In-flight refuelling receptacle in top of centre-fuselage, aft of cockpit. Auxiliary fuel can be carried in drop tanks on underwing and underfuselage hardpoints.

ACCOMMODATION: Pilot only in F-16C in air-conditioned cockpit. McDonnell Douglas ACES II zero/zero ejection seat. Transparent bubble canopy made of polycarbonate advanced plastics material. The windscreen and forward canopy are an integral unit without a forward bow frame, and are separated from the aft canopy by a simple support structure which also serves as the break point where the forward section pivots upward and aft to give access to the cockpit. A redundant safety lock feature prevents canopy loss. Windscreen/canopy design provides 360° all-round view, 195° fore and aft, 40° down over the side, and 15° down over the nose. To enable the pilot to sustain high *g* forces, and for comfort, the seat is inclined 30° aft and the heel line is raised. In normal operation the canopy is pivoted upward and aft by electrical power; the pilot is also able to unlatch the canopy manually and open it with a backup handcrank. Emergency jettison is provided by explosive unlatching devices and two rockets. A limited displacement, force sensing control stick is provided on the right hand console, with a suitable armrest, to provide precise control inputs during combat manoeuvres. The F-16D has two cockpits in tandem, equipped with all controls, displays, instruments, avionics, and

life support systems required to perform both training and combat missions. The layout of the F-16D second station is essentially the same as that of the F-16C, and is fully systems-operational. A single-enclosure polycarbonate canopy transparency, made in two pieces and spliced aft of the forward seat with metal bow frame and lateral support member, provides outstanding view from both cockpits.

SYSTEMS: Hamilton Standard regenerative 12kW bootstrap air cycle environmental control system, using engine bleed air, for pressurisation and cooling. Two separate and independent hydraulic systems supply power for the operation of primary flight control surfaces and the utility functions. System pressure (each) 207 bars (3,000 lb/sq in), rated at 161 litres (42.5 US gallons)/min. Bootstrap type reservoirs, rated at 5.79 bars (84 lb/sq in). Electrical system powered by engine driven Westinghouse 60kVA main generator and Lear Siegler 10kVA standby generator (including ground annunciator panel for total electrical system fault reporting), with Sundstrand constant speed drive. Four dedicated, sealed cell batteries provide transient electrical power protection for the fly by wire flight control system. Application of the control configured vehicle (CCV) principle of relaxed static stability produces a significant reduction in trim drag, especially at high load factors and supersonic speeds. The aircraft centre of gravity is allowed to move aft, reducing both the tail drag and the change in drag on the wing due to changes in lift required to balance the download on the tail. Relaxed static stability imposes a requirement for a highly reliable, full-time operating, stability augmentation system, including reliable electronic, electrical, and hydraulic provisions. The single paths in this quad-redundant system are used to control the aircraft, replacing the usual mechanical linkages. Direct electrical control is employed from pilot controls to surface actuators. An onboard Sundstrand/Solar jet fuel starter is provided for engine self-start capability. Simmonds fuel measuring system. Garrett emergency power unit automatically drives a standby generator and pump to provide uninterrupted electrical and hydraulic power for control in the event of the engine or primary power systems becoming inoperative.

AVIONICS AND EQUIPMENT: Westinghouse APG-68 pulse-Doppler range and angle track radar, with planar array in nose. Radar provides air-to-air modes for range-while-search, uplook search, velocity search, air combat, track-while-scan (ten targets), raid cluster resolution, single target track, and (later) high PRF track to provide target illumination for AIM-7 missiles; and air-to-surface modes for ground mapping, Doppler beam sharpening, ground moving target, sea target, fixed target track, target freeze after pop-up, beacon for nav fix and offset weapon delivery with ground FAC, and air-to-ground ranging. Forward avionics bay, immediately forward of cockpit, contains radar, air data equipment, inertial navigation system, flight control computer, and combined altitude radar altimeter (CARA). Rear avionics bay contains ILS, Tacan, and IFF, with space for future equipment. A Dalmo-Victor AN/ALR-69 radar warning system is installed. Communications equipment includes Magnavox AN/ARC-164 UHF transceiver; provisions for Magnavox KY-58 secure voice system; Collins AN/ARC-186 VHF AM/FM transceiver; government furnished AN/AIC-18/25 intercom; and Novatronics interference blanker. Sperry Flight Systems central air data computer. Litton LN-39 inertial navigation system; Collins AN/ARN-108 ILS; Collins AN/ARN-118 Tacan; Teledyne Electronics AN/APX-101 air-to-ground IFF transponder with a government furnished IFF control; government furnished National Security Agency KIT-1A/TSEC cryptographic equipment; Lear Siegler stick force sensors; GEC Avionics wide-angle electronic head-up display with raster video capability and integrated keyboard; horizontal situation indicator; Teledyne Avionics angle of attack transmitter; Gull Airborne angle of attack indicator; Clifton Precision attitude director indicator; Delco enhanced fire control computer; Sperry multi-function display set; and cockpit/TV set. Cockpit and core avionics integrated on two MIL-STD-1553B multiplex buses. Optional equipment includes VIR-130 VOR/ILS and ARC-190 HF radio. Essential structure and wiring provisions are built into the airframe to allow for easy incorporation of future avionics systems under development for the F-16 by the US Air Force.

ARMAMENT: General Electric M61A1 20 mm multi-barrel cannon in port side wing/body fairing, equipped with a General Electric ammunition handling system and a 'snapshoot' gunsight (part of the head-up display system) and 515 rounds of ammunition. There is a mounting for an air-to-air missile at each wingtip, one underfuselage centreline hardpoint, and six underwing hardpoints for additional stores. For manoeuvring flight at 5.5*g* the underfuselage station is stressed for a load of up to 1,000 kg (2,200 lb), the two inboard underwing stations for 2,041 kg (4,500 lb) each, the two centre underwing stations for 1,587 kg (3,500 lb) each, the two outboard underwing stations for 318 kg (700 lb) each, and the two wingtip stations for 193 kg (425 lb) each. For manoeuvring flight at 9*g* the underfuselage station is stressed for a load of up to 544 kg (1,200 lb), the two inboard underwing stations for 1,134 kg (2,500 lb) each, the two centre underwing stations for 907 kg (2,000 lb) each, the two outboard underwing stations for 204 kg (450 lb) each, and the two wingtip stations for 193 kg (425 lb) each. There are mounting provisions on each side of the inlet shoulder for the specific carriage of sensor pods (electro-optical, FLIR, etc); each of these stations is stressed for 408 kg (900 lb) at 5.5*g*, and 250 kg (550 lb) at 9*g*. Typical stores loads can include two wingtip mounted AIM-9J/L Sidewinders, with up to four more on the outer underwing stations; Sargent-Fletcher 1,400 litre (370 US gallon) drop tanks, or 2,271 litre (600 US gallon) drop tanks, on the inboard underwing stations; a 1,136 litre (300 US gallon) drop tank on the underfuselage station; a Martin Marietta Pave Penny laser tracker pod along the starboard side of the nacelle; and single or cluster bombs, air-to-surface missiles, or flare pods, on the four inner underwing stations. Stores can be launched from Aircraft Hydro-Forming MAU-12C/A bomb ejector racks, Hughes LAU-88 launchers, or Orgen triple or multiple ejector racks. Westinghouse AN/ALQ-119 and AN/ALQ-131 ECM (jammer) pods can be carried on centreline and two underwing stations. Provision for future internal installation of Westinghouse/ITT AN/ALQ-165 airborne self-protection jammer (ASPJ) instead of ECM pods. ALE-40 internal chaff/flare dispensers. Current capabilities include air-to-air combat with gun and Sidewinder missiles; and air-to-ground attack with gun, rockets, conventional bombs, special weapons, and laser guided and electro-optical weapons. Specific structure, wiring provisions, and systems architecture are built in to ensure acceptance of future sensor and weapons systems, including electro-optical and FLIR pods, and advanced beyond-visual-range missiles. Weapons already launched successfully from F-16s, in addition to Sidewinders and AMRAAM, include radar guided Sparrow and Sky Flash air-to-air missiles and AGM-65 Maverick and Penguin air-to-surface missiles.

DIMENSIONS, EXTERNAL (F-16C, D):

Wing span over missile launchers	9.45 m (31 ft 0 in)
Wing span over missiles	10.00 m (32 ft 9¾ in)
Wing aspect ratio	3.0
Length overall	15.03 m (49 ft 4 in)
Height overall	5.09 m (16 ft 8½ in)
Tailplane span	5.58 m (18 ft 3¾ in)
Wheel track	2.36 m (7 ft 9 in)
Wheelbase	4.00 m (13 ft 1½ in)

AREAS (F-16C, D):

Wings, gross	27.87 m² (300.0 sq ft)
Flaperons (total)	5.82 m² (62.64 sq ft)
Leading-edge flaps (total)	6.82 m² (73.42 sq ft)
Vertical tail surfaces (total)	5.09 m² (54.75 sq ft)
Rudder	1.08 m² (11.65 sq ft)
Horizontal tail surfaces (total)	5.92 m² (63.70 sq ft)

WEIGHTS AND LOADINGS:

Weight empty:	
F-16C	7,618 kg (16,794 lb)
F-16D	7,896 kg (17,408 lb)
Internal fuel load:	
F-16C	3,162 kg (6,972 lb)
F-16D	2,624 kg (5,785 lb)
Max external load: both models	5,443 kg (12,000 lb)
Structural design gross weight (9*g*) with full internal fuel: both models	11,839 kg (26,100 lb)
Max T-O weight:	
air-to-air, no external tanks:	
F-16C	11,372 kg (25,071 lb)
F-16D	11,114 kg (24,502 lb)
with external load: both models	17,010 kg (37,500 lb)
Wing loading:	
at 11,839 kg (26,100 lb) AUW	425 kg/m² (87 lb/sq ft)
at 17,010 kg (37,500 lb) AUW	610 kg/m² (125 lb/sq ft)
Thrust/weight ratio ('clean')	1.1 to 1

PERFORMANCE:

Max level speed at 12,200 m (40,000 ft)	above Mach 2.0
Service ceiling	more than 15,240 m (50,000 ft)
Radius of action	more than 500 nm (925 km; 575 miles)
Ferry range with drop tanks	more than 2,100 nm (3,890 km; 2,415 miles)
Max symmetrical design load factor with full internal fuel	+9

PROMAVIA

PROMAVIA SA, Chaussée de Fleurus 181, B-6200 Gosselies-Aéroport, Belgium

Promavia SA was formed by a number of industrialists, investment companies, and a bank, with offices and facilities near Charleroi Airport. Results of a market survey completed in 1983 confirmed the company's belief that a requirement existed for an 'all-through' jet trainer, built to a specification similar to that which led to the US Air Force new generation trainer (NGT). Promavia therefore initiated the Jet Squalus programme, commissioning Dott Ing Stelio Frati of General Avia in Italy to undertake the aircraft's design and prototype construction. Substantial financial backing was obtained from the Belgian government in 1985 to contribute towards prototype research and development.

Marketing and support of the production version, including training programmes, will be undertaken by Promavia, with Sonaca of Belgium as major subcontractor. Promavia believes there may be some USAF participation in the flight and static test programmes, and in April 1986 announced an agreement to team with Rockwell International Corporation to submit the Jet Squalus as a possible USAF alternative to the Fairchild T-46A new generation trainer. Under this agreement, Rockwell would build any examples sold in the USA.

PROMAVIA JET SQUALUS F1300 NGT

The Jet Squalus (Latin for 'Shark') was designed to cover all stages of flying training, from ab initio to part of the advanced syllabus, and to be powered by a small, modern, fuel-efficient, and quiet turbofan engine. A side by side seating arrangement was chosen for instructor and trainee, and the aircraft is provided with four underwing attachment points enabling it also to undertake weapons training or light tactical missions.

Two prototypes are being built in Italy by General Avia, the first of which made its public debut as a static exhibit at the Farnborough International air show in September 1986. It was expected to make its first flight by the end of that year. Fatigue, flutter,

and other testing of major components has been completed, as have drawings for the production version, which will be manufactured in Belgium by Promavia.

In its initial configuration the first Jet Squalus prototype is powered by a derated Garrett TFE109-1 turbofan engine, of the kind developed for the twin-engined T-46A, and is not fitted with ejection seats. The more powerful Williams International FJ44 will be installed in the second prototype, and the first aircraft's TFE109 will eventually be uprated to a comparable thrust level. Possible future options include Martin-Baker ejection seats and cockpit pressurisation.

The following description applies to the first prototype, except where indicated:

TYPE: Two-seat basic training aircraft.

AIRFRAME: Composite materials are used for fairings and some non-structural components; otherwise the aircraft is basically of metal construction throughout.

WINGS: Cantilever low-wing monoplane, with GAW-2 wing section. Dihedral 5° from roots. Incidence 1° at root, −1° 30′ at tip. All-metal single-spar structure in light alloy with flush riveted stressed skin. Differentially operated all-metal ailerons and hydraulically operated metal trailing-edge flaps.

FUSELAGE: All-metal semi-monocoque structure with flush riveted aluminium alloy skin. Hydraulically operated two-piece airbrake in lower central part of fuselage, in line with flaps. Avionics and equipment bay in nose. Large quick-disconnect panel in lower rear fuselage permits rapid engine access or removal. Small auxiliary aerofoil surface mid-mounted on each air intake trunk (Promavia calls these 'spinners'), to smooth out turbulence at wing/fuselage junction and delay onset of stall.

TAIL UNIT: Cantilever all-metal structure with flush riveted skin. Sweptback fin and rudder (42° on fin leading-edge). Non-swept, fixed incidence tailplane. Trim tab in port elevator.

LANDING GEAR: Retractable tricycle type, with single wheel and oleo-pneumatic shock absorber on each unit. Mainwheels retract inward, nosewheel rearward. Hydraulic actuation, with built-in emergency system. Nosewheel steerable 18° left and right. Mainwheels and tyres size 6.00-6, nosewheel 5.00-5. Goodyear brakes.

POWER PLANT: One Garrett TFE109-1 (F109-GA-100) turbofan engine in first prototype, for initial flight trials, mounted in rear fuselage and derated to 5.92 kN (1,330 lb st); will later be progressively uprated, first to 6.67 kN (1,500 lb st) and later to 8.23 kN (1,850 lb st). Second prototype will have an 8.01 kN (1,800 lb st) Williams International FJ44 turbofan. Semi-integral fuel tank in centre-fuselage, max usable capacity 720 litres (158 Imp gallons; 190 US gallons) in prototypes, 800 litres (176 Imp gallons; 211 US gallons) in production aircraft. Single gravity refuelling point on top of fuselage. Electric fuel pump for engine starting and emergency use.

ACCOMMODATION: Side by side seats for two persons in non-pressurised air-conditioned cockpit. One-piece framed canopy is hinged at rear and opens upward hydraulically. Provision for pressurisation to 0.28 bars (4.0 lb/sq in), and for optional Martin-Baker Mk 11 lightweight ejection seats for both occupants, capable of operation at altitudes up to 12,200 m (40,000 ft) and at any speed between 60 and 400 knots (111–741 km/h; 69–461 mph), including ejection through canopy.

SYSTEMS: Environmental control system for cockpit air-conditioning. Hydraulic system (operating pressure 107 bars; 1,550 lb/sq in) for actuation of airbrake, landing gear, flaps, and canopy. System incorporates electrically driven oil pump, with two air/oil accumulators (one for normal and one for emergency operation); separate standby system for emergency lowering of landing gear. Electrical system is 28V DC, using an engine driven starter/generator and nickel-cadmium or lead-acid battery. Negretti Aviation oxygen system.

AVIONICS AND EQUIPMENT: Include dual Collins EFIS avionics and radio equipment.

ARMAMENT: Four underwing attachment points for such weapons or other stores as 0.50 in/12.7 mm machine-gun pods, seven-round 2.75 in rocket launchers, practice bombs, or auxiliary fuel tanks.

Promavia Jet Squalus F1300 NGT at the 1986 Farnborough Air Show

DIMENSIONS, EXTERNAL:

Wing span	9.04 m (29 ft 8 in)
Wing chord: at root	1.90 m (6 ft 2¾ in)
at tip	1.00 m (3 ft 3¼ in)
mean aerodynamic	1.575 m (5 ft 2 in)
Wing aspect ratio	6.02
Length overall	9.36 m (30 ft 8½ in)
Height overall	3.60 m (11 ft 9¾ in)
Tailplane span	3.80 m (12 ft 5½ in)
Wheel track	3.59 m (11 ft 9¼ in)
Wheelbase	3.58 m (11 ft 9 in)

AREAS:

Wings, gross	13.58 m² (146.17 sq ft)
Vertical tail surfaces (total)	2.04 m² (21.96 sq ft)
Horizontal tail surfaces (total)	3.67 m² (39.50 sq ft)

WEIGHTS AND LOADINGS (A: standard derated engine, B: uprated engines):

Weight empty: A	1,200 kg (2,645 lb)
B	1,400 kg (3,086 lb)
Max T-O weight:	
A (Aerobatic)	2,000 kg (4,409 lb)
A (Normal), B	2,400 kg (5,291 lb)
Max wing loading:	
A (Aerobatic)	147.27 kg/m² (30.18 lb/sq ft)
A (Normal), B	176.73 kg/m² (36.21 lb/sq ft)
Max power loading:	
A (Aerobatic)	337.75 kg/kN (3.31 lb/lb st)
A (Normal), B (TFE109-1)	291.83 kg/kN (2.86 lb/lb st)
A (Normal), B (FJ44)	300.00 kg/kN (2.94 lb/lb st)

PERFORMANCE (estimated at max T-O weight, A and B as above):

Max permissible diving speed:	
A	380 knots (704 km/h; 437 mph)
Never-exceed speed in level flight:	
A	Mach 0.70 (345 knots; 638 km/h; 397 mph)
Max level speed at 4,265 m (14,000 ft):	
A	315 knots (584 km/h; 363 mph)
Normal operating speed:	
A	Mach 0.60 (300 knots; 556 km/h; 345 mph)
Design manoeuvring speed:	
A	210 knots (389 km/h; 242 mph)
Max speed for landing gear extension:	
A	150 knots (278 km/h; 173 mph)
Max speed for flap extension (landing position):	
A	130 knots (241 km/h; 150 mph)
Stalling speed, flaps down:	
A	67 knots (124 km/h; 77 mph)
Max rate of climb at S/L:	
A	975 m (3,200 ft)/min
B	1,219 m (4,000 ft)/min
Service ceiling:	
A	11,280 m (37,000 ft)
B	12,800 m (42,000 ft)
Max operating ceiling (unpressurised):	
A	7,620 m (25,000 ft)
T-O run at S/L, ISA:	
A	366 m (1,200 ft)
B	305 m (1,000 ft)
Landing run at S/L, ISA:	
A	336 m (1,100 ft)
Radius of action with four Mk 81 underwing bombs:	
A	250 nm (463 km; 288 miles)
Ferry range at 6,100 m (20,000 ft), max internal fuel:	
A	1,000 nm (1,850 km; 1,150 miles)
g limits (A):	
sustained, at 3,050 m (10,000 ft)	+2.8
aerobatic	+7/−3.5

CANADAIR

CANADAIR LIMITED, PO Box 6087, Station A, Montreal, Quebec H3C 3G9, Canada

In August 1986, after long deliberation and a detailed market survey, Canadair announced its intention to go ahead with development of a turboprop version of the piston engined CL-215 amphibian, sales of which had reached 111 by that date. Of these, 49 are or will be operated by eight Canadian provincial governments, mainly for firefighting (water bombing) and other aerial spraying roles such as oil slick dispersal and the application of pesticides. The other 62 have been sold to France (15), Greece (15), Italy (4), Spain (19), Thailand (2), Venezuela (2), and Yugoslavia (5). Most of the European CL-215s are used for duties similar to those undertaken throughout Canada, although the Spanish fleet includes eight employed for coastal patrol, search and rescue. The Royal Thai Navy's two aircraft are also employed for SAR and other maritime duties, while the two Venezuelan CL-215s serve as personnel and utility transports.

Deliveries of the piston engined CL-215 began as long ago as 1969, but 41 of the 111 sold have been ordered since the beginning of 1983, and production in 1986 was at the rate of one and a half aircraft per month. Canadair expects to continue building the radial engined version for a few more years, while the turboprop CL-215T is being developed and certificated. The latter will become available in 1989, both as a new-build aircraft and in the form of retrofit kits for existing operators. The company believes that the well proven strength and reliability of the basic airframe (for which US designer Ed Heinemann was design consultant), allied to the performance improvements conferred by turboprop power, offer the best possible solution for the tasks that the aircraft was designed to perform. Firefighting/aerial spraying are still expected to head this list and account for some 42 per cent of CL-215T sales, but a larger share of the potential market is envisaged for various maritime versions (35 per cent, including surveillance, ASV/ASW coastal defence, SAR, and customs/immigration patrol), and for civil or military personnel or utility transport versions (23 per cent). Scope for more widespread use of aircraft like the CL-215T could be enhanced by parallel development of small

Standard piston engined Canadair CL-215 demonstrating its water bombing capability

shoreline operating bases ('amphiports') and a water based air traffic control system.

CANADAIR CL-215T

The CL-215T will, in essence, continue to utilise the well proven basic airframe of the piston engined CL-215, with a number of improvements. It will also offer a choice of Pratt & Whitney Canada engines, both variants of the PW120. The PW100/47, with a take-off rating of 1,491 kW (2,000 shp), is expected to meet the requirements of most potential operators in Canada and Europe. For 'hot and high' applications in such areas as Asia and Latin America, the PW100/37 will offer the same level of power at temperatures up to 50°C.

Other standard improvements will include an upgraded and air-conditioned flight deck, a new fuel system with both pressure and gravity refuelling, nosewheel steering (on new-build aircraft only), and a choice of drop patterns for firefighting missions. An extensive list of options will be available for specialised applications, including underwing hardpoints. Various military and commercial versions have been defined, including variants equipped with airborne radar and for night firefighting and maritime operations.

Canadair will begin modifying two CL-215s as CL-215T prototypes in July and September 1987, with a first flight planned for May 1988, followed by certification in March 1989 with the PW100/47 and September 1989 with the PW100/37. Retrofit kits will become available first, in February 1989, followed by new-production CL-215Ts two months later. At the time of the initial press briefing in September 1986, three potential launch customers had been identified, and orders for "upwards of 24" aircraft were said to be required to substantiate a production commitment. Co-production or licence manufacture agreements are open for negotiation.

TYPE: Twin-turboprop multi-purpose amphibian.

WINGS: Cantilever high-wing monoplane. No dihedral. All-metal one-piece fail-safe structure, with front and rear spars at 16 and 49 per cent chord. Spars of conventional construction, with extruded caps and webs stiffened by vertical members. Aluminium alloy skin, with riveted spanwise extruded stringers, is supported at 762 mm (30 in) pitch by interspar ribs. Leading-edge consists of aluminium alloy skin attached to pressed nose-ribs and spanwise stringers. Detachable glassfibre wingtips. Hydraulically operated all-metal single-slotted flaps, supported by four external hinges on interspar ribs on each wing. Trim tab and geared tab in port aileron, rudder/aileron interconnect tab in starboard aileron. Powered ailerons, and ice protection system for leading-edges, optional.

FUSELAGE: All-metal single-step flying-boat hull of conventional fail-safe construction.

TAIL UNIT: Cantilever all-metal fail-safe structure with horizontal surfaces mounted midway up fin. Structure of aluminium alloy sheet, honeycomb panels, extrusions, and fittings. Elevators and rudder fitted with dynamic balance, trim tab (port elevator only), spring tabs, and geared tabs. Provision for de-icing of leading-edges.

LANDING GEAR: Hydraulically retractable tricycle type. Fully castoring, self-centring twin-wheel nose unit (steerable on new-build CL-215T) retracts rearward into hull and is fully enclosed by doors. Main gear support structures retract into wells in sides of hull. A plate mounted on each main gear assembly encloses bottom of wheel well. Hydraulic disc brakes. Non-retractable stabilising floats are each carried on a pylon cantilevered from wing box structure, with breakaway provision.

POWER PLANT: Two 1,491 kW (2,000 shp) Pratt & Whitney Canada PW100/47 or PW100/37 (PW123) turboprop engines, each driving a Hamilton Standard 14SF four-blade constant-speed fully-feathering reversible-pitch propeller with spinner. Two fuel tanks, each of eight identical flexible cells, in wing spar box, with total usable capacity of 5,910 litres (1,300 Imp gallons; 1,561 US gallons). Single-point pressure refuelling, plus gravity point above each tank. Provision for carrying two 1,136 litre (250 Imp gallon; 300 US gallon) auxiliary fuel tanks on underwing pylons. Oil in two tanks, aft of engine firewalls.

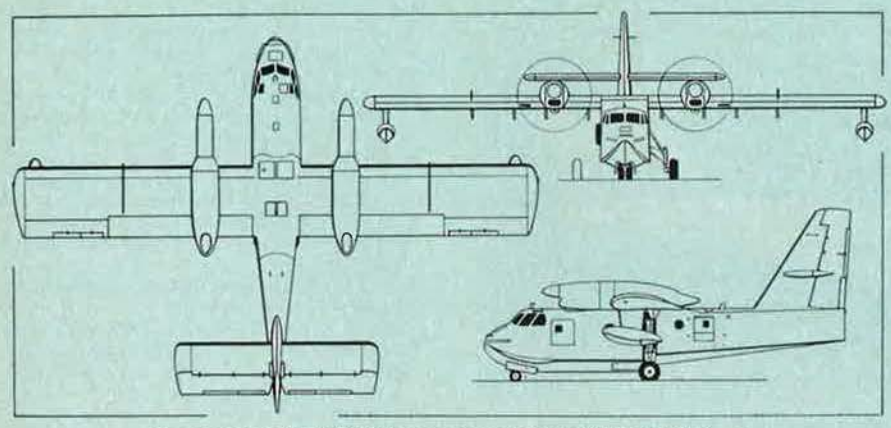
ACCOMMODATION: Normal crew of two side by side on flight deck, with dual controls. Additional stations in maritime patrol/SAR versions for flight engineer, navigator, and two observers. For water bomber cabin installation, see under 'Equipment' paragraph. With water tanks removed, transport configurations can include shuttle layout for 35 passenger seats plus toilet; or standard layout for 32 passengers plus toilet, galley, and baggage area, both with seat pitch of 79 cm (31 in). Combi layout offers cargo at front, full firefighting capability, plus 11 seats at rear. Other quick-change interiors available for medevac (12 stretchers and two medical attendants), utility/paratroop (up to 14 foldup troop-type canvas seats in cabin, in two inward facing rows), all-cargo, or other special missions according to customer's requirements. Flush doors to main cabin on port side of fuselage forward and aft of wings. Emergency exit on starboard side aft of wing trailing-edge. Crew emergency hatch in flight deck roof on starboard side. Mooring hatch in upper surface of nose. Large cargo loading door optional; provision for additional cabin windows.

SYSTEMS: Flight deck air-conditioning standard; cabin heating and air-conditioning optional. Hydraulic system, pressure 207 bars (3,000 lb/sq in), utilises two engine driven pumps to actuate landing gear, flaps, water drop doors, water pickup probes, and wheel brakes. Unpressurised air/oil reservoir. Electrically driven third pump provides hydraulic power for emergency actuation of landing gear, brakes, and closure of water doors. Electrical system includes two 400VA 115V 400Hz static inverters (800VA in SAR version), two 200A 28V DC engine driven generators, two 40Ah nickel-cadmium batteries, and an engine driven GPU. Ice protection system optional.

Spain uses its CL-215s for coastal patrol, search and rescue

AVIONICS: Assumed to be generally similar to CL-215, in which standard installation includes dual VHF transceivers, single VHF/FM com, dual VOR/ILS receivers, dual ADF, two marker beacon receivers, ATC transponder, and ELT, with options including HF com, DME, and radio altimeter. Stated options for CL-215T include autopilot, VLF/Omega nav system, search radar, and colour weather radar.

EQUIPMENT (water bomber): Two 2,673 litre (588 Imp gallon; 706 US gallon) water tanks in main fuselage compartment, near CG, forward of which are eight inward facing seats. (Feasibility study in progress to increase water tank capacity by up to 25 per cent.) Hydraulically actuated scoop on each side, aft of hull step, fillable also on ground by hose adaptor on each side of fuselage. Independently openable water drop door in each side of hull bottom. Improved drop pattern and drop door sequencing compared with CL-215. Optional spray kit can be coupled with firefighting tanks for large scale spraying of oil dispersants and insecticides. In a typical mission profile, with a fire 100 nm (185 km; 115 miles) from



The Canadair CL-215T turboprop-powered amphibian *(Pilot Press)*

the CL-215T's base, a water source 6 nm (11 km; 7 miles) from the fire, and 45 min fuel reserves, the aircraft could make 35 water scoop and drop circuits before having to return to base to refuel. Water tanks can be scoop-filled completely (on smooth water in ISA conditions) in an on-water distance of only 564 m (1,850 ft); partial water loads can be scooped on smaller bodies of water. Minimum safe water depth for scooping operations is only 1.40 m (4 ft 7 in).

EQUIPMENT (other versions): Stretcher kits, passenger or troop seats, cargo tiedowns, searchlight, and other equipment according to mission and customer requirements. Provision for two underwing pylon attachment points for auxiliary fuel tanks or other stores.

DIMENSIONS, EXTERNAL:

Wing span	28.60 m (93 ft 10 in)
Wing chord, constant	3.54 m (11 ft 7½ in)
Wing aspect ratio	8.15
Length overall	19.94 m (65 ft 5 in)
Beam	2.59 m (8 ft 6 in)
Length/beam ratio	7.5
Height overall: on land	8.99 m (29 ft 6 in)
on water	6.88 m (22 ft 7 in)
Draught: wheels up	1.12 m (3 ft 8 in)
wheels down	2.03 m (6 ft 8 in)
Tailplane span	10.97 m (36 ft 0 in)
Wheel track	5.28 m (17 ft 4 in)
Wheelbase	7.23 m (23 ft 9 in)
Propeller diameter	3.96 m (13 ft 0 in)
Propeller/water clearance	0.99 m (3 ft 3 in)
Forward door: Height*	1.37 m (4 ft 6 in)
Width	1.03 m (3 ft 4 in)
Height to sill	1.68 m (5 ft 6 in)
Rear door: Height	1.12 m (3 ft 8 in)
Width	1.03 m (3 ft 4 in)
Height to sill	1.83 m (6 ft 0 in)
Water drop doors, each:	
Length	1.60 m (5 ft 3 in)
Width	0.81 m (2 ft 8 in)
Emergency exit: Height	0.91 m (3 ft 0 in)
Width	0 51 m (1 ft 8 in)

DIMENSIONS, INTERNAL:

Cabin, excl flight deck:	
Length	9.40 m (30 ft 10 in)
Max width	2.39 m (7 ft 10 in)
Max height	1.90 m (6 ft 3 in)
Floor area	19.69 m² (212.0 sq ft)
Volume	35.59 m³ (1,257.0 cu ft)

AREAS:

Wings, gross	100.33 m² (1,080.0 sq ft)
Ailerons (total, incl tabs)	8.05 m² (86.6 sq ft)
Trailing-edge flaps	22.39 m² (241.0 sq ft)
Fin	11.22 m² (120.75 sq ft)
Rudder, incl tabs	6.02 m² (64.75 sq ft)
Tailplane	20.55 m² (221.2 sq ft)
Elevators (total, incl tabs)	7.88 m² (84.8 sq ft)

WEIGHTS AND LOADINGS (A: water bomber, land based; B: utility, land or water based):

Manufacturer's weight empty:	
A, B	10,977 kg (24,200 lb)
Typical operating weight empty:	
A, B	11,158 kg (24,600 lb)
Max internal fuel weight:	
A, B	4,817 kg (10,620 lb)
Max payload: A	5,443 kg (12,000 lb)
B	5,352 kg (11,800 lb)
Max ramp weight: A	19,731 kg (43,500 lb)
B	17,236 kg (38,000 lb)
Max T-O weight:	
A, B (land)	19,731 kg (43,500 lb)
B (water)	17,100 kg (37,700 lb)
Max flying weight (A):	
before scooping	15,195 kg (33,500 lb)
after scooping	19,731 kg (43,500 lb)
Max landing weight:	
A, B	16,783 kg (37,000 lb)
Max zero-fuel weight:	
A	18,597 kg (41,000 lb)
B	16,511 kg (36,400 lb)
Max cabin floor loading:	
A, B	732 kg/m² (150 lb/sq ft)
Max wing loading:	
A	196.55 kg/m² (40.28 lb/sq ft)
B	170.35 kg/m² (34.91 lb/sq ft)
Max power loading:	
A	6.62 kg/kW (10.87 lb/shp)
B	5.74 kg/kW (9.42 lb/shp)

PERFORMANCE (estimated at weights shown; ISA conditions except where indicated):

Cruising speed at 3,050 m (10,000 ft):	
at 16,329 kg (36,000 lb), max cruise power	188 knots (348 km/h; 216 mph)
at 18,144 kg (40,000 lb), max recommended power	184 knots (341 km/h; 212 mph)
at 16,329 kg (36,000 lb), normal cruise power	175 knots (324 km/h; 201 mph)
at 16,329 kg (36,000 lb), long-range cruise power	167 knots (309 km/h; 192 mph)
Patrol speed at S/L, at 16,329 kg (36,000 lb)	115 knots (213 km/h; 132 mph)
Stalling speed at S/L at max landing weight, 25° flap, power off	69 knots (128 km/h; 80 mph)
Max rate of climb at S/L (15°C) at 19,731 kg (43,500 lb), max climb power, 15° flap:	
PW100/47	254 m (832 ft)/min
PW100/37	338 m (1,108 ft)/min
Rate of climb at S/L, one engine out, at 14,288 kg (31,500 lb), T-O power	113 m (370 ft)/min
Service ceiling at 19,731 kg (43,500 lb)	6,100 m (20,000 ft)
Service ceiling, one engine out, at 16,329 kg (36,000 lb):	
PW100/47	4,300 m (14,100 ft)
PW100/37	4,850 m (15,900 ft)
Runway bearing requirements at max land T-O weight:	
CBR	6
LCN	18.5
T-O to 10.7 m (35 ft) at S/L:	
at max land T-O weight	778 m (2,550 ft)
at max T-O weight on water	775 m (2,540 ft)
Landing from 15 m (50 ft) at S/L, at max landing weight:	
on land	768 m (2,520 ft)
on water	835 m (2,740 ft)
Typical SAR mission	Fly 45 min search pattern at low level, 540 nm (1,000 km; 621 miles) from base, land to pick up 11 survivors, T-O and return to base at max cruising speed
Range with 1,814 kg (4,000 lb) payload at long-range cruise power	1,150 nm (2,131 km; 1,324 miles)
Maritime patrol endurance at 200 nm (370 km; 230 miles) from base	6 h
Design *g* limits	+3.25/−1

**incl 25 cm (10 in) removable sill*

AEROTEC

AEROTEC S/A INDUSTRIA AERONAUTICA, Caixa Postal 286, 12200 São José dos Campos, SP, Brazil

AEROTEC A-135 TANGARÁ II

The original A-132 Tangará (see 1983–84 *Jane's*) was developed in the late 1970s as a potential replacement for the Brazilian Air Force's T-23 Uirapuru primary trainer, and was based largely on the airframe of the latter aircraft. Powered by a 119 kW (160 hp) Avco Lycoming O-320-B2B flat-four engine driving a two-blade fixed-pitch propeller, the A-132 featured side by side seating for trainee and instructor and made its first flight on 26 February 1981.

The A-132 had completed its basic CTA flight test programme by the Spring of 1982, at which time it was reportedly planned to refit the aircraft with a 149 kW (200 hp) engine. Nothing more had been heard of this proposal until October 1986, when Aerotec exhibited a full size mockup of the A-135

Mockup of Aerotec Tangará II two-seat primary trainer *(Mario B. M. Vinagre)*

The lengthened fuselage of the Antonov An-74, compared with the An-72, is evident in this view *(Paul R. Duffy)*

Tangará II at a defence and aerospace display in São José dos Campos. Apart from the more powerful engine, major changes from the A-132 version include wings of increased span and area, and relocation of the seats in tandem configuration under a single elongated bubble canopy.

The Tangará II, which would be fully aerobatic, is designed for pilot training, liaison, observation, and glider towing duties, with the ability to operate from unprepared airstrips.

TYPE: Two-seat primary trainer and multi-purpose light aircraft.

WINGS: Cantilever low-wing monoplane of constant chord, with sweptforward roots. Wing section NACA 2415. Dihedral 7° from roots. Light alloy structure, with all-metal ailerons and trailing-edge split flaps.

FUSELAGE: All-metal semi-monocoque structure, of mostly aluminium alloy construction.

TAIL UNIT: Cantilever metal structure, with swept-back vertical and non-swept horizontal surfaces. Ground adjustable tab on rudder; trim tab in starboard half of one-piece balanced elevator.

LANDING GEAR: Non-retractable tricycle type, with steerable nosewheel. Shock absorption in all units. Small fairings on mainwheel legs. Disc brakes on main units.

POWER PLANT: One 149 kW (200 hp) Avco Lycoming AEIO-360-A1B6 flat-four engine, driving a three-blade constant-speed propeller with spinner. Fuel tank in each wing leading-edge, immediately outboard of root fillet.

ACCOMMODATION: Two fully adjustable seats in tandem under one-piece rearward sliding bubble canopy. One-piece wraparound windscreen. Dual controls standard. Baggage space aft of rear seat.

DIMENSIONS, EXTERNAL:

Wing span	9.636 m (31 ft 7½ in)
Wing aspect ratio	6.34
Length overall	7.90 m (25 ft 11 in)
Height overall	2.70 m (8 ft 10¼ in)

DIMENSION, INTERNAL:

Cockpit: Max width	0.80 m (2 ft 7½ in)

AREAS:

Wings, gross	14.65 m² (157.7 sq ft)
Ailerons (total)	1.14 m² (12.27 sq ft)
Trailing-edge flaps (total)	1.78 m² (19.16 sq ft)
Fin	0.75 m² (8.07 sq ft)
Rudder, incl tab	0.54 m² (5.81 sq ft)
Tailplane	1.71 m² (18.41 sq ft)
Elevator, incl tab	1.11 m² (11.95 sq ft)

WEIGHTS AND LOADINGS:

Weight empty	660 kg (1,455 lb)
Max T-O weight (Aerobatic category)	960 kg (2,116 lb)
Max wing loading (Aerobatic category)	65.53 kg/m² (13.43 lb/sq ft)
Max power loading (Aerobatic category)	6.44 kg/kW (10.58 lb/hp)

PERFORMANCE (estimated at max Aerobatic T-O weight):

Max level speed	136 knots (252 km/h; 156 mph)
Max cruising speed	120 knots (222 km/h; 138 mph)
Econ cruising speed	110 knots (204 km/h; 127 mph)
Stalling speed:	
flaps up	55 knots (101 km/h; 63 mph)
flaps down	48 knots (89 km/h; 56 mph)
Max rate of climb at S/L	427 m (1,400 ft)/min
Service ceiling	6,100 m (20,000 ft)
T-O run	270 m (886 ft)
Landing run	160 m (525 ft)
Range with max fuel	432 nm (800 km; 497 miles)
Endurance with max fuel	4 h

ANTONOV

OLEG K. ANTONOV DESIGN BUREAU, Kiev, Ukraine, USSR

ANTONOV An-74

In February 1984 the Soviet newspaper *Pravda* referred to a new Soviet transport aircraft, designated An-74, which had been built for operation in the Arctic and Antarctic regions. It stated that, unlike the Il-18D turboprop transports used to carry men and equipment between Leningrad and the Antarctic base of Molodejnaya, the An-74 can have a wheel-ski landing gear for operation on snow and ice landing strips. It was described as an all-weather aircraft, equipped with the latest available navigation aids, and with de-icing equipment on the wings, tail unit, and engine air intakes. In the polar regions, its duties will include assistance in setting up scientific stations on Arctic ice floes, airdropping supplies to motorised trans-Antarctic expeditions, and reconnaissance to observe changes in the icefields. It was assumed to be a development of the An-72 (described in the 1986–87 and previous editions of *Jane's*). This was confirmed on 28 July 1986, when an An-74 (SSSR-58642, c/n 0202) made its first appearance in the West, at Shannon Airport, Ireland, en route to the Expo 86 exhibition in Vancouver, Canada. Major changes by comparison with the An-72 are as follows:

WINGS: The span has been extended considerably, with two new tapered outer panels displaying reduced leading-edge sweepback and modest trailing-edge sweepback. Leading-edge flaps on inner wing panels only. Multi-slotted trailing-edge flaps for STOL operation, as An-72.

FUSELAGE: This is lengthened, both forward and aft of the wings, but is otherwise generally similar to that of An-72.

TAIL UNIT AND LANDING GEAR: Generally as for An-72. Wheel-skis optional.

POWER PLANT: Two 63.74 kN (14,330 lb st) Lotarev D-36 high bypass ratio turbofan engines mounted above and forward of wings, as An-72. Large deflector doors on each side at the rear of each engine nacelle have been eliminated, as expected.

ACCOMMODATION: Crew of four, comprising pilot, co-pilot, navigator, and engineer. Lengthened cabin. Large downward hinged and forward sliding rear ramp-door as on An-72. Mobile winch and provision for roller conveyors on floor. Able to carry eight passengers in combi role, in two rows of seats, with tables, and with two bunks installed, one on each side of cabin aft of seats. Bulged observation windows on port side for navigator and hydrologist. Provision for wardrobe and galley. Movable bulkhead between passenger and freight compartments. Freight can be air-dropped.

DIMENSIONS, EXTERNAL:

Wing span	31.89 m (104 ft 7½ in)
Length overall	28.07 m (92 ft 1¼ in)
Height overall	8.65 m (28 ft 4½ in)

DIMENSIONS, INTERNAL:

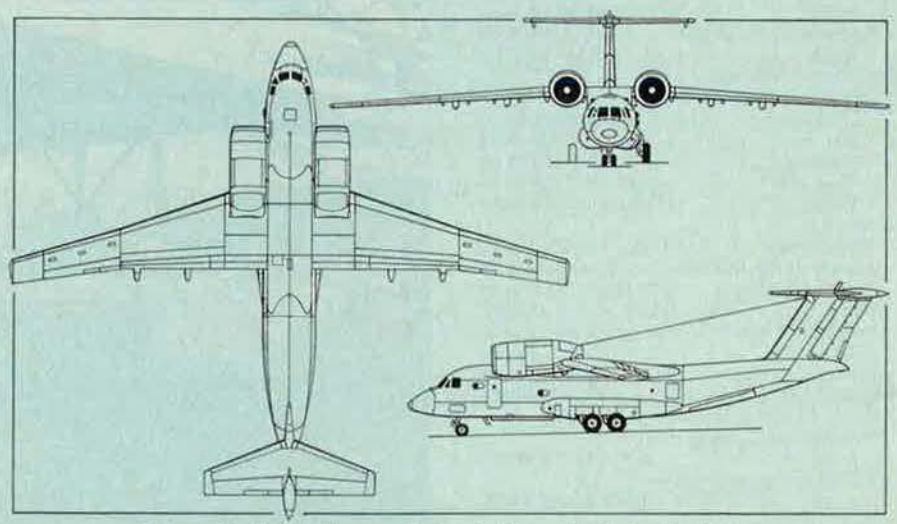
Cabin: Length	10.50 m (34 ft 5¼ in)
Width at floor level	2.15 m (7 ft 0½ in)
Height	2.20 m (7 ft 2½ in)

WEIGHTS:

Max payload: Normal	10,000 kg (22,045 lb)
Max T-O weight, from 1,800 m (5,905 ft) runway	34,500 kg (76,060 lb)

PERFORMANCE:

Max level speed	380 knots (705 km/h; 438 mph)
Normal cruising speed at 8,000–10,000 m (26,250–32,800 ft)	297 knots (550 km/h; 342 mph)
Service ceiling	10,500 m (34,450 ft)
Range with 1,500 kg (3,307 lb) payload and 2 h reserves	2,430 nm (4,500 km; 2,796 miles)
Range, cargo version, with 1 h reserves:	
with 10,000 kg (22,045 lb) payload	620 nm (1,150 km; 715 miles)
with 5,000 kg (11,023 lb) payload	1,781 nm (3,300 km; 2,050 miles)
with max fuel and 2,300 kg (5,070 lb) payload	2,537 nm (4,700 km; 2,920 miles)



Antonov An-74 (two Lotarev D-36 turbofan engines) *(Jane's/Mike Keep)*

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AIRMAN'S BOOKSHELF

The Airpower Part

Naval Air Power, by Michael Taylor. An Arco Aviation Book published by Prentice-Hall Press, New York, N. Y., 1986. 192 pages with illustrations and index. $19.95.

The US Navy is embarking on new shipbuilding programs in response to the buildup of Soviet naval forces and the requirements of US military strategy. The Navy's long-term goal is a 600-ship force. Carriers make up a significant part of that force. Eight aircraft carriers will be upgraded to lengthen their operational life, and new flattops will be added to the fleet.

New ships are enormously expensive, however, and much time is needed to design and build them. Critics have claimed that aircraft carriers cost too much and amount to little more than sitting ducks for modern weapons.

Carriers proved their worth decisively during World War II. More recently, carrier operations by the Royal Navy during the Falklands conflict and various deployments and strikes by US carrier forces in the Mediterranean have reaffirmed the great utility of the aircraft carrier. Despite the objections of critics, the White House and Congress appear inclined to remain steadfast in their support of the large carrier battle group, and it seems destined to remain a significant part of the US military arsenal.

Understanding why aircraft carriers are considered such an important part of modern maritime forces is what *Naval Air Power* is all about. This book provides a comprehensive look at the airpower part of seapower.

Ships and airplanes first got together when Eugene Ely took off from the USS *Birmingham* on November 14, 1910. A few months later, Ely landed on and then took off from the USS *Pennsylvania* anchored in San Francisco Bay. When Ely alighted on the *Pennsylvania,* Capt. C. F. Pond is said to have remarked, "This is the most important landing of a bird since the dove flew back to the Ark."

Ships built or converted to carry airplanes date from 1912, when the French Navy converted the torpedo boat *Foudre* to carry seaplanes. The HMS *Furious,* intended originally as a battle cruiser, was the first warship to be built as an aircraft carrier. It became the longest-serving carrier in history, not being scrapped until 1949.

Following World War II, many naval planners assumed that the era of large capital ships—such as battle cruisers and aircraft carriers—was over. The submarine was expected to rule the waves. That view is not so widely held today.

Despite the submarine threat, the aircraft carrier remains a powerful element of force projection. During the 1982 Falklands conflict, for instance, Britain used its carriers to help control the sea around the islands and to bring airpower to bear on ground targets.

While it is apparent that aircraft carriers can project power swiftly, they are also a crucial element in antisubmarine warfare (ASW), the author points out, threatening the very forces that had once promised to render them obsolete. Mr. Taylor details the contribution of naval airpower in countering the submarine threat, describing the various types of aircraft, radar, and electronic sensors used for ASW. He concludes that airborne surveillance and strike systems will continue to be effective in dealing with the burgeoning submarine threat.

The Soviet Union seems not to harbor any illusions about the usefulness or survivability of carrier forces, the author notes. The Soviets are now building large carriers, and the Soviet Navy has recently begun practicing carrier battle group tactics. According to Mr. Taylor, these Soviet developments presage a major change in the maritime balance of power.

The aircraft carrier, according to the author, makes possible the flexible and sustained application of airpower because of its ability to go anywhere in the world with awesome strike capability and to remain on station for months at a time. A modern aircraft carrier provides a fully self-sustaining and mobile air base that can prove invaluable as an expression of political will during times of tension. Used in conjunction with land-based airpower, naval airpower can be a most effective way of locating, tracking, and countering subsurface and air threats.

Aircraft carrier battle groups, however, have some disadvantages as well. As Mr. Taylor writes, "The flip side of the coin is that they are prime targets for an enemy."

This book delves into the gritty details of operating an air force at sea. For example, the reader will find excellent descriptions of jamming and offensive and defensive air combat maneuvers—the hook, the defensive split, the vector roll, the scissors, and the sandwich. It also examines the twelve force multipliers that greatly increase the effectiveness of fleet fighters, with particular attention to airborne early warning aircraft. Naval air armament and the impact of V/STOL aircraft are also covered.

A remarkable selection of more than 200 illustrations complements the text. Of special merit are the cutaway drawings of such significant naval aircraft as the Curtiss SB2C-4 Helldiver, the Tupolev Tu-142 Bear-D, the Dassault-Breguet Super Etendard, and the British Aerospace Harrier jump jet.

Michael Taylor is well qualified to explain the subject of naval airpower. An internationally known aviation author, he is a contributor to *Jane's All the World's Aircraft,* edits the annual *Jane's Aviation Review,* and has more than fifty books to his credit.

Written and organized for easy access, *Naval Air Power* is a comprehensive sourcebook on the history, hardware, tactics, and strategy of naval air operations. It will appeal to the serious student of naval airpower—and to airpower enthusiasts in general.

—Reviewed by Maj. Michael B. Perini, USAF. Major Perini is a student at the Armed Forces Staff College in Norfolk, Va., and a frequent writer for this magazine.

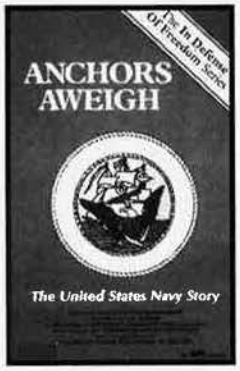
MILITARY HERITAGE ON VIDEO

Lowel Thomas Remembers: *America* The War Years #1

America: The War Years #1—Narrated by Lowel Thomas, this film examines the World War II from 1941 - 1943. The sights and sounds of war as well as the sights and sounds of back home are brilliantly documented.
RH 7929 $29.95

Vietnam: The Secret Agent—This film is the first comprehensive look at the history, the effects, and the implications of the deadly containment 2, 4, 5-T —a main ingredient of the defoliant code-named Agent Orange during the Vietnam War.
MP 1352 Color 56 min.
Not Rated $29.95

Heritage of Glory — The United States Marine Corps Story—The events of both world wars has shown the Marine Corps to be a proud and inspirational part of our armed forces. The footage is real and the action dramatic, which makes this the definitive program for followers of the Marines.
MP 1183 Color 45 min.
Not Rated $29.95

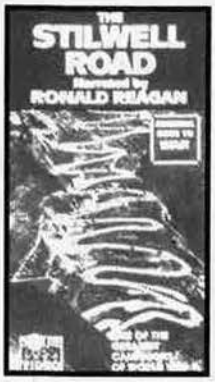


Anchors Aweigh—The United States Navy Story—From its birth more than two centuries ago to its accomplishments in Vietnam, the Navy has been a force to be reckoned with. There's plenty of action in this historical account that will keep both history buffs and lovers of action happy.
MP 1182 Color 45 min.
Not Rated $29.95

The Wild Blue Yonder—The United States Air Force Story—The story of the American "Flyboys" from the first warplane in 1909 is vividly told in this fascinating program. Real "dogfights" from WWI and WWII, precision bombing, the Enola Gay, and the jet age is all shown with rare footage. A definite collectible.
MP 1184 Color 45 min.
Not Rated $29.95

The Nazi Strike—The Nazis conquer Austria and Czechoslovakia, and invade Poland. Hope is finally abandoned for "peace in our time."
MP 1073 B/W 41 min.
Not Rated $19.95

Patton—Old Blood and Guts—Gain an insight into one of America's greatest military minds with this entertaining and insightful biography. General George S. Patton was a multifaceted man: gruff, abusive, hard driving, brilliant, ambitious, erudite, and compelling. Ronald Reagan narrates Patton's rise from West Point cadet to one of America's greatest warriors.
MP 1355 B/W 25 min.
Not Rated $19.95



Stilwell Road—The U.S. Army fought the Japanese, Mountains, and Jungles in Burma in WWII. This film captures the heroism and struggle to paving the way to victory. Narrated by Ronald Reagan.
RH 7785 $19.95

The Negro Soldier—World War II was the first war that featured an entirely integrated army. This is the history of how blacks have served in the armed forces from 1776 through 1944.
RH 7442 B/W 42 min.
Not Rated $19.95

Vietnam—Time of the Locust—This award-winning compilation on the Vietnam War utilizes footage from numerous sources, including suppressed footage shot by Japanese television, to produce a powerful anti-war statement.
MP 1326 B/W 45 min.
Not Rated $29.95

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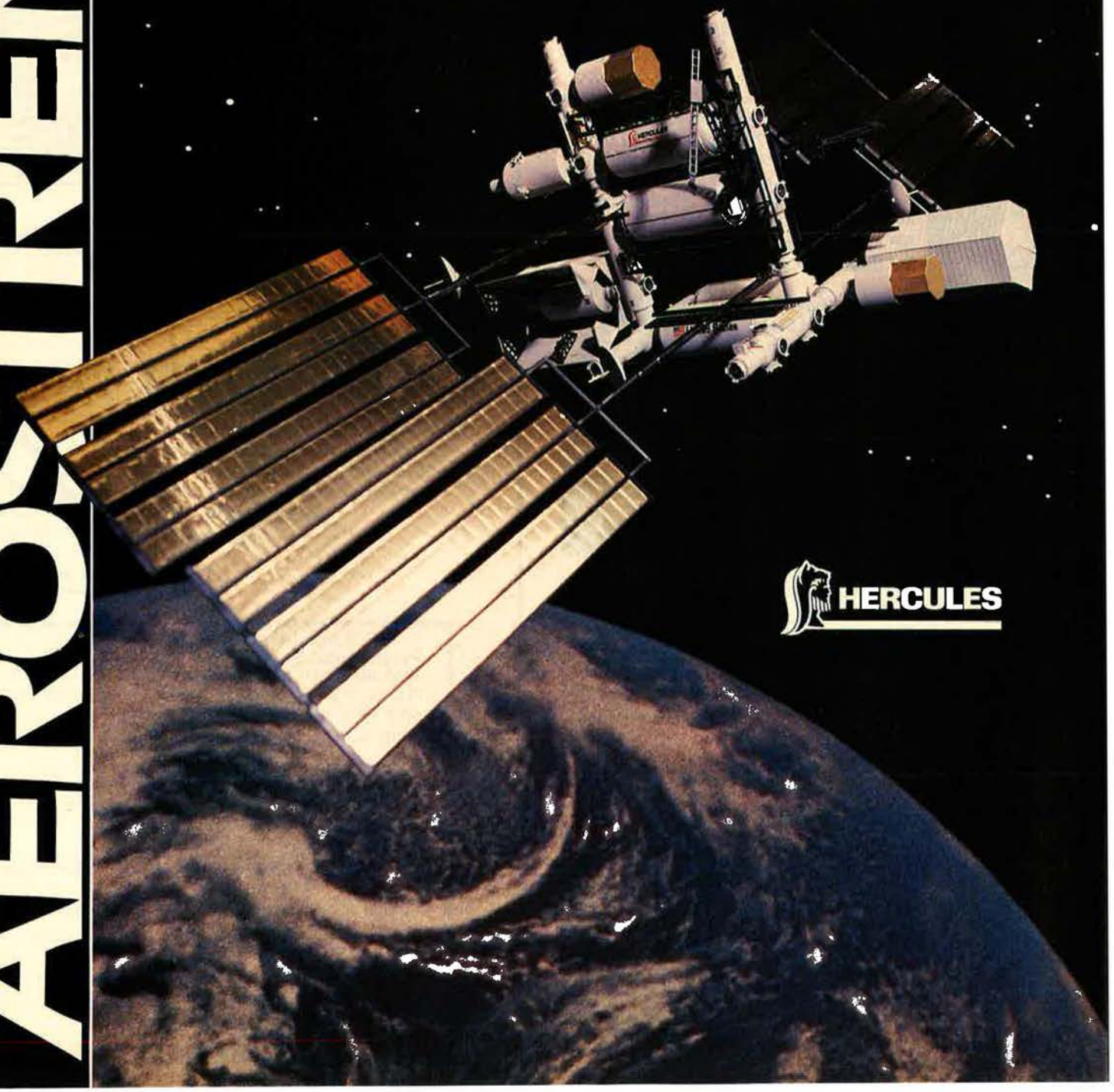


HERCULES

The Pinnacle of Professionalism

Col. Ralph Parr's unique combination of achievements spans three wars and 8,000 hours of fighter time.

BY JOHN L. FRISBEE
CONTRIBUTING EDITOR

THE Distinguished Service Cross and its successor, the Air Force Cross, rank second to the Medal of Honor as decorations for valor in combat. Only one man, Col. Ralph S. Parr, has been awarded both medals.

Ralph Parr's combat career began as a P-38 pilot in the Pacific in the closing weeks of World War II. In 1950, while flying F-86s in the States, he was picked to be one of the first pilots sent to Korea to fly F-80s with the 49th Fighter Bomber Wing. On that tour, Lieutenant Parr flew 165 combat missions against close-support and interdiction targets.

After more than a year in the States developing new air-to-air tactics for jet fighters, then-Captain Parr wangled a second tour in Korea, flying F-86s with the 4th Fighter Interceptor Wing. In forty-seven missions during a remarkable seven weeks at the end of the war, he earned the Silver Star and the Distinguished Service Cross and downed ten enemy aircraft, including the last Communist plane shot down over Korea, an Il-12 transport apparently far off course.

Parr's DSC was awarded for a mission on June 30, 1953. He and his wingman, Lt. Al Cox, were attacked by ten MiG-15s. Captain Parr shot down two MiGs and was maneuvering for his third kill when a call for help came from his wing commander, Col. James Johnson, whose F-86 had flamed out after swallowing debris from a MiG he had downed and who was under attack by several other MiGs. Though low on fuel, Captain Parr found his boss, drove off the attackers, giving Colonel Johnson time to restart his engine, and escorted him back to base.

Ralph Parr, who racked up a grand total of 641 missions in three wars.

In the interim between our "limited wars" in Asia, Ralph Parr's career continued to center on fighters. He was one of the first instructors in F-4s and, in the fall of 1967, was named Operations Officer of the 12th TFW in Vietnam. Before that tour ended, he had logged 226 combat missions, the most memorable on March 16, 1968, when he was awarded the Air Force Cross for extraordinary valor during the siege of Khe Sanh.

On that day, Colonel Parr and his backseater, Capt. Tom McManus, "a very gutty guy," were flying one of two F-4s fragged to escort C-130s that were resupplying the Marines at Khe Sanh. As they approached the rendezvous point, a FAC, Fingerprint 54, diverted the flight to attack two mortar positions within seventy meters of friendly forces. Only napalm, which Colonel Parr carried, could be used, and there was but one possible run-in heading, dictated by terrain, poor visibility, and troop locations.

The second F-4 held at a higher altitude while Colonel Parr destroyed both mortar positions in two runs, releasing at absolute minimum altitude. On the second run, six well-camouflaged heavy automatic weapons—five of them quad mounts—that were sited to destroy departing cargo aircraft opened fire, severely damaging Parr's F-4. The fire from the twenty-two 14.5-mm guns was described by the FAC as "unbelievably intense."

Nevertheless, Colonel Parr decided to continue the strike until his ordnance was expended. With two napalm runs and four 20-mm cannon passes—all on the same restricted run-in—he destroyed five of the automatic weapons and silenced the sixth.

Visibility had now become extremely poor, and there still was heavy small-arms fire from enemy troops a few meters from the landing strip. Judging that it was not safe for three aircraft to operate in those conditions, Colonel Parr asked the slow-moving FAC "to back off a bit" so he could call troop targets for the second F-4. After that, the route was clear for C-130s departing the Khe Sanh strip.

Fingerprint 54 later reported that he had never seen such aggressiveness and courage in the face of such intense fire. The Marines whom Colonel Parr had defended called his bravery and skill "the pinnacle of aerial professionalism."

Two years later, Ralph Parr returned to Vietnam for a second tour, this time as commander of the 12th TFW, flying 201 more combat sorties for a grand total of 641 missions in three wars. That may well be an Air Force record to add to Colonel Parr's array of some sixty US and foreign decorations.

In 1976, Ralph Parr was retired for physical disability after suffering a serious back injury while inspecting hurricane damage to a roof at Eglin AFB, Fla. "You'd think," he says, "I could have picked a more graceful way to depart the military."

It's not the leaving, but the doing that counts. Colonel Parr may have hung up his blue suit, but his achievements in five combat tours remain a shining symbol in the annals of Air Force valor. ■

Announced at the annual Air Force Ball . . .

1986 SCAMP Scholarship Winners

An annual highlight of AFA activities in southern California is the Air Force Ball that through the years has raised thousands of dollars for AFA's Aerospace Education Foundation and SCAMP (Scholarships for Children of American Military Personnel). This year, at the fifteenth annual Ball in October, six scholarship awards went to these SCAMP recipients:

- **James S. Crittenberger,** McLean, Va., son of Army Col. Dale J. Crittenberger, who was killed in action in 1969.
- **Glyn C. Griffin,** Alexandria, Va., daughter of Navy Cmdr. James L. Griffin, MIA in 1967.
- **Beverly E. Kuykendall,** Boulder, Colo., daughter of Lt. Col. Robert M. Brown, USAF, MIA in 1972 and presumed killed but subsequently returned to the US.
- **Thomas R. Latendresse,** Walnut Creek, Calif., son of Navy Ens. Thomas B. Latendresse, POW from 1972–73.
- **Kristen Panek,** Joliet, Ill., daughter of Lt. Col. Robert J. Panek, USAF, MIA in 1970 and presumed killed but subsequenty returned to the US.
- **Laura K. Vinson,** Annapolis, Md., daughter of Col. Bobby G. Vinson, USAF, MIA in 1968.

—THE EDITORS

Several SCAMP scholarship recipients attended the Air Force Ball last October. Pictured above are (from left) Air Force Secretary Edward C. Aldridge, Jr., Kristen Panek, James S. Crittenberger, Thomas R. Latendresse, Beverly E. Kuykendall, USAF Chief of Staff Gen. Larry Welch, and SCAMP President Ed Stearn.

The Ball attracted a crowd of distinguished guests. Pictured above with Aerospace Education Foundation President Dr. Eleanor P. Wynne is former astronaut Col. Edwin E. "Buzz" Aldrin.

During the Air Force Ball, AFA National President Sam E. Keith, Jr., paused to chat with the Ball's military cohosts, Lt. Gen. James E. Light, Jr., left, and Lt. Gen. Aloysius G. Casey, right.

AFA INTERCOM

By Robin Whittle, AFA DIRECTOR OF COMMUNICATIONS

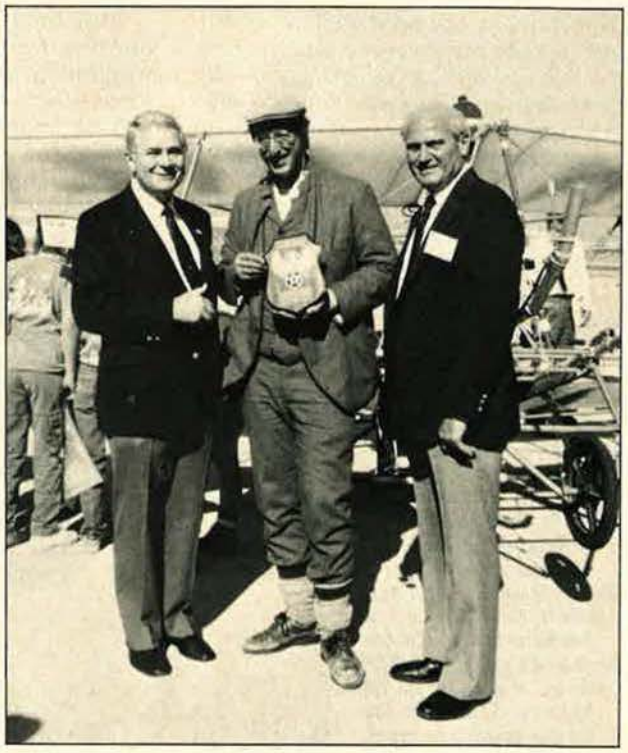
AFA Banquet Honors Historic Flight

While AFA wasn't around seventy-five years ago to witness and celebrate the nation's first successful transcontinental flight, it was present in Pasadena, Calif., last November at the anniversary celebration of that flight. In fact, officials from AFA's General Jimmy Doolittle/Los Angeles Area, Pasadena Area, and Greater Los Angeles Airpower Chapters sponsored a diamond anniversary banquet featuring former Air Force Secretary Verne Orr as speaker. The event also celebrated the carefully planned reenactment of the 1911 flight. James R. Lloyd of Fishkill, N. Y., a research engineer and lifelong aviation buff, successfully completed the commemorative flight last November 12.

Eight years after the first powered flight by the Wright brothers, aviation pioneer Calbraith Perry Rodgers completed a harrowing, forty-nine-day odyssey from Sheepshead Bay in Brooklyn, N. Y., to Long Beach, Calif. Mr. Rodgers had hoped to win a prize of $50,000 for the flight, but, because of several mishaps and bad weather, was unable to complete the flight in the thirty days called for by the contest's organizers. He did, however, go down in the history books as the first aviator to fly coast to coast.

Mr. Lloyd strove for authenticity in his reenactment of Rodgers's coast-to-coast journey. Dressed in period costume and flying a specially constructed Pterodactyl Light Flyer biplane—a carefully crafted, near "replica" of the original Wright EX biplane—Mr. Lloyd found that the weather during his 4,300-mile flight caused almost as many problems as it did for Rodgers, delaying his planned arrival in California by some two weeks. Mr. Lloyd did, however, manage to avoid the twenty crashes that plagued Rodgers during his flight.

The commemorative flight was sponsored by the Armour Food Co., which had a hand in the original flight as well. Rodgers's plane, the *Vin Fiz,* was named after a soft drink then made by Armour. Mr. Lloyd's aircraft was called, appropriately, *Vin Fiz II.*



Hal Strack, left, past-President of AFA's General Doolittle/Los Angeles Area Chapter (and CAFA Vice President/South), and Larry Molnar, Chapter President (right), present an AFA award to pilot James R. Lloyd for successfully reenacting the first transcontinental flight of Calbraith Perry Rodgers on the seventy-fifth anniversary of that historic flight.

"Our Doolittle Chapter had planned the commemorative banquet in Pasadena earlier this year, and then I got wind of the reenactment of the flight," said program chairman Pat Koughan, who served as public relations chairman of AFA's fifteenth anniversary celebration held in Pasadena in 1961. "Jim [Lloyd] called me and said he expected to land in Long Beach in late October, which would have precluded his attendance at our banquet," Mr. Koughan recalled.

As it turned out, Mr. Lloyd was delayed by weather problems. He arrived the day of the banquet and was greeted by Doolittle Chapter board members Larry Molnar, President; Bud Chamberlain, Executive Vice President; Hal Strack, California AFA Vice President/South, and Mr. Koughan. They presented the intrepid aviator with an AFA plaque in recognition of his feat.

Mr. Lloyd was honored again at the AFA banquet that evening. Pasadena Mayor John Crowley proclaimed November 12 "Jim Lloyd Day" at the request of Mr. Koughan, who worked with Bob McCaffrey, past president of the Aero Club of Southern California, in contacting the news media and attracting a stellar aviation crowd to the event. Mayor Crowley and Mr. McCaffrey presented awards to Mr. Lloyd, who received a Smithsonian plaque, which included a portion of Rodgers's original plane and a rare photograph of it.

The banquet also paid tribute to former Air Force Secretary Verne Orr, who addressed the crowd and who received a commemorative scroll from the city of Pasadena. Richard Epstein, author of *The Flight of the Vin Fiz,* which recounts the original 1911 flight, was also recognized at the banquet. Armour Food Companies has indicated an interest in donating the ultralight *Vin Fiz II* to a Los Angeles-area aerospace museum, according to Mr. Koughan, who has agreed to help in selecting a museum.

INTERCOM

Knoxville Celebrates Veterans Day

AFA's General Bruce K. Holloway Chapter, in concert with the Knoxville, Tenn., Chamber of Commerce and the Greater Knoxville Committee for America, ushered in Veterans Day with its annual community-wide program. Gen. Charles L. Donnelly, Jr., Commander in Chief of USAFE, appeared as guest speaker during the program's luncheon event.

Held at the Hyatt Regency, the luncheon attracted nearly 300 citizens and garnered excellent coverage in both the Knoxville *Journal* and the *News-Sentinel* as well as on all three local television stations and several radio newscasts, according to Tennessee AFA President Jack Westbrook.

"I am charged with leading a force of young men and women in the defense of America in a part of the world that is under constant pressure from Communist forces that are poised and ready to crush our freedom and the freedom of our allies," General Donnelly said. "In today's world, as throughout history, only the strong have avoided war."

The General was quoted as saying that he favors both an arms-control agreement with the Soviets and the Strategic Defense Initiative. The General also cited Sir John Slessor, a former chief of staff of Britain's Royal Air Force, who has noted that the most important social service a government can provide its people is to keep them alive and free.

"But today we are engaged in a continuing debate that questions whether a strong, capable military force is now necessary or affordable, and we must be prepared to argue against the reduction of forces that caused America so many problems following the two world wars," General Donnelly insisted. The nation cannot allow a return to those dangerous times when all America could do was hope and pray that no emergency would come "because we knew we were not ready."

Also participating in the luncheon were the color guard from the Air Force ROTC detachment at the University of Tennessee, which presented the colors; Rev. Toombs H. Kay, Jr., who gave the invocation; Harwell Proffitt, Chairman of the Board of the Greater Knoxville Chamber, who served as toastmaster; and Sid Hatfield, President of the General Bruce K. Holloway Chapter, who led the Pledge of Allegiance.

"It was a replay of what has become a successful and appreciated event in Knoxville. It generates great press for AFA while contributing to a better public understanding of the real meaning behind Veterans Day," Mr. Westbrook concluded.

New handicapped-parking signs were the result of a community effort by AFA's Joe Walker Chapter, its Community Partner, and the Disabled American Veterans. Showing off the sign are, at left, Ron Chromulak, President of AFA's Joe Walker Chapter, and Ron Tuman, President of the Mon Valley DAV. In the background are members of both organizations and community leaders.

Joe Walker Chapter Assists DAV Project

A nationwide project by the Disabled American Veterans (DAV) to upgrade, improve, and expand handicapped-parking spaces took a local turn when Ron Chromulak, President of AFA's Joe Walker Chapter in Pennsylvania, solicited the support of a Chapter Community Partner to help with the local effort.

Kaylor Displays of Greensburg got involved with the project when Mr. Chromulak contacted owner Charles Kaylor and asked if the company would be interested in donating new handicapped-parking signs. Mr. Kaylor said "he would be extremely happy to assist us in this project," said the AFA leader, who also serves as legislative officer of the local DAV and as Pennsylvania AFA Vice President.

The signs were needed for parking spaces where the handicapped logo painted on the ground had become faded over time. Each one carried the identifier, "Signs donated to the DAV by the Air Force Association and its Community Partner, C. Kaylor Displays, Inc., Greensburg, Penn."

"This is one example of how AFA Community Partners can work with AFA and other organizations for the betterment of the community," Mr. Chromulak said.

AFA's National Committees

The makeup of AFA's National Committees for 1986–1987 has been determined. The following members have been named to serve on the committees.

- *Executive Committee:* Sam E. Keith, Jr. (Chairman), Martin H. Harris (Vice Chairman), George H. Chabbott, Thomas J. Hanlon, William V. McBride, James M. McCoy, Thomas J. McKee, Jack C. Price, A. A. West, and David L. Gray, ex officio (nonvoting).
- *Finance Committee:* George H. Chabbott (Chairman), Charles H. Church, Jr. (Vice Chairman), John R. Alison, Gary L. Brinner, Ollie R. Crawford, R. L. Devoucoux, Thomas W. Henderson, William N. Webb, and Sam E. Keith, Jr., ex officio (voting).
- *Membership Committee:* James

M. McCoy (Chairman), Amos L. Chalif, Hugh L. Enyart, Joseph R. Falcone, Maureen E. Gavin, William J. Gibson, H. Lake Hamrick, Jan M. Laitos, James P. LeBlanc, Bryan L. Murphy, Jr., William L. Ryon, Jr., Walter E. Scott, and Sam E. Keith, Jr., ex officio (voting).

• *Constitution Committee:* William C. Rapp (Chairman), Lee C. Lingelbach (Vice Chairman), Anthea L. Germano, Paul G. Markgraf, Arley McQueen, Jr., Philip G. Saxton, Herbert M. West, Jr., and Sam E. Keith, Jr., ex officio (voting).

• *Resolutions Committee:* A. A. West (Chairman), George H. Chabbott, Thomas J. Hanlon, Martin H. Harris, Sam E. Keith, Jr., William V. McBride, James M. McCoy, Thomas J. McKee, Jack C. Price, and David L. Gray, ex officio (nonvoting).

• *Audit Committee:* Richard H. Becker (Chairman), Earl D. Clark, Jr., George M. Douglas, Arthur McFadden, Hugh W. Stewart, L. T. (Zack) Taylor, and Martin H. Harris, ex officio (nonvoting).

• *Communications Committee:* John P. E. Kruse (Chairman), Donald D. Adams, Joseph E. Assaf, Donald T. Beck, John Boeman, Jon R. Donnelly, Toby J. duCellier, Jack Flaig, William A. Solemene, and Sam E. Keith, Jr., ex officio (voting).

• *Long-Range Planning Committee:* Edward A. Stearn (Chairman), C. Cliff Ball, E. F. Faust, Nathan H. Mazer, Craig R. McKinley, Ellis T. Nottingham, Mary Ann Seibel, R. E. Smith, William W. Spruance, Howard C. Strand, Edward I. Wexler, Sam E. Keith, Jr., ex officio (voting), Capt. Thomas D. Shearer, USAF, ex officio (nonvoting), and CMSgt. Richard E. Williamson, USAF (Ret.), ex officio (nonvoting).

• *Science and Technology Committee:* Robert T. Marsh (Chairman), H. B. Henderson, Vic Reis, John C. Toomay, Albert C. Pierce, Henry C. Smythe, Jr., George R. Weinbrenner, and Sam E. Keith, Jr., ex officio (voting).

Leaders of AFA's Nation's Capital Chapter convened for pre-holiday greetings at the Marriott Crystal Gateway Hotel. From left to right: Don Dawson, Counsel; Fred Rhodes, Educational Chairman; Grant Miller, Program Chairman; Paul McManus, Congressional Affairs; Denny Sharon, President; former-Sen. Howard Cannon, Immediate Past President; Al Barbero, Military Affairs; Ed Rodriguez, Membership Chairman; and Pat Briggs, International/Public Affairs.

AFA National Director R. L. "Dev" Devoucoux recently presented a W. Randolph Lovelace Memorial Award to AFROTC Cadet Thaya Poel at an awards banquet held at St. Michael's College in Winooski, Vt.

On the Scene

Mobile, Ala., Chapter members supported the Mobile Bay Area Veterans Commission, Inc., in paying tribute to the 8,100 veterans in the Mobile Bay area during a special luncheon and awards ceremony held at the Riverview Plaza Hotel. In December, the Chapter honored the more than thirty business and civic organizations that have joined the Chapter as AFA Community Partners, said Chapter President **H. R. "Bobby" Case.** The evening speaker was AFA National President **Sam E. Keith, Jr.**

H. H. Arnold Chapter members were treated to the cogent remarks of **Lt. Gen. Bernard P. Randolph,** Deputy Chief of Staff for Research, Development and Acquisition, at the annual Military Ball held at the Huntington Town House on Long Island on November 21 . . . Miami Chapter members recently joined members of the Gold Coast Chapter in Fort Lauderdale, Fla., for a nostalgic viewing of AFA's "Gathering of Eagles" videotape, which captured key highlights of AFA's fortieth anniversary celebration held in Las Vegas last April. The event included a seven-course meal and was a great success, according to Miami Chapter President **Stan Bodner.**

Union Morris Chapter officials couldn't think of a better man to be named the Chapter's 1987 "Man of the Year" than longtime leader **Stan Shapiro,** who was honored at the Chapter's annual "roast and toast" event held at The Bottle Inn on De-

INTERCOM

cember 4 . . . "The Air National Guard of Arizona and the Total Force Concept" was the theme of a Cochise Chapter meeting held recently at the Sun Canyon Inn in Sierra Vista. The featured speaker at the meeting was **Brig. Gen. John A. Almquist,** Commander of the Arizona Air National Guard, reports organizer **Joe Anton.**

The skies were filled with the fighters, bombers, trainers, and pursuit planes of years gone by when AFA's Fresno Chapter sponsored its fifteenth annual "Gathering of Warbirds" in Madera, Calif., in August. The largest event yet, the crowd over the three-day period was estimated at 35,000 and included, among others, retired **Gen. Curtis E. LeMay,** former Chief of Staff and present AFA board member; retired **Col. Gregory "Pappy" Boyington, USMC,** Medal of Honor recipient and former commander of the renowned "Black Sheep" Squadron; **Robert Smith,** Flying Tiger fighter ace; and **Deet Eichel,** former Luftwaffe pilot and veteran of the Condor Legion. Mr. Eichel fought on the Eastern Front during World War II and was credited with ninety-six kills.

National President Sam E. Keith, Jr. (right), presents an AFA Special Presidential Citation to Tom Moore, director of military sales and operations for Anheuser-Busch, for outstanding support of AFA national programs. Helping with the presentation is, at left, AFA Board Chairman Martin H. Harris.

Honored as the top graduate of Class 86-E at the Senior NCO Academy at Gunter AFS, Ala., SMSgt. James R. Moore, right, of the Electronic Warfare Center at Kelly AFB, received AFA's National Security Affairs/Force Employment Award. Doing the honors was AFA National Director Jim McCoy, a former CMSAF.

AFA National President **Sam Keith, Jr.,** joined Board Chairman **Marty Harris** in presenting an AFA Special Presidential Citation to **Tom Moore,** director of military sales and operations for Anheuser-Busch and longtime AFA and Air Force supporter. Mr. Moore was recognized "for dedicated and consistent support of national AFA programs designed to enhance the *esprit,* morale, and welfare of the men and women of the United States Air Force." He was honored prior to AFA's Air Force Ball in October. Another top honor went to **SMSgt. James R. Moore** of the Electronic Warfare Center at Kelly AFB, Tex. Sergeant Moore earned AFA's National Security Affairs/Force Employment Award as the top graduate in Class 86-E at the Senior NCO Academy at Gunter AFS, Ala. AFA National Director **Jim McCoy,** a former CMSAF, presented the award.

Lt. Gen. Fred Woerner, Sixth Army Commander, was the scheduled speaker for the Dale O. Smith Chapter's December meeting, according to President **Jim Minish.** General Woerner held several assignments in South America and Central America prior to becoming Sixth Army Commander. His appearance "provided [Chapter members] the opportunity to meet jointly with the Army Association while learning more about a critical issue," Mr. Minish said. The AFA Chapter in Reno, Nev., is celebrating its tenth year . . . Another anniversary was celebrated recently by **Joe Falcone,** National Vice President for AFA's New England Region. Mr. Falcone has been an AFA member and leader for forty years.

Sedona Chapter past-President **Ed Przybys** has high praise for the Luke AFB Honor Guard and its stirring "Pageant of Flags" presentation, which it has given to community groups throughout Arizona and surrounding states. "It's a half-hour presentation showing American history through the American flag as it has evolved from the St. George Cross, the King's Colors, and the British Red Ensign flag to the current flag with thirteen stripes and fifty stars," Mr. Przybys explained, noting that other AFA chapters might well be interested in the pageant. The flag presentation was first given at the Arizona AFA convention in 1983. Since then, it has be-

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Additional Coverage Up to $200,000

In the event a member insured under this program wishes additional life insurance coverage, the Association sponsors a supplemental program that provides up to $200,000 in level term insurance.

Who Is Eligible?

All members of the Air Force Association who are under age 65 are eligible to apply for coverage under this program. (Once insured, however, coverage may be retained to age 75.)

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come a popular feature at many national conventions, patriotic events, school assemblies, and other programs throughout the West. Mr. Przybys, who writes a regular column for the Sedona Red Rocks *News*, was recently inducted into the Aviation/Space Writers Association.

Harry L. Kowal, Communications Director for AFA's Passaic/Bergen Chapter, won an all-expense-paid weekend at the Golden Eagle Inn in Cape May in the New Jersey AFA raffle. The raffle helped chapters bolster their treasuries by providing a rebate on overall sales of the $1 tickets. AFAers who signed up three new civilian members were allowed to put their names in the hat without charge.

Twenty-eight high schools in the Newport Beach, Calif., area receive AIR FORCE Magazine thanks to AFA's General Curtis E. LeMay Chapter in Orange County. Recently, Chapter officials conducted a survey to determine if the magazine helps students with their assigned studies. One reply came from librarian **Lucille Woods** of Esperanza High School:

"It is extremely valuable and is used extensively by our Current Affairs classes. In addition, every senior does a foreign policy paper concerning the relationship between two countries. The magazine is the best source of up-to-date military information for this assignment. I keep the current issue on my desk so that students have easy access to its figures on the military. . . . We feel the magazine is a very valuable research tool for secondary school students and appreciate our subscription."

If your chapter is engaged in a similar program, write to "Intercom" and let us know about it.

Bill Stone, Michigan AFA President and a United Methodist pastor for thirty-eight years, may be the first clergyman to serve AFA as a state president. Bill served as chairman of the domestic action program at Wurtsmith when he and his wife, **Helen,** who is the manager of jet engines at Wurtsmith AFB, first moved to Oscoda in 1969. It was there that Bill became acquainted with **Gen. David C. Jones** and got involved in base community affairs, helped organize an AFA chapter, served on the board as vice president and president, and went on to become active at the AFA state level. He was first elected as a trustee of the Charter Township of Oscoda in 1978 and continues to serve in that capacity. He also is chairman of the Iosco County Townships Association, is a Civil Air Patrol Chaplain, and is active on the local and state boards of mental health. ■

UNIT REUNIONS

Aloe/Foster and Matagorda
Personnel who were stationed or worked at Aloe and Foster Army Airfields and the Matagorda Island, Tex., Bombing and Gunnery Range during the 1940s through the 1950s will hold a reunion on June 5–7, 1987. **Contact:** Paul A. Kneblick, 601 Cambridge, Rte. 6, Victoria, Tex. 77901. Phone: (512) 575-5840. Helen Welch, P. O. Box 173, Telferner, Tex. 77988. Phone: (512) 575-7560.

Tachikawa
Personnel who were stationed in Tachikawa, Japan, will hold a reunion on September 24–27, 1987, in Orlando, Fla. **Contact:** Al Lemesh, 2697 Sunbranch Dr., Orlando, Fla. 32822. Phone: (305) 275-6764.

2d Ferrying Group
The Air Transport Command's 2d Ferrying Group (now the Wilmington Warrior Association), which was based at New Castle AAB, Del., during World War II, will hold a reunion on May 21–23, 1987, in St. Louis, Mo. **Contact:** Ray Kuhlman, 7 Springwood Lane, Kinston, N. C. 28501. Phone: (919) 522-0356.

21st Bomb Squadron
The 21st Bomb Squadron, which was stationed in the Aleutians during 1942 and 1943, is planning to hold a reunion in 1987. **Contact:** Allen McRae, 4455 27th Ave., S. E., Salem, Ore. 97302.

Class 48-A
Air Force Officers Candidate Class 48-A will hold a reunion in June 1987 in San Antonio, Tex. **Contact:** G. A. Musgrove, 2414 Farrington Rd., Wichita Falls, Tex. 76308. Phone: (817) 767-5947.

P-51 Mustang Pilots Ass'n
P-51 Mustang Pilots will hold their seventh annual reunion on August 5–8, 1987, at the Red Lion Inn in Colorado Springs, Colo. **Contact:** Col. Lester R. Morrow, USAF (Ret.), 8327 Benton Way, Arvado, Colo. 80003. Phone: (303) 429-6046 or (303) 429-5517.

52d Troop Carrier Squadron
Pilots and navigators of the 52d Troop Carrier Squadron who were stationed at Donaldson AFB, S. C., will hold a reunion on June 5–7, 1987, in Greenville, S. C. **Contact:** Fred Schwartz, 208 Devon Dr., Mauldin, S. C. 29662. Phone: (803) 288-1281.

55th Fighter Group
Members of the 55th Fighter Group and the 442d Air Service Group Association will hold a reunion on June 4–6, 1987, in Omaha, Neb. **Contact:** Brig. Gen. Regis F. A. Urschler, USAF (Ret.), 1312 Camp Gifford Rd., Bellevue, Neb. 68005.

55th Weather Recon Squadron
The 55th Weather Reconnaissance Squadron, Flight "B," which served at Oklahoma City, Okla., and on Guam (1944–45), will hold a reunion on April 24–26, 1987, in Oklahoma City, Okla. **Contact:** Lt. Col. David T. Jenkins, USAF (Ret.), 392 Tulip St., Fairfield, Calif. 94533. Phone: (707) 422-6541.

71st Service Squadron
The 71st Service Squadron will hold a reunion on July 17–19, 1987, in Denver, Colo. **Contact:** John DeFrange, 4720 Federal Blvd., Denver, Colo. 80211. Phone: (303) 477-7281.

360th TEWS
The 360th Tactical Electronic Warfare Squadron, 460th Tactical Reconnaissance Wing, will hold its first reunion on April 18, 1987, at Andrews AFB, Md. **Contact:** Lt. Col. Charles J. Tringali, USAF (Ret.), 494 Old Orchard Circle, Millersville, Md. 21108.

390th Bomb Squadron
The 390th Bomb Squadron, 42d Bomb Group, will hold a reunion on May 28–31, 1987, at the Marriott Hotel in Denver, Colo. **Contact:** Charles Wells, 196 Athlone Beach, Bay City, Mich. 48706. Phone: (517) 686-3678.

474th Fighter Group Ass'n
The 474th Fighter Group will hold a reunion on May 21–24, 1987, at the Loews L'Enfant Plaza Hotel in Washington, D. C. **Contact:** Robert D. Hanson, 1643 Virginia Ave. S., Minneapolis, Minn. 55426. Phone: (612) 544-4122.

622d Air Refueling Squadron
Members of the 622d Air Refueling Squadron will hold a reunion on May 6–10, 1987, in Alexandria, La. **Contact:** Dan Sloan, 1507 Highway 1204, Pineville, La. 71360. Phone: (318) 640-4208. Millie Sanders, 2210 Madeline St., Alexandria, La. 71301. Phone: (318) 442-2127.

751st AC&W Squadron
The 751st Aircraft Control and Warning Squadron stationed at Mount Laguna AFS, Calif., will hold a reunion on April 30–May 2, 1987, at Humphrey's Half Moon Inn in San Diego, Calif. **Contact:** Roger D. Scow, 865 W. Coll St., New Braunfels, Tex. 78130. Phone: (512) 629-4786.

820th Bomb Squadron
Members of the 820th Bomb Squadron will hold a reunion on May 14–17, 1987, at the Fort Magruder Inn in Williamsburg, Va. **Contact:** William W. Childs, 3637 Patsy Ann Dr., Richmond, Va. 23234. Phone: (804) 275-6012.

NEACP
Personnel of the National Emergency Airborne Command Post (NEACP) and 1st Airborne Command Control Squadron (1st ACCS), also known as "Nightwatch" and "Silver Dollar," are planning to hold a twenty-fifth-year anniversary celebration on June 4–6, 1987. **Contact:** Col. Stephen H. Evans, USAF, OJCS/NEACP, Offutt AFB, Neb. 68113-5000. Phone: (402) 294-6291.

Espiritu Santo Weather Personnel

I would like to hear from weather station personnel who served on Espiritu Santo Island in the New Hebrides during World War II and who would be interested in holding a reunion.

Please contact the address below.

Norman Fehrenbach
P. O. Box 185
Marshfield, Wis. 54449

Jones Army Airfield

I am trying to locate students who graduated in 1941 through 1944 from Jones Army Airfield in Bonham, Tex.

Please send the names and addresses of students and instructors to the address listed below for information on class reunions.

Lt. Col. John E. Connor, USAF (Ret.)
2109 River Oaks
Abilene, Tex. 79605

Reunion Notices

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to "Unit Reunions," AIR FORCE Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Please designate the unit holding the reunion, the time, the location, and a contact for more information.

Class 43-A-1

I would like to hear from members of Pilot Class 43-A-1 who underwent primary, basic, and advanced instructor training at Mather Army Airfield, Calif. I am planning a reunion for 1987.

Please contact the address below.

Lt. Col. Wallace E. Linn, Jr., USAF (Ret.)
2300 Nacogdoches Rd., #232-I
San Antonio, Tex. 78209
Phone: (512) 828-1277

307th CAMS

We are trying to organize a reunion for former members of the 307th Consolidated Aircraft Maintenance Squadron who served at Travis AFB, Calif. The date and location are tentative, based on the number of people who respond.

Please contact the address below for additional information.

Mrs. Jay Marshall
Mrs. Ricardo Irizarry
743 La Cruz Lane
Vacaville, Calif. 95688
Phone: (707) 447-6817 (Marshall)
(707) 425-9407 (Irizarry)

566th Bomb Squadron

I am trying to locate crew members who served with Robert Nickols in the 566th Bomb Squadron, 389th Bomb Group. I would like to organize a crew reunion.

Please contact the address below.

Gene R. Shanley
16758 E. Floyd Ave.
Aurora, Colo. 80013

MOVING?

Let us know your new address six weeks in advance so that you don't miss any copies of AIR FORCE.

Clip this form and attach your mailing label (from the plastic bag that contained this copy of your magazine), and send to:

Air Force Association
Attn: Change of Address
1501 Lee Highway
Arlington, VA
22209-1198

Please fasten your mailing label here

Please print your NEW address here:

NAME _____

ADDRESS _____

CITY, STATE, ZIP CODE _____

AFA CHAMPLUS® .... Strong Protection

When a Single Accident or Illness Could Cost *You* Thousands of Dollars, You Need AFA CHAMPLUS®. . . for *Strong* Protection against Costs CHAMPUS Doesn't Cover!

For military retirees and their dependents . . . and dependents of active-duty personnel . . . more and more medical care is being provided through the government CHAMPUS program.

And, of course CHAMPUS pays 75% of allowable charges.

But today's soaring hospital costs—nearly $550 a day in some major metropolitan medical centers—can run up a $20,000 bill for even a moderately serious accident or illness.

Your 25% of $20,000 is no joke!

AFA CHAMPLUS® protects you against that kind of financial catastrophe *and* covers most of your share of routine medical expenses as well.

HOW AFA CHAMPLUS® WORKS FOR YOU!

WHO IS ELIGIBLE?

1) All AFA members under 65 years of age who are currently receiving military retired pay and are eligible for benefits under Public Law 89-614 (CHAMPUS), their spouses under age 65 and their unmarried dependent children under age 21, or age 23 if in college. (There are some exceptions for older age children. See "Exceptions and Limitations".)
2) All eligible dependents of AFA members on active duty. Eligible dependents are spouses under age 65 and unmarried dependent children under age 21, or age 23 if in college. (There are some exceptions for older age children. See "Exceptions and Limitations".)

EXCEPTIONAL BENEFIT PLAN

(See chart at right)

FOUR YEAR BASIC BENEFIT. Benefits for most injuries or illnesses may be paid for up to a four-year period.

PLUS THESE SPECIAL BENEFITS . . .

1) Up to 45 consecutive days of in-hospital care for mental, nervous, or emotional disorders. Outpatient care may include up to 20 visits of a physician or $500 per insured person each year.
2) Up to 30 days care per insured per year in a Skilled Nursing Facility.
3) Up to 30 days care per insured per year and up to 60 days lifetime in a CHAMPUS-approved Residential Treatment Center.
4) Up to 30 days care per insured per year and up to 60 days lifetime in a CHAMPUS-approved Special Treatment Facility.
5) Up to 5 visits per insured per year to Marriage and Family Counselors under conditions defined by CHAMPUS.

YOUR INSURANCE IS NON-CANCELLABLE

As long as you are a member of the Air Force Association, pay your premiums on time, and the master contract remains in force, your insurance cannot be cancelled.

ADMINISTERED BY YOUR ASSOCIATION . . . UNDERWRITTEN BY MUTUAL OF OMAHA

AFA CHAMPLUS® insurance is administered by trained insurance professionals on your Association staff. You get prompt, reliable, courteous service from people who know your needs and know every detail of your coverage. Your insurance is underwritten by Mutual of Omaha, the largest individual and family health insurance company in the world.

AFA OFFERS YOU HOSPITAL BENEFITS AFTER AGE 65

Once you reach Age 65 and are covered under Medicare, AFA offers you protection against hospital expenses not covered by Medicare through the *Senior Age Benefit Plan* of AFA Hospital Indemnity Insurance. Members enrolled in AFA CHAMPLUS® will automatically receive full information about AFA's Medicare supplement program upon attainment of Age 65 so there will be no lapse in coverage.

AFA CHAMPLUS® BENEFIT SCHEDULE

Care	*CHAMPUS Pays*	*AFA CHAMPLUS® Pays*
	For Military Retirees Under Age 65 and Their Dependents	
Inpatient civilian hospital care	CHAMPUS pays 75% of allowable charges.	CHAMPLUS® pays the 25% of allowable charges not covered by CHAMPUS.
Inpatient military hospital care	The only charge normally made is a $7.30 per day subsistence fee, not covered by CHAMPUS.	CHAMPLUS® pays the $7.30 per day subsistence fee.
Outpatient care	CHAMPUS COVERS 75% of outpatient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 25% of allowable charges not covered by CHAMPUS after the deductible has been satisfied.
	For Dependents of Active-Duty Military Personnel	
Inpatient civilian hospital care	CHAMPUS pays all covered services and supplies furnished by a hospital, less $25 or $7.30 per day, whichever is greater.	CHAMPLUS® pays the greater of $7.30 per day or $25 of the reasonable hospital charges not covered by CHAMPUS.
Inpatient military hospital care	The only charge normally made is a $7.30 per day subsistence fee, not covered by CHAMPUS.	CHAMPLUS® pays the $7.30 per day subsistence fee.
Outpatient care	CHAMPUS covers 80% of outpatient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 20% of allowable charges not covered by CHAMPUS after the deductible has been satisfied.

NOTE: Outpatient benefits cover emergency room treatment, doctor bills, pharmaceuticals, and other professional services.

There are some reasonable limitations and exclusions for both inpatient and outpatient coverage. Please note these elsewhere in the plan description.

Against Costs CHAMPUS Doesn't Cover

APPLY TODAY!
JUST FOLLOW THESE STEPS

Choose either AFA CHAMPLUS® Inpatient coverage or combined Inpatient and Outpatient coverage for yourself. Determine the coverage you want for dependent members of your family. Complete the enclosed application form in full. Total the premium for the coverage you select from the premium tables on this page. Mail the application with your check or money order for your initial premium payment, payable to AFA.

AFA's CHAMPLUS®

EXCEPTIONS & LIMITATIONS

Coverage will not be provided for conditions for which treatment has been received during the 12-month period prior to the effective date of insurance until the expiration of 12 consecutive months of insurance coverage without further treatment. *After coverage has been in force for 24 consecutive months, pre-existing* conditions will be covered regardless of prior treatment. Children over age 21 (age 23 if in college) will continue to be eligible if they have been declared incapacitated and if they were insured under CHAMPLUS® on the date so declared. Coverage for these older age children will be provided at slightly higher rates upon notification to AFA.

EXCLUSIONS

This plan does not cover and no payment shall be made for:

a) routine physical examinations or immunizations

b) domiciliary or custodial care

c) dental care (except as required as a necessary adjunct to medical or surgical treatment)

d) routine care of the newborn or well-baby care

e) injuries or sickness resulting from declared or undeclared war or any act thereof

f) injuries or sickness due to acts of intentional self-destruction or attempted suicide, while sane or insane

g) treatment for prevention or cure of alcoholism or drug addiction

h) eye refraction examinations

i) Prosthetic devices (other than artificial limbs and artificial eyes), hearing aids, orthopedic footwear, eyeglasses and contact lenses

j) expenses for which benefits are or may be payable under Public Law 89-614 (CHAMPUS)

PREMIUM SCHEDULE

Plan 1—For military retirees and dependents (Quarterly Premiums)

Inpatient Benefits

Member's Attained Age	Member	Spouse	Each Child
Under 50	$21.88	$27.35	$14.85
50–54	$32.70	$40.88	$14.85
55–59	$39.78	$49.73	$14.85
60–64	$45.80	$57.25	$14.85

Inpatient and Outpatient Benefits

Under 50	$30.82	$36.98	$37.13
50–54	$42.35	$50.82	$37.13
55–59	$56.01	$67.21	$37.13
60–64	$64.48	$77.38	$37.13

Plan 2—For dependents of active-duty personnel (Annual Premiums)

Inpatient Only	None	$ 9.68	$ 5.94
Inpatient and Outpatient	None	$38.72	$29.70

APPLICATION FOR AFA CHAMPLUS®

Group Policy GMG-FC70
Mutual of Omaha Insurance Company
Home Office: Omaha, Nebraska

Full name of Member _____ (Rank / Last / First / Middle)

Address _____ (Number and Street / City / State / ZIP Code)

Date of Birth _____ (Month/Day/Year) Current Age ____ Height ____ Weight ____ Soc. Sec. No. _____

This insurance coverage may only be issued to AFA members. Please check the appropriate box below:

☐ I am currently an AFA Member.

☐ I enclose $18 for annual AFA membership dues (includes subscription ($14) to AIR FORCE Magazine).

PLAN & TYPE OF COVERAGE REQUESTED

Plan Requested (Check One)
☐ AFA CHAMPLUS® PLAN I (for military retirees & dependents)
☐ AFA CHAMPLUS® PLAN II (for dependents of active-duty personnel)

Coverage Requested (Check One)
☐ Inpatient Benefits Only
☐ Inpatient and Outpatient Benefits

Person(s) to be insured (Check One)
☐ Member Only
☐ Spouse Only
☐ Member & Spouse
☐ Member & Children
☐ Spouse & Children
☐ Member, Spouse & Children

PREMIUM CALCULATION

All premiums are based on the attained age of the AFA member applying for this coverage. Plan I premium payments are normally paid on a quarterly basis but, if desired, they may be made on either a semi-annual (multiply by 2), or annual (multiply by 4) basis.

Quarterly (annual) premium for member (age ____) $_____

Quarterly (annual) premium for spouse (based on member's age) $_____

Quarterly (annual) premium for ____ children @ $ $_____

Total premium enclosed $_____

If this application requests coverage for your spouse and/or eligible children, please complete the following information for each person for whom you are requesting coverage.

Names of Dependents to be Insured	Relationship to Member	Date of Birth (Month/Day/Year)

(To list additional dependents, please use a separate sheet.)

In applying for this coverage, I understand and agree that (a) coverage shall become effective on the last day of the calendar month during which my application together with the proper amount is mailed to AFA, (b) only hospital confinements (both inpatient and outpatient) or other CHAMPUS-approved services commencing after the effective date of insurance are covered and (c) any conditions for which I or my eligible dependents received medical treatment or advice or have taken prescribed drugs or medicine within 12 months prior to the effective date of this insurance coverage will not be covered until the expiration of 12 consecutive months of insurance coverage without medical treatment or advice or having taken prescribed drugs or medicine for such conditions. I also understand and agree that all such pre-existing conditions will be covered after this insurance has been in effect for 24 consecutive months.

Date _____, 19 ____ _____ Member's Signature

Form 6173GH App.

Application must be accompanied by a check or money order. Send remittance to: Air Force Association, Insurance Division, 1501 Lee Highway, Arlington, VA 22209-1198

2/87

Bob Stevens'

"There I was..."

ONE OF THE BIGGEST OBSTACLES STANDING BETWEEN THE USAF AIR CREWMAN and CLEAR, CONCISE RADIO COMMUNICATION IS THE "WAFER SWITCH". THIS INNOCENT-LOOKING ROTATABLE SELECTOR KNOB BECOMES A DEMON OF MODERN SCIENCE WHEN LEFT IN THE WRONG POSITION.

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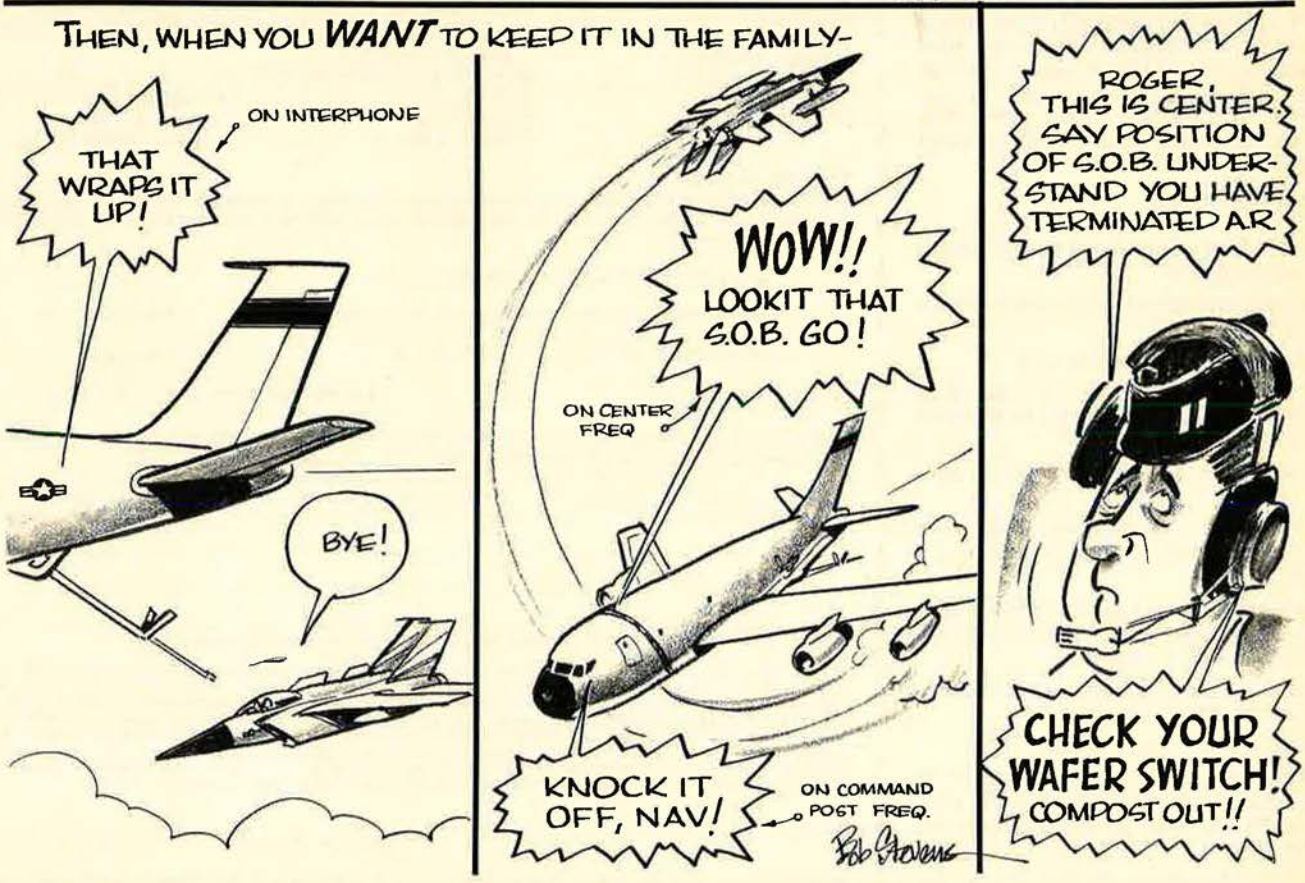
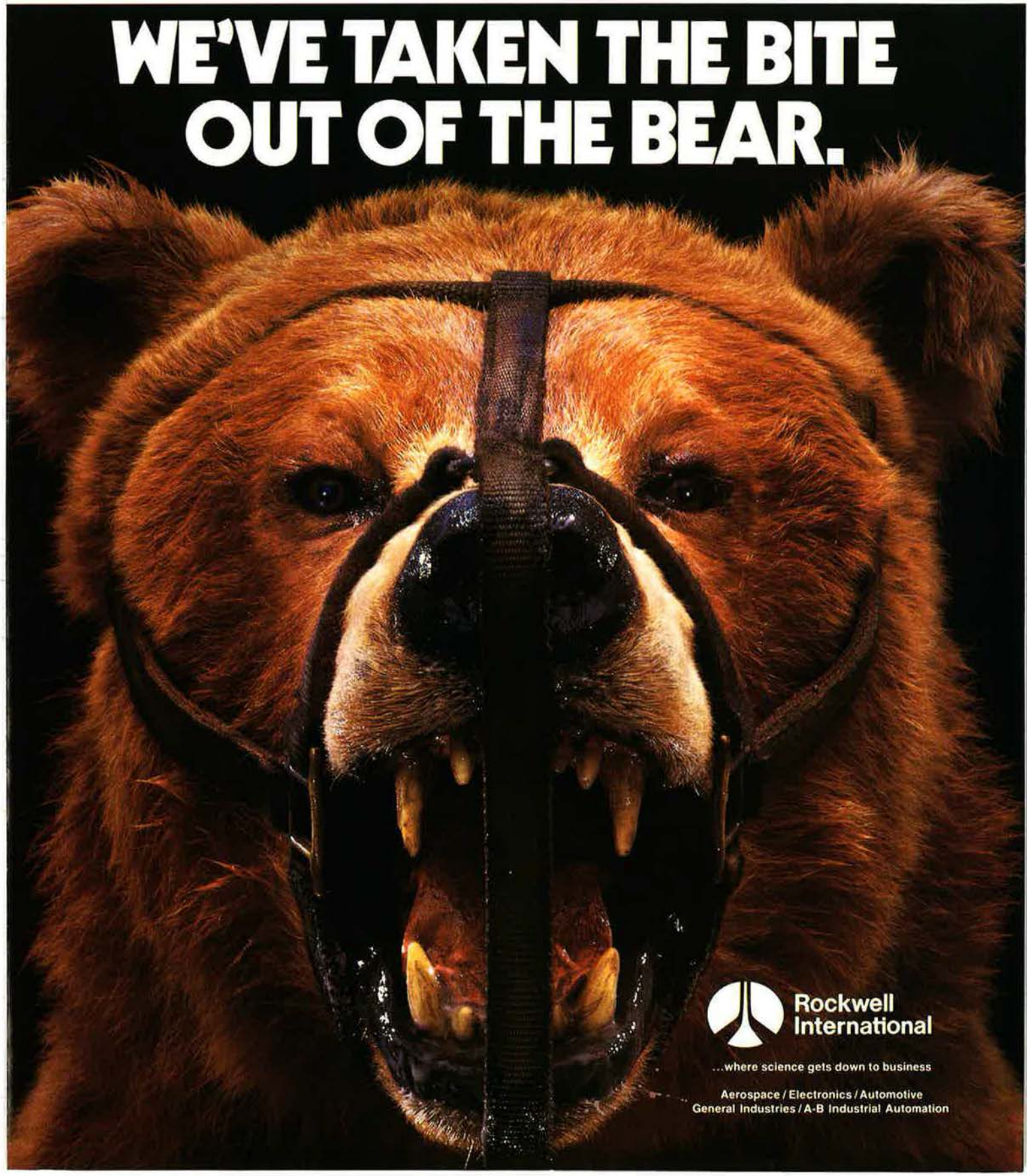


The new Collins GRC-171A(V)4 is a colocatable ECCM multi-channel transceiver with space-saving frequency agile filter built right in. ■ This frequency agile UHF AM/FM Have Quick radio eliminates the need for external assets, which allows the use of multiple radios in transportable shelters, control towers, command posts and other space-limited installations. ■ Since the basic GRC-171 is already the standard air traffic control radio for the Air Force, the new GRC-171A(V)4 minimizes additional logistic support costs. This new GRC-171 is also wave form adaptable for international use. ■ For details contact: Collins Defense Communications, Rockwell International, 350 Collins Road N.E., MS 120-131, Cedar Rapids, Iowa 52498, U.S.A. (319) 395-1600, Telex 464-435. **Collins ACCD: The Electronic Combat Specialists.**

WE'VE TAKEN THE BITE OUT OF THE BEAR.



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THE F-15: KEY PLAYER ON THE USAF TEAM.

THE MISSION: FLY FAR BEHIND THE BATTLE AREA TO DENY AN ENEMY THE MEANS AND WILL TO CONTINUE AN ATTACK.

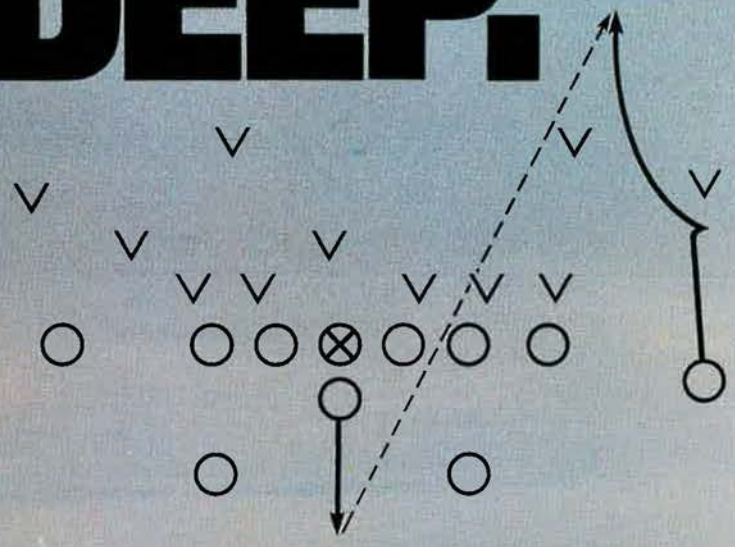
Deep interdiction is a crucial U.S. Air Force mission. Why? Because hostile forces are brought closer to defeat when denied the resources to continue.

A strong defense for America means that the Air Force must be able to go deep when necessary. The mission requires a plane that can fight its way to and from the target through hostile skies, in any weather, day or night, then deliver its payload with precision on high-value, rear-echelon targets.

The Air Force chose the F-15E for this deep interdiction mission. The Eagle's range gets it deep. Its sensors guide it over enemy terrain in any weather, day or night, with a payload large enough to do the job. Its speed, maneuverability, countermeasures and air-to-air weapons get it back safely.

For a strong defense, America counts on the Air Force. And the Air Force counts on the F-15 Eagle.

GOING DEEP.



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