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MAGAZINE

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About the cover: Tropical Storm Sam in the Indian Ocean was photographed from the space shuttle *Discovery* in 1989. The US seeks to recapture its preeminent position in spaceflight. See "Fogbound in Space," p. 22.

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By John T. Correll, Editor in Chief

Another Shot at Roles and Missions

AS PART of the 1994 defense authorization bill passed in November, Congress instructed the Secretary of Defense to appoint a commission of seven private citizens to review the roles and missions of the armed forces. The roles and missions report turned in last February by Gen. Colin L. Powell, Chairman of the Joint Chiefs of Staff, did not satisfy Congress, which wanted more dramatic results, especially in the areas of functional overlaps and cost savings.

In framing the new directive, the authorization bill said that reviews conducted by the Pentagon have "not produced the comprehensive review envisioned by Congress." The seven-member commission will be appointed by the Secretary of Defense and make its report by early 1995.

Lest there be any doubt about the focus, the Congressional Research Service has produced a study called "Four US 'Air Forces': Overlap and Alternatives." As always, some overlaps are of more interest than others. There is no great hue and cry, for example, about duplication of light infantry capabilities in the Army and the Marine Corps. The primary target is airpower.

The present roles and missions debate was launched in July 1992 by Sen. Sam Nunn (D-Ga.), chairman of the Armed Services Committee. In a ringing floor speech, he cited economy as a major motivation. He held out the prospect of the armed forces eliminating five air wings and—even more lucrative—the potential reduction of aircraft procurement programs. Reductions ordered since then will cut the Air Force by another 6.5 fighter wings and the Navy by one air wing. Two of the four tactical aircraft modernization programs planned have been canceled. The roles and missions controversy, however, is still alive.

No matter what fringe theorists may argue, the issue is not the relative value of airpower. The first measure of a nation's military strength today is combat aircraft. Across the

spectrum of conflict, the United States looks to airpower as the initial instrument of force application. In some instances, it will be the primary instrument. All of the armed services respect and emphasize airpower. The US Navy currently has about 400 ships but tends to define itself in terms of thirteen of them, its aircraft carriers. The roles and missions issue is not airpower. It is the basing mode for airpower.

The commission is not likely to find new evidence, although it could propose a change in the verdict.

The pivotal question, of course, is the mix of Air Force and Navy airpower. As the commission will discover (if it doesn't know at the outset), each has particular strengths and advantages. Aircraft carriers provide a forward presence in areas where the US has no bases. When a limited amount of force is sufficient, carriers can put some impressive airpower across the beach. Depending on the crisis, naval aviation may be the best instrument for initial response. In other circumstances, heavy bombers and strike aircraft—reaching any point on Earth quickly from distant bases—will be a better choice.

If a conflict is of larger scope or threatens to escalate to something larger, it will require the weight, sustained sorties, and flexibility of a full-service Air Force. Conflicts differ, but in the nation's most recent war, Operation Desert Storm in 1991, land-based Air Force units delivered ninety percent of the US precision guided munitions and seventy-two percent of the US gravity bombs.

Like the Navy, the Air Force can do some of its work from a distance, but practical considerations call for bases in reasonable proximity to a major regional conflict. If land bases will not be available for the Army as well as the Air Force, the nation should be very careful about getting involved in serious fights there.

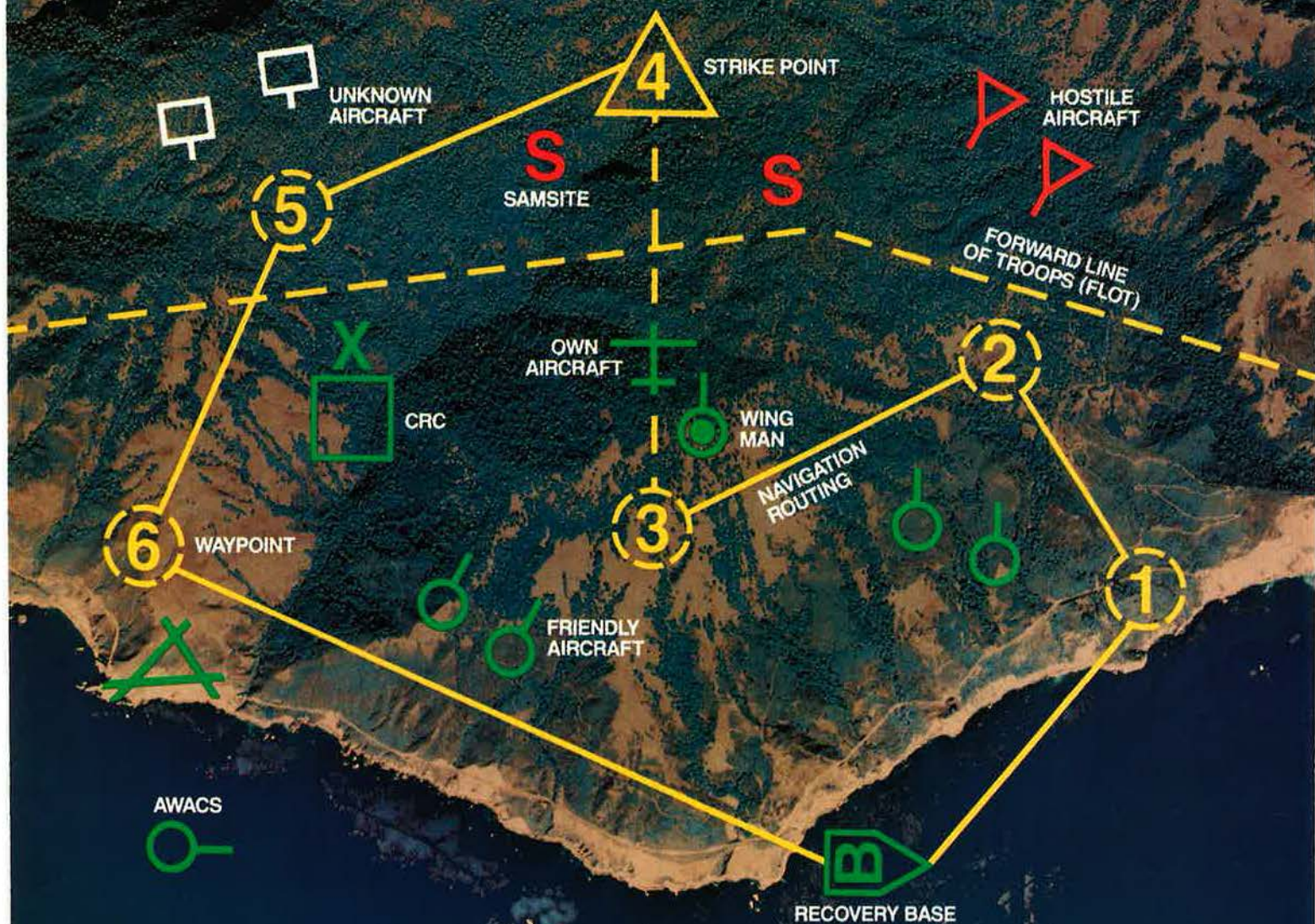
The commission should also note that the nation is measuring its airpower in exceedingly small quantities. It was regarded as a victory for the Navy when it lost only one (rather than two) carrier air wings in last summer's Bottom-Up Review. The Air Force was hit harder and is headed down toward twenty fighter wings, seven of them in the Guard and Reserve. We cannot afford to lose any more.

The usual approach is to count the number of fighter and attack wings as sort of a shorthand for force structure, but that's only part of the requirement. US strategy prescribes a capability to respond to two major conflicts almost simultaneously. Each crisis calls for ten Air Force fighter wings, 100 heavy bombers, massive airlift, and four or five aircraft carriers. We are at the limit on fighter wings. The total bomber force may be close to 100 within a few years. Airlift, the main limiting factor in response to global contingencies, is under the gun for budget reductions.

The roles and missions issue has already been plowed and sifted thoroughly. The commission is not likely to find much new evidence—although it could recommend a change in the verdict. The commission should beware of advice from fiscally-oriented strategists who may not understand the problem as well as they profess to.

If the commission is wise, its major conclusion will be fairly close to the one General Powell announced a year ago: "America has one Air Force—the US Air Force. Other services have aviation arms essential to their warfighting roles. Each arm provides unique but complementary capabilities. All work *jointly* to project airpower." ■

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Letters

Doolittle Remembered

My late father, CMSgt. Lewis C. Fogleman, USAF (Ret.), always counted Gen. Jimmy Doolittle as one of his heroes. I grew up with tales of the exploits of General Doolittle. They made me proud of people who serve their country in the armed forces and proud to be an American. This man embodied the spirit of what it is to be American. On behalf of my father, I salute him and your wonderful tribute [*"An American Hero,"* by C. V. Glines, November 1993, p. 18], which I shall pass on to my own children.

Sharon E. Hockensmith
Eagan, Minn.

As a fourteen-year-old in 1942, I met Brig. Gen. Jimmy Doolittle at my home in Santa Ana, Calif., where he had kindly come to visit my father, through the good graces of the General's friend Col. Sandy Goodman (USA Coastal Artillery). I had, of course, expected a swashbuckling fellow, but to my surprise there appeared an unassuming and humble man in a worn flight jacket, tan shirt, and Army "pink" pants. After some prompting, he patiently related the story of the B-25 attack on Japan.

Needless to say, I was greatly impressed by this kindly gentleman, who, if memory serves, was on a bond drive but found the time to visit with us and effected a long-lasting influence on a young man.

Not too long after that meeting and stimulated by the General's words, I began a twenty-five-year career in USAF—without doubt well below the standards set by Jimmy Doolittle. I never forgot the wisdom he imparted to me: Use your ability as best you can in service to others.

It is not common knowledge, and I have seen no mention in his many obituaries, but Jimmy Doolittle was knighted and in 1953 was elevated to the rank of Knight-Commander of the Military Order of Saint John of Jerusalem (Knights of Malta). . . .

His passing is a grievous loss to many of his comrades and is particularly felt by his fellow military members who shared knighthood with him.

We shall always remember a small man with an enormous heart and great mind.

Harrold H. Miller
Toney, Ala.

Your wonderful color cover photo of General Doolittle will be a lifetime memento for me. The very small town in Missouri where I grew up has streets named for Generals Eisenhower and MacArthur and President Truman. The most important thing, however, is that the town's name is Doolittle!

I had very good reason to be aware of General Doolittle's career and accomplishments. I have also been fortunate to have been a member of AFA—an organization that appreciated General Doolittle and was obviously close to his heart.

Thank you for the cover, which I will treasure.

William E. DeLashmit
Plymouth, N. H.

Congratulations to C. V. Glines for a wonderful article. Jimmy Doolittle was one of aviation's outstanding pioneers.

Of interest is the picture of Jimmy Doolittle and his B-25 crew, taken prior to their attack on Japan [p. 24]. On Doolittle's A-2 jacket, there is a patch symbolizing Wright Field, Ohio, of days gone by. This symbol belonged to the flight test organizations there.

General Doolittle had a close working relationship with Wright Field and, as stated in the article, spent many significant years testing aircraft at

McCook Field, which preceded Wright Field. These fields were the site of flight testing of military aircraft prior to and during World War II. Wright Field was an exciting place to be then. I was fortunate to have been working there, assigned to the Flight Test Branch as a civilian mechanic. One memorable moment was assisting in changing the engine of Doolittle's assigned P-40. He was then a major, shortly after coming on active duty in 1940.

Here on Long Island, N. Y., Doolittle's famous air feats are not forgotten. We have, at old Mitchel Field, the Cradle of Aviation Museum housed in two hangars and the firehouse. Prior to their tour of this museum, visitors are briefed on Doolittle's famous blind flights, which were conducted a short distance from the hangars.

Lt. Col. Anthony R. Gludino,
USAF (Ret.)
Commack, N. Y.

LeMay Remembered

My first impression, when reviewing the November *AIR FORCE Magazine*, was to compare the extensive coverage given to the career of James H. Doolittle with that provided in November 1990 to cover the accomplishments of the late Curtis E. LeMay. As I recall, that issue included approximately half a page recounting his distinguished career—in my opinion, hardly adequate.

I do not question the eight-page article and the cover photograph of General Doolittle. His illustrious career certainly justifies this coverage. In comparison, the scant half-page tribute to General LeMay did not do justice to his tremendous deeds. General Doolittle's career was longer than General LeMay's, but, in the opinion of many, General LeMay's accomplishments during World War II surpassed General Doolittle's. LeMay devised the most effective tactics to employ both the B-17 and the B-29; he was the preeminent air commander of World War II. His achievements after the war included building SAC, initially setting up the Berlin Airlift, and rising to Chief of Staff of the Air Force.

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

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1st	F-16	F-16
2nd	F-16	F-16
3rd	F-16	F-15E
4th	F-16	F-16
5th	F-15E	F-16
6th	F-16	F-16
7th	F-16	F-15E
8th	F-15E	A-10
9th	A-10	F-16
10th	F-16	A-10

F-16 Competition Awards

- #1 – Overall Competition
- #1 – Fighter Team
- #1 – Operations Team
- #1 – Top Gun
- #1 – Dive Bombing
- #1 – Low Angle Bombing
- #1 – Navigation Attack
- #1 – Fighter Maintenance



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Letters

One wonders if the lack of coverage is due to possible resentment of LeMay. After all, until World War II, he was essentially an unknown—an “outsider”—not a service academy graduate. He was taciturn and slightly pudgy. His ill-advised, brief foray into politics after retirement must have annoyed many, but that should not detract from what he accomplished while in uniform.

Lt. Col. Hector F. Evans, Jr.,
USAF (Ret.)
Fountain Hills, Ariz.

■ *In the same issue as the item mentioned by Colonel Evans, Gen. T. R. Milton, USAF (Ret.), paid tribute to General LeMay with “Last Visit With LeMay,” which used the General’s words to sum up his life and work. In the January 1987 issue, Maj. Gen. Dale O. Smith, USAF (Ret.), discussed LeMay’s contributions to US airpower in “The Airman Who Shook the World.” Far from harboring resentment toward Curtis LeMay, AIR FORCE Magazine is second to none in recognizing his many accomplishments, and the tribute to Doolittle in no way detracts from the legacy of LeMay.*—THE EDITORS

Hank Redmond’s Crew

I have a correction with regard to the caption on p. 63 of the September issue [“The Jacket That Lives Forever”], which reads, “Above are members of Hank Redmond’s B-24 crew of the 12th Bomb Group.”

My brother, a former lead bombardier with the 12th Bomb Group, assures me that his group was issued B-25s, not B-24s.

Richard Taylor
Wintersville, Ohio

Success at Warner Robins

I always look forward to the informative articles in AIR FORCE Magazine—especially those that focus on the people and the mission of our Air Force Materiel Command. As Senior Editor James W. Canan pointed out in his article [“Materiel Command Faces Uncertainty,” November 1993, p. 26], our commander, Gen. Ronald W. Yates, believes the Air Force should permit the defense industry to compete for its annual \$4 billion projects.

Although the article did not mention Warner Robins Air Logistics Center in the text or captions, let me assure you that we at Robins AFB, Ga., are at the forefront of such programs.

Peter Grier, in your March 1993 issue [“Warner Robins, Inc.,” p. 54], reported on our successful bid to replace the center wing boxes on 113

C-141s. Because of the proven skill and ingenuity of our people at Robins AFB, we were able to bid more than fifty percent lower than the next most competitive offer and won the repair project bid on the open market. We continue to implement the two-level maintenance system, called the most important task in AFMC today, and pioneer the F-15 Integrated Weapon System Management program.

Our high-quality people and the support of the Warner Robins community will continue to help us effectively compete and provide our high level of service to the Air Force, while saving money for the taxpayers as the defense budget continues to decline.

Maj. Gen. William P. Hallin, USAF
Commander, Warner Robins ALC
Robins AFB, Ga.

A Crew Dog’s Life

When I first began reading “The Loadmasters” [October 1993, p. 44], I was glad to see fellow “crew dogs” getting some well-deserved and long overdue praise and recognition. As I read on, I was very much offended.

I am a C-130 flight engineer with seven years and more than 2,200 hours of flight experience. In C-130s, as with other multiplace aircraft, the crew concept is very important. But after reading this article, I was amazed to see how it praised only one crew dog at the expense of the others.

For example, the article said that much of the loadmaster’s work was never seen because “the crew bus has carted everybody else off to a hot meal and a warm bed while he is still at work.” It failed to say that during the loadmaster’s early “showtime,” the flight engineer was right there, accomplishing his preflight, which encompasses inspecting the entire aircraft and all the systems that keep it flying.

As for the rest of the crew, that crew bus is transporting them to Base Operations, Weather, and other locations, where they are involved in flight planning and other tasks. At the end of the day, the loadmaster is not left to fend for himself while the rest of the crew goes off to a warm bed. Crew duty day does not end until the last crew member departs the aircraft.

The suggestion that the loadmaster is “ultimately responsible” for “hefting luggage from the cargo ramp and humping it to the crew bus” is absolutely ridiculous. It isn’t just “all too familiar to other crew dogs.” They’re dragging bags to that bus, too.

I’m glad to see crew dogs get well-deserved praise, but to demean other crew members, who have important

and stressful jobs, is uncalled for. The C-130 world is not only short on loadmasters. It also needs flight engineers, pilots, and navigators. It is a tough life, especially in these lean times, but we're all out there plugging away, long deployment after long deployment, doing our jobs in a professional manner.

To suggest that one crew dog has it tougher or has more weight on his or her shoulders is ridiculous, just as it is ridiculous to suggest that other Air Force specialties have a lesser load.

We are all proud of our jobs, but the loadmasters quoted in this article sounded as if they were complaining rather than showing pride. We are a crew in the true meaning of the term—pilots, navigators, flight engineers, and loadmasters alike. . . .

TSgt. David D. Massey,
USAF
Satellite Beach, Fla.

Korean War Memories

The picture of Lt. Warren Guibor in the cockpit of the F-80 from the 80th Fighter-Bomber Squadron of the 8th Wing that flew the wing's 50,000th sortie really rang my memory chimes [*"Cold War Color,"* October 1993, p. 52]. When I saw the picture, I could hardly believe my eyes.

I graduated from the Avionics Officers Maintenance School at Lowry AFB, Colo., in February 1952, and my first assignment as a second lieutenant fresh out of school was as the Avionics Maintenance Officer for the 80th (Headquarters) Fighter-Bomber Squadron of the 8th Wing. I had the responsibility for loading the ordnance on the F-80 that Lieutenant Guibor flew on that 50,000th sortie.

Col. Edward H. Curtis,
USAF (Ret.)
Arlington, Tex.

Admirable "Aardvarks"

The article by Maj. Michael J. "Boone" Bodner and William W. Bruner III [*"Tank Plinking,"* October 1993, p. 28] warmed the heart of this former "Aardvark Aviator." Congratulations on an article that illustrates the unique capabilities of the F-111 without diluting them by comparisons to the B-52.

In the past, the precision bombing capabilities of the F-111 have been appreciated more by the Russians than by military analysts in this country. It is comforting to learn that our own military planners have recognized these capabilities and employed them better than the planners in Vietnam did.

I am envious of Majors Bodner and Bruner for having had the opportunity to realize the full potential of the F-111. What a thrill it must have been to have had "open season" on tanks that didn't

know where or when the next bomb would drop. I am equally impressed that they have presented such an interesting account of the development of the "new" tactic.

Medium-level bombing was conducted in Laos and Cambodia in 1973 by F-111s, in admittedly low-threat environments, though not with the accuracy possible with today's technology. However, the capabilities of the F-111s in 1973 were extended by assigning them to "pathfind" for other aircraft, such as the F-4. . . .

Lt. Col. Gordon M. Amsler,
USAF (Ret.)
Alexander City, Ala.

Docs to the Rescue

I have just read "The Docs and the Jocks" [*August 1993, p. 38*] and certainly enjoyed it, but I feel that you neglected one mission in which flight docs can really shine. The flight surgeon's role during a rescue mission can be critical as he observes circumstances similar to the stresses of combat. While flying in the Air Force's search-and-rescue (SAR) helicopters, flight docs work closely with para-rescue specialists to save lives in extremely difficult circumstances.

One of the best examples of this tradition was Maj. Brian "Doc" Parsa, who flew on frequent long overwater missions out of NAS Keflavik, Iceland, with the 56th Rescue Squadron. Major Parsa, who earned an Air Medal on one of those missions, even volunteered to act as a survivor during an SAR exercise requiring him to ride in a two-man raft fifty miles off the coast in very cold water.

An SAR mission allows the flight surgeon to be a crew member and practice lifesaving skills at the same time. While the image of flying with an F-16 jock is appealing, the docs I have known would cancel that sortie for a rescue mission—anytime, any day.

Lt. Col. Dale A. Kissinger,
USAF
Annandale, Va.

Errata

In "Up From Kitty Hawk" on p. 34 of the December 1993 issue, Capt. Steve Ritchie and Capt. Chuck DeBellevue were misidentified. On p. 35, the article correctly noted the records set by Major Bledsoe and Captain Joersz but omitted Captain Robert C. Helt, who set the altitude record. The three pilots' reconnaissance systems officers were Maj. John T. Fuller, Maj. George T. Morgan, Jr., and Maj. Larry A. Elliott, respectively.



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By Brian Green, Congressional Editor

The Legislative Finish

From personnel to weapon systems, here are the highlights of the FY 1994 defense bills.

IN ITS final version of the Fiscal 1994 national defense budget, Congress approved a small military pay raise, several new personnel benefits, and most of the funding requests for key Air Force programs, including the F-22 fighter, C-17 airlifter, and B-1 and B-2 bombers. The \$260.9 billion authorization bill and a companion defense appropriations bill were completed in November and signed by President Clinton.

Personnel

Pay raise. Congress approved a 2.2 percent increase in active-duty military basic pay, basic allowance for quarters, and basic allowance for subsistence. President Clinton's 1994 budget submission, unveiled in March, proposed to freeze the pay of both civilian and military personnel, but the services found money to fund a troop pay raise because they cut end strength more rapidly than planned. Civilian defense employees did not get an across-the-board raise, but some received an increase based on the gap between private-sector and federal pay levels in the region where they work. The new locality pay system, phased in over a nine-year period, will provide increases to white-collar civil servants to dramatically reduce this gap.

Ban on homosexuals. The defense legislation codifies the White House-Congress compromise that bans openly homosexual men and women from serving in the military.

Combat exclusion. The authorization bill ends the long-standing exclusion of women from combat vessels.

Benefits

Health-care program. The defense appropriations bill, which funds authorized defense programs, ordered the Defense Department to establish a nationwide military health-care system "featuring a uniform,

stabilized benefit structure for all military members, retirees, and their families." Congress wants it to include care for eligible beneficiaries at bases to be closed, over-the-counter prescription drug programs, dental benefits, and mental health-care benefits.

Permanent change of station cost. The lawmakers authorized improved reimbursement of temporary lodging expenses incurred during permanent changes of station.

Transition assistance. Congress extended transition assistance programs, including the Voluntary Separation Incentive and the Special Separation Benefit, through the end of Fiscal 1999.

Veterans Issues

COLA caps. A deficit reduction proposal sponsored by Reps. Timothy J. Penny (D-Minn.) and John R. Kasich (R-Ohio), which was not part of the defense budget debate per se, included provisions that would have eliminated cost-of-living allowances (COLAs) for military retirees under the age of sixty-two and reduced federal contributions to civilian employees' thrift savings plans. The House rejected the proposal. This summer, Congress approved an annual COLA, deferred in 1994 until April.

COLA for disabled vets. A separate veterans bill provides a 2.6 percent COLA for disabled veterans and dependency indemnity compensation recipients.

Medal of Honor pension. Another veterans bill increases the pension received by Medal of Honor recipients from \$200 a month to \$400 a month.

Major Weapons Programs

Heavy bombers. The congressional budget gives the Air Force authority to release previously approved funding for the last four B-2 bombers and approves virtually all the funding requested for Fiscal 1994. The program remains capped at twenty aircraft, to be built at a total cost of \$44.4 billion.

Authorization conferees recognized

that the B-1B force is "irreplaceable" and "must be given improved conventional weapons capability in order to meet possible near-term contingencies." B-1B procurement is boosted from the request of \$163 million to \$232 million.

Fighters. The lawmakers fully authorized the \$2.2 billion request for development of the F-22, the Air Force's stealthy, next-generation air-superiority fighter. When it actually appropriated money, however, Congress trimmed the amount by \$163 million, a move which could force rephasing of the program.

Congress approved \$400 million for twelve new F-16 fighters, a sharp cut in the USAF request for \$725 million for twenty-four.

The appropriations bill approved \$30 million of the Pentagon's \$50 million request for the new Joint Advanced Strike Technology (JAST) program. The program is to provide common technology for aircraft to replace the canceled Navy A/F-X deep strike and Air Force Multirole Fighter programs. The authorization bill, however, approved only \$10 million to start such an effort.

C-17 transport. Congress approved the six C-17 airlifters requested, but it fenced some of the funding and provided other airlift options. The Air Force requested a total of \$2.4 billion for six C-17s in FY 1994 and advance procurement of components for another eight in FY 1995. Congress authorized \$1.9 billion to fund four planes in 1994 and buy components for six next year. It also provided for up to \$400 million either to buy two additional C-17s in 1994 or to procure "nondevelopmental intertheater airlift alternatives."

Space. The authorization bill consolidated into a single funding account about \$900 million for such spacebased surveillance and warning programs as Brilliant Eyes, the Follow-On Early Warning System (FEWS), and the Defense Support Program. The account is to be controlled by the Secretary of Defense. However, the Pentagon intends to terminate the FEWS program. ■

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The Chart Page

By Tamar A. Mehuron, Associate Editor

The Final Fiscal 1994 Defense Budget

Total National Defense Program

(Budget authority in billions of current dollars)

Category	FY 1993 Final	FY 1994 Request	FY 1994 Final
Military personnel	76.3	70.1	70.2
Operations and maintenance	86.4	89.5	87.4
Procurement	53.6	45.5	46.3
Research, development, testing, and evaluation	38.2	38.6	34.7
Military construction and family housing	4.6	7.0	10.1
Department of Energy and other	13.9	12.7	12.2
Total National Defense	273.0	263.4	260.9

Service Shares

(Budget authority in billions of current dollars)

Service	FY 1993 Final	FY 1994 Request	FY 1994 Final
Air Force	78.5	76.5	74.3
Army	63.6	61.7	56.9
Navy	82.6	78.9	74.8
Defense Agencies	34.2	37.1	42.7

Includes active-duty, Guard, and Reserve personnel; operations and maintenance; procurement; research, development, testing, and evaluation; and military construction and family housing.

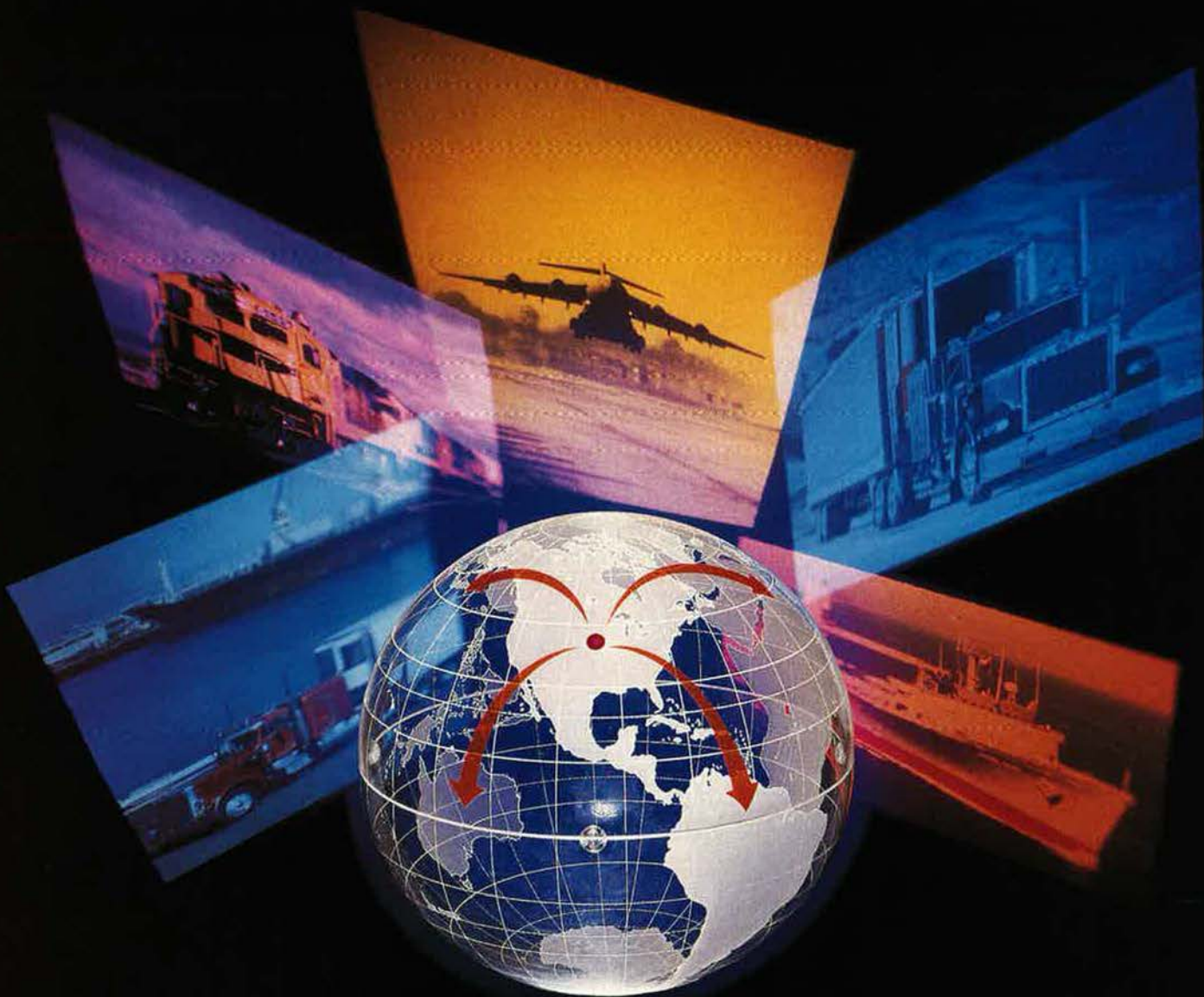
The figures here are expressed as budget authority, which is the value of new obligations that the government is authorized to incur. These include some to be met in later years. Figures are stated in current dollars, not adjusted for inflation. This is the actual amount of dollars that has been or is to be spent or budgeted. (Figures in all tables have been rounded.)

Key Air Force Budget Figures

(Budget authority in billions of current dollars)

Category	FY 1993 Final	FY 1994 Request	FY 1994 Final
Personnel	20.3	17.6	17.8
Operations and maintenance	21.1	23.8	23.3
Procurement	22.0	19.6	18.5
Research, development, testing, and evaluation	13.2	13.7	12.3
Military construction and family housing	2.3	2.1	2.4
Net offsetting receipts	-0.3	-0.3	0.0
Total	78.5	76.5	74.3

Includes active-duty, Guard, and Reserve.



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Aerospace World

By Frank Oliveri, Associate Editor

Nuclear Forces Face Big Change

At the direction of Defense Secretary Les Aspin, the Pentagon has embarked on a comprehensive review of the US nuclear posture. The review foreshadows substantial change in the nation's strategic arsenal.

The review, first of its kind in more than a decade, seeks input from the Office of the Secretary of Defense, Joint Staff, armed services, and various commands. It will examine nuclear policy, doctrine, targets, force struc-

ture, operations, safety and security, and arms control efforts. The seven areas will be studied together rather than as separate entities.

shape US conventional forces but that "the world has changed even more fundamentally for our nuclear forces."

Two Named to High USAF Posts

The Pentagon announced in November the nominations of Edwin A. Deagle, Jr., to be under secretary of the Air Force and Clark G. Fiester to be assistant secretary of the Air Force for Acquisition.

Mr. Deagle is director of business development and manager of prod-

forces with 1,622,700 active-duty troops. President Clinton signed the Fiscal 1994 Defense Authorization Act on November 30.

The congressional budget plan calls for the Air Force to lose 32,400 more airmen during FY 1994, which ends next September 30. Service end strength will drop from 458,100 to 425,700. The Air Force hit a Cold War peak of 608,199 in 1986.

The following active personnel levels were approved: Army, 540,000;



Defense Secretary Les Aspin meets US troops during his November visit to Osan AB, South Korea. The Secretary was in South Korea for annual security meetings with members of the Republic of Korea's Ministry of National Defense.

uct operations at Hughes Identification Devices, a subsidiary of Hughes Aircraft Co. A former Army officer, he was decorated five times for valor during combat tours in Vietnam.

Mr. Fiester, a consultant with GTE Government Systems Corp., serves on the Army Security Agency Advisory Board and belongs to the Air Force Association and Arnold Air Society.

Mr. Aspin said that results from the review were likely to be available by late spring 1994 and that the conclusions will have an impact on planning for force structure and weapons. He noted that the Pentagon undertook a six-month Bottom-Up Review to re-

shape US conventional forces but that "the world has changed even more fundamentally for our nuclear forces."

More Force Cuts in Store

Wrapping up work on the Fiscal Year 1994 defense budget, Congress authorized a \$262 billion spending blueprint that further reduces the size of the military, leaving the armed

Army, 540,000; Air Force, 425,700; Navy, 480,000; and Marine Corps, 177,000.

The act sets Air National Guard and Air Force Reserve end strengths at 117,700 and 81,500, respectively, down from 119,400 and 82,400 last year.

Readiness to Be Monitored

If the Fiscal 1994 Defense Authorization Act is any guide, Congress wants to keep close tabs on the readiness of the armed forces as defense spending declines.

According to this year's defense budget report, Congress wants the Chairman of the Joint Chiefs of Staff to provide an annual assessment of

force readiness for the next three years, focusing on the armed forces' ability to carry out their missions and the risks they may face in countering threats to national security.

Air Force operations and maintenance funding declined from \$21 billion in Fiscal 1993 to \$19.3 billion in Fiscal 1994. The Air Force Reserve O&M account increased from \$1.26 billion to \$1.34 billion in FY 1994, while the ANG account declined from \$2.72 billion in FY 1993 to \$2.6 billion in FY 1994.

The act, passed late last year, requires the JCS Chairman to provide his assessment on March 1, 1994, 1995, and 1996. The assessment will include information for the fiscal year in which the assessment is done and the three preceding fiscal years, plus a projection for the next fiscal year.

The JCS Chairman will also personally assess the readiness of the armed forces and judge whether there are problems or risks regarding readiness and capabilities. The Chairman will then recommend a course of action.

The unclassified report will consider personnel; training and exercises; logistics; equipment modernization; installations, real property, and facilities; munitions; mobility; and wartime sustainability.

Reservists Help Fight Fire

Members of USAF's Air Reserve Component lent a big hand to fire-fighting efforts in southern California by dropping tons of chemical retardants on raging fires. The operation in late October enlisted the aid of Air Force Reservists from the 302d Airlift Wing, Peterson AFB, Colo., and Air National Guardsmen from the 146th Airlift Wing, Channel Islands ANG, Calif., and 153d Airlift Group, Cheyenne, Wyo.

The airmen staged from Channel Islands ANG. Their units flew modified C-130 transports equipped with the Modular Airborne Firefighting System, which sprays chemicals in much the same way that crop dusters spray pesticides. The agent most frequently dropped is the commercial chemical Phos Chek.

The aircraft can spray about fifteen tons of the liquid chemical over an area the size of five football fields in less than six seconds. It can fly at an altitude of 150 to 200 feet and travel at about 140 miles per hour.

Six C-130s dropped nearly two million pounds of retardant in one week.

Memorial Honors Servicewomen

In a Veterans Day ceremony in Washington, D. C., Vice President

Albert Gore dedicated the new Vietnam Women's Memorial in West Potomac Park near the Mall.

The statue depicts two nurses aiding a wounded soldier. Its dedication culminates a ten-year effort led by Dianne Carlson Evans, who served as a nurse during the Vietnam War and who conceived the idea of the memorial.

The memorial, sculpted by Glenna Goodacre, commemorates the efforts of the 265,000 women who served in uniform during the Vietnam War, including 11,000 who served in Vietnam. Vice President Gore, a Vietnam veteran, said that about two-thirds of the 11,000 were exposed to combat and many were wounded. Eight died in Vietnam. Their names are engraved on the black granite wall of the Vietnam Veterans Memorial.

Nunn Hits Defense Cuts

Sen. Sam Nunn (D-Ga.), chairman of the Senate Armed Services Com-

Clinton's proposal" issued in March 1993.

In a floor speech, Senator Nunn declared that the 1990 Budget Summit Agreement was supposed to produce a net five-year reduction in deficit spending of \$500 billion but that the deficit will grow by \$500 billion during this period.

"Despite this," he said, "the defense budget was cut, just as planned in the 1990 Budget Summit Agreement. All the defense cuts were made as planned, but the rest of the savings have not materialized." No other category—spending on entitlements, interest payments, or revenues—met goals set at the summit, said Senator Nunn.

B-2 Team Wins Schriever Trophy

The government team in charge of producing the B-2 bomber won the 1993 Gen. Bernard A. Schriever Trophy, the Air Force announced.

The trophy goes to the Major Pro-



President Clinton placed a wreath on the Tomb of the Unknowns at Arlington Cemetery on Veterans Day. He paid special tribute to the more than twenty-seven million living American veterans, a constant reminder of past struggles.

mittee, told his colleagues that the Department of Defense is carrying more than its share of the government's deficit-cutting burden. Meanwhile, he said, other types of so-called "discretionary" federal spending have risen.

"It is increasingly clear," the Senator said, "that a combination of forces in the Administration and in the Congress—the fiscal squeeze and the strong desire to fund other programs—continues to erode the defense budget substantially below President

gram Team of the Year, chosen by Air Force Materiel Command. The award signifies superior program management and efforts that greatly benefit the Air Force and the nation.

The team consisted of the B-2 Program Office at Wright-Patterson AFB, Ohio; Oklahoma Air Logistics Center at Tinker AFB, Okla.; B-2 Combined Test Force, Air Force Flight Test Center, Edwards AFB, Calif.; Site Activation Task Force, Whiteman AFB, Mo.; and B-2 Mission Planning System

Development Office, Hanscom AFB, Mass.

F-16s Show Their Stuff

In Gunsmoke '93, the 388th Fighter Wing, Hill AFB, Utah, won the overall, fighter, and fighter operations awards. Pilots of the 388th flew the new Block 50 versions of the F-16C. The top bomber team at the October meet was the 93d Bomb Wing, Castle AFB, Calif., flying B-52s. [See p. 40.]

In the USAF air-to-ground meet, units flying F-16s took five of the top six positions in the overall competition; six of the top seven positions in the bombing finish; and first place in fighter team, operations team, top

The October records were set during a routine test mission at Edwards AFB, Calif. "P-1," the first production C-17, set records in the gross weight category of 551,000-661,000 pounds. The first record came when the plane flew a 161,023-pound payload to an altitude of 8,860 feet. The previous record in this weight class was 67,177 pounds, set by a Soviet aircraft in 1989.

In the second record-breaking mission, the C-17 carried a 161,023-pound payload to an altitude of 32,152 feet.

McDonnell Douglas delivered the third operational C-17 to the Air Force in November. The new C-17 will go to

fitness center, children's playground, snack bar, and full-service restaurant.

Troops in Germany Face HIV Scare

US service members in Germany were caught up in a health scare when authorities there discovered that blood containing the human immunodeficiency virus (HIV) was used for transfusions and plasma products. HIV has been linked to acquired immunodeficiency syndrome (AIDS).

Air Force medical officials in Europe said very few American service members could actually be affected. They explained that, based on the most current information, exposure could have happened only to those who had received a transfusion of plasma products in a German facility since 1985.

US Air Force blood supplies are checked for HIV. Personnel concerned that they are at risk will be tested for the AIDS-producing virus, the Air Force said.

President Kicks Off TRP Contracts

In October, President Clinton announced the names of the first companies, universities, and research organizations to win contracts under the Technology Reinvestment Project. Selections included forty-one proposals representing the efforts of 272 industrial and academic organizations.

In Fiscal 1994, the Advanced Research Projects Agency will award a minimum of \$464 million in defense funds for these efforts. The Administration's defense reinvestment program emphasizes investments in dual-use technology for both commercial and military applications.

Defense Secretary Les Aspin said, "The companies and organizations selected today will spearhead the Clinton Administration's efforts to revitalize the US economy and create jobs and will improve many aspects of life in the US. The Technology Reinvestment Project is an example of how we can use defense dollars in a way that not only insures a strong defense but also benefits the US's commercial position."

The Pentagon says it will rely heavily on dual-use technologies as a key element in creating jobs and stimulating economic growth, while fostering the kinds of technological advances required for defense. The TRP is seen as a major step toward integrating the military and commercial production bases.

Photo by Ross Harrison Koty



Gunsmoke '93 turned into an F-16 show. F-16 units won overall, fighter, and fighter operations awards. B-52 and B-1B bombers made their Gunsmoke debut, reflecting the evolving mission of the big bombers. (See story on p. 40.)

gun, dive-bombing, low-angle bombing, navigation and attack, fighter maintenance, and arrival.

Taking part in the competition were seventeen teams representing Air Combat Command, US Air Forces in Europe, Pacific Air Forces, the Air National Guard, and the Air Force Reserve. B-1B and B-52 bomber crews and their ground support personnel took part in Gunsmoke for the first time.

C-17 Sets More Records

The C-17 airlifter continues to shatter records. It broke two more in October, bringing to twenty-one the number of records set by the McDonnell Douglas transport aircraft.

Charleston AFB, S. C., to join the 437th Airlift Wing.

The Army's Disney Invasion

The Pentagon said in November that the Army was leasing a 288-room Disney Inn at Walt Disney World in Orlando, Fla., as an Armed Forces Recreation Center for all military members, including retirees and their families.

The inn will be renamed The Shades of Green on Walt Disney World Resort and should open in February. Rates will be based on a guest's rank.

The new resort will operate on funds from hotel operations alone, not taxes. It features two swimming pools, two tennis courts, an arcade,

California Aids Veterans' Children

California Governor Pete Wilson signed a bill increasing tuition waivers and fee waivers for the children of disabled veterans, veterans killed in service, and veterans who died of a service-related disability. The November action raises the waiver from \$5,000 to \$7,000, effective July 1, 1994.

The California Department of Veterans Affairs administers a college fee waiver program for children and dependents of certain veterans. The fee waiver is applicable to California community colleges, state universities, and the University of California. Benefits are awarded annually, and awardees must reapply each year.

Reserve Unit Changes

In 1993, the Air Force Reserve received B-52H bombers for the first time. The 46th Fighter Training Squadron (Associate), Robins AFB, Ga., received eight of the updated BUFFs.

In mid-1994, the 507th Fighter Group, Tinker AFB, Okla., will become an air refueling group and convert from twenty-four F-16 fighters to ten KC-135 tankers.

The 98th Air Refueling Group (Associate) will move from Barksdale AFB, La., to McGuire AFB, N. J., along with its active-duty counterpart and nineteen KC-10 tankers, with the first ten aircraft arriving in late 1994. The 514th Airlift Wing (Associate) will remain at McGuire AFB as a Reserve associate unit and assume Reserve command and control of the 98th ARG. The Air Force will eventually base twenty-four KC-10As at McGuire, but the timing for the arrival of the remaining fourteen aircraft has not been set.

Travis AFB, Calif., will receive ten KC-10A tankers in late 1994 as the 79th Air Refueling Squadron (Associate) transfers to Travis from March AFB, Calif. The 349th AW (Associate) will resume Reserve command and control of the 79th ARS (Associate). The Air Force plans to base twenty-four KC-10A tankers at Travis. The arrival date of the last fourteen aircraft is not known at this point.

The 916th ARG (Associate) at Seymour Johnson AFB, N. C., will end its KC-10 associate unit status in late 1994 and receive ten KC-135 tankers.

The 924th Fighter Group will remain in a cantonment area at Bergstrom ARS, Tex., and operate the

base as a Reserve-owned installation through the end of 1996. The decision to modernize the unit's F-16A/B fighters has been put on hold indefinitely.

As a result of a Base Realignment and Closure Commission decision, the 482d Fighter Wing and its F-16A/Bs will not transfer from Homestead AFB, Fla., to MacDill AFB, Fla. The unit will remain at Homestead in a cantonment area upon completion of construction. The unit's conversion from F-16s to KC-135s was canceled.

The 301st Rescue Squadron and its HC-130N/P and HH-60G aircraft will temporarily move from Homestead to Patrick AFB, Fla., in a permanent change of station status. Upon completion of construction, the unit will return to Homestead.

Vouchers for Maternity Clothing

The Air Force said in November that it had begun to provide vouchers for maternity clothing.

The Fiscal 1994 maternity clothing allowance is \$231.25 per person, and mandatory items will cost \$117.60, the Air Force said. The remaining cash may be used for optional maternity clothing.

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If the clothing costs less than the allowance, the woman forfeits the balance of the voucher.

Yates: USAF Needs to Cut Depots

Gen. Ronald W. Yates, the head of Air Force Materiel Command, acknowledged that the service will have to curtail or end operations at some of its depots. He said selection of winners and losers should be determined through competition.

"There is no question we need to downsize the defense depot structure," said the AFMC commander in a statement at the *Aviation Week—Aerospace Industries Association* government industry forum held last October in Washington. "The question is, how should downsizing be done while still preserving a strong, viable depot maintenance structure in support of our armed forces?"

The most likely survivors will be those that are most competitive and



Capt. Bobby Loher (foreground), an instructor pilot with the 52d Flying Training Squadron, Reese AFB, Tex., became the first Air Force pilot to log more than 1,000 hours in the T-1A Jayhawk in November.



Air Force Materiel Command's Electronic Systems Center, Hanscom AFB, Mass., awarded Boeing a contract to deliver two 767 AWACS planes to Japan. The \$408 million contract will be completed in March 1998.

least expensive to operate, he said. To weed out weaker depots, General Yates advocates vigorous competition among them. For defense contractors to compete with Air Force depots, said General Yates, they must lower their overhead.

Widnall Seeks to Improve Intelligence System

Because the Air Force's intelligence and surveillance capabilities are less robust than during the Cold War, the

US must improve threat detection, data processing, and dissemination systems, Air Force Secretary Sheila Widnall said in November.

"If I had to single out one challenge, it would be to speed up the process of getting intel[ligence] from the collectors to air, ground, and sea forces," Dr. Widnall said. "Besides supporting decision-makers, we need to add the combatants to our list of priority customers. They need near-real-time battle damage assessments,

planning information for combat missions, and intel pumped directly into their cockpits."

F-15Es to Gather at Seymour Johnson

The Air Force has decided to transfer F-15E Initial Qualification Training from Luke AFB, Ariz., to Seymour Johnson AFB, N. C., by late 1994 as part of a force-structure and realignment proposal.

The action will give Seymour Johnson an additional twenty-eight F-15Es and 781 full-time military and sixteen civilian personnel. Twenty-five F-16C/D aircraft will be transferred to the 58th Fighter Wing at Luke this year. This will consolidate active-duty and Air Reserve Component F-16 training at Luke.

More Overseas Facilities Close

The Department of Defense announced in October it would close or reduce operations at fourteen additional US military sites overseas, four of which are USAF facilities.

Air Force locations affected are Eisenach Storage Annex, Trier, Bitburg AB, Germany; Geilenkirchen Storage Annex, Geilenkirchen, Bitburg; Mötsch Ammunition Storage Annex, Trier, Bitburg; and Rötgen Communication Tower, Lammersdorf, Bitburg.

Of the fourteen major locations, thirteen are in Germany and the United Kingdom, the nations with the largest concentrations of US forces in Eu-

rope. The Pentagon announcement stated, "This is a smaller number of facilities than listed in previous announcements because the Department of Defense has nearly completed its reduction of sites in Europe to get down to a troop level of about 100,000 by the end of 1996."

The new reduction brings to 854 the number of locations overseas where operations have been ended, reduced, or placed on standby in the last three years. Of that number, 786 are in Europe. These cutbacks drop about 231,000 authorized positions.

USAFE's Oldest Unit Inactivated

The 55th Fighter Squadron, the oldest flying unit in US Air Forces in Europe, closed down in October.

The unit was inactivated at RAF Upper Heyford, UK. This ended the presence of F-111 fighters in Europe and concluded the commitment of the 20th Fighter Wing to US Air Forces in Europe. The seventy-six-year-old squadron had been located at RAF Upper Heyford since 1971.

The 55th was the largest squadron in Europe. A few F-111s will be on permanent display in the US and England, but nearly all of the aircraft will be retired to the Aerospace Maintenance and Regeneration Center at Davis-Monthan AFB, Ariz.

Upper Heyford will be completely closed in September 1994. About 2,000 personnel still serve at the base.

Top USAF Recruiting Squadron

In October, the Air Force named the 337th Recruiting Squadron as its top recruiting squadron for 1993.

The unit beat twenty-eight others for the win. The 337th is responsible for most of North Carolina and two-thirds of South Carolina.

The 337th signed up 1,216 active-duty enlistees in Fiscal 1993 and 1,154 people in the delayed enlistment program. The unit, based at Shaw AFB, S. C., also brought in six fully qualified doctors and twenty nurses. The goals were four doctors and thirteen nurses.

In 1993, the Air Force enlisted 30,000 people and expects to do the same in 1994.

Athletes of the Year

Two officers were named the 1993 Air Force female and male athletes of the year in November.

Capt. Teresa Lewis, Seymour Johnson AFB, N. C., and 2d Lt. Matthew Zuber, McClellan AFB, Calif., both gold medal winners at the 1993 Olympic Festival at San Antonio, Tex., are now in the running for the 1993 Armed Forces Athlete of the Year Award.

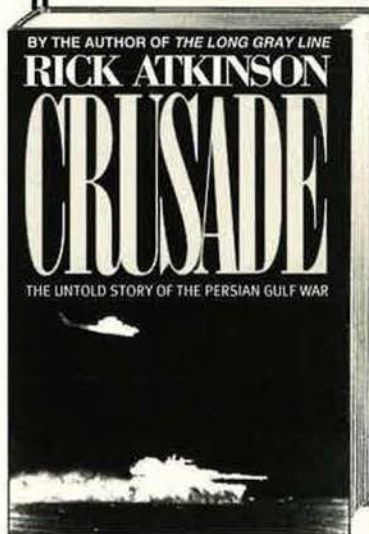
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Captain Lewis, a bioenvironmental engineer, won a gold medal in team fencing and silver medals in the individual and team pentathlons at the Olympic Festival. Lieutenant Zuber, a flight-test engineer, won a gold medal in the decathlon.

Arrow Fails to Destroy Missile

The US-Israel Arrow antimissile missile program suffered a minor setback in October. In a test in Israeli airspace, the interceptor acquired and homed in on the target but failed to destroy it, according to the Israeli Ministry of Defense.

The Ministry said the Arrow locked on to its target and passed "as closely as possible." However, "the Arrow warhead did not work, and the target missile was not destroyed." The results of the test are being examined.

It was the sixth test of the Arrow missile and the second one in which a target was intercepted, the Defense Ministry said. While the Arrow program is a joint US-Israel project, the missile is being developed principally for the defense of Israel. Technologies developed in this program will benefit development of US antimissile systems.

Computers Aid Cancer Research

The Air Force is redirecting the capabilities of computers used in weapons research to fight cancer. USAF computers can process information millions of times faster than those currently used by the medical research community. The service said its com-

puters will enhance the accuracy and usefulness of mammograms, the X rays used to detect breast cancer.

Image scanners convert X-ray information into digital information. Digital mammography produces a highly refined image revealing information not normally seen on X-ray film.

Wright Laboratory's Armament Directorate at Eglin AFB, Fla., is part of a worldwide research team that seeks to advance the technology to a level of sophistication that will allow mammographers to detect breast tumors only one millimeter in diameter. About one in five mammograms today fails to detect existing tumors. New techniques could cut that failure rate significantly.

Streamlined DSB Confirmed

John Deutch, the under secretary of Defense for Acquisition, announced in October the members of the newly configured Defense Science Board, a senior independent advisory body.

The DSB has been streamlined, dropping from forty-two to thirty-one members. They will serve through December 31, 1995. The board advises the Defense Secretary, deputy Defense Secretary, JCS Chairman, and under secretary of Defense for Acquisition on scientific, technical, manufacturing, and other matters of importance to the Defense Department.

DSB members are Dr. Paul G. Kaminski, chairman; David R. Heebner, vice chairman; Edward C. Aldridge; Adm. Lee Baggett, Jr., USN

(Ret.); Edwin L. Biggers; Dr. H. Kent Bowen; G. Dean Clubb; Gordon R. England; Dr. Craig I. Fields; Dr. John S. Foster, Jr.; Charles A. Fowler; Dr. Jacques S. Gansler; Joan E. Habermann; George H. Heilmeyer; Dr. Robert J. Hermann; Arthur E. Johnson; Dr. Donald M. Kerr; C. G. King; Dr. Steven E. Koonin; Dr. Joshua Lederberg; Walter E. Morrow, Jr.; Philip A. Odeen; Robert N. Parker; Dr. Percy A. Pierre; Gen. Bernard P. Randolph, USAF (Ret.); Dr. Maxine L. Savitz; Gen. John W. Vessey, USA (Ret.); Gen. Larry D. Welch, USAF (Ret.); Dr. George M. Whitesides; Dr. Susan Wood; and Lt. Gen. John W. Woodmansee, USA (Ret.).

Spacecast 2020 Initiated

Air Force Chief of Staff Gen. Merrill A. McPeak ordered Air University to conduct a major study on future space requirements. The study, called Spacecast 2020, will focus on analyzing space capabilities needed to support operational combat forces.

More than 150 students and faculty of the current Air War College and Air Command and Staff College are involved in the ten-month program.

"The Air Force mission is to defend the United States through control and exploitation of air and space," General McPeak said. "To fulfill that mission in the next century, we must identify now those high-leverage space technologies and systems that will best support the warfighter."

DoD Counterdrug Policy Redirected

The Pentagon has embraced a new counterdrug strategy emphasizing support to nations battling coca cultivation and cocaine processing. It shifts attention away from high-seas interdiction.

The new guidance is based on the Clinton Administration's interim national drug control strategy and on the findings of an internal comprehensive DoD review of its counterdrug program.

The policy has five strategic elements: supporting source nations; dismantling cartels; detecting and monitoring the transport of illegal drugs; supporting drug-law enforcement agencies directly, emphasizing the US-Mexico border and other high-intensity drug trafficking areas; and reducing demand.

New DACOWITS Chair Appointed

In October, Wilma D. Powell was appointed chair of the Defense Advi-

Senior Staff Changes

RETIREMENTS: L/G Edward P. Barry, Jr.; L/G Eugene H. Fischer; M/G Robert M. Marquette, Jr.

PROMOTIONS: To be Lieutenant General: Marcus A. Anderson, Richard M. Scofield.

CHANGES: M/G (L/G selectee) Marcus A. Anderson, from Cmdr., AFOTEC, AFMC, Kirtland AFB, N. M., to IG, OSAF, Washington, D. C., replacing retired L/G Eugene H. Fischer. . . B/G Andrew M. Egeland, Jr., from Dir., Civil Law and Litigation, AFLSA, Rosslyn, Va., to Dep. JAG, Hq. USAF, Washington, D. C., replacing M/G Nolan Sklute. . . M/G Carl E. Franklin, from Dir., P&P, Hq. USAFE, Ramstein AB, Germany, to Cmdr., USAF Air Warfare Ctr., ACC, Eglin AFB, Fla., replacing M/G George B. Harrison. . . M/G George B. Harrison, from Cmdr., USAF Air Warfare Ctr., ACC, Eglin AFB, Fla., to Cmdr., AFOTEC, AFMC, Kirtland AFB, N. M., replacing M/G (L/G selectee) Marcus A. Anderson. . . B/G William F. Moore, from Vice Cmdr., San Antonio ALC, AFMC, Kelly AFB, Tex., to PEO, Bombers, Missiles, and Trainers, AFPEO, Hq. USAF, Washington, D. C., replacing M/G (L/G selectee) Richard M. Scofield. . . M/G (L/G selectee) Richard M. Scofield, from PEO, Bombers, Missiles, and Trainers, AFPEO, Hq. USAF, Washington, D. C., to Cmdr., SMSC, AFMC, Los Angeles AFB, Calif., replacing retired L/G Edward P. Barry, Jr. ■

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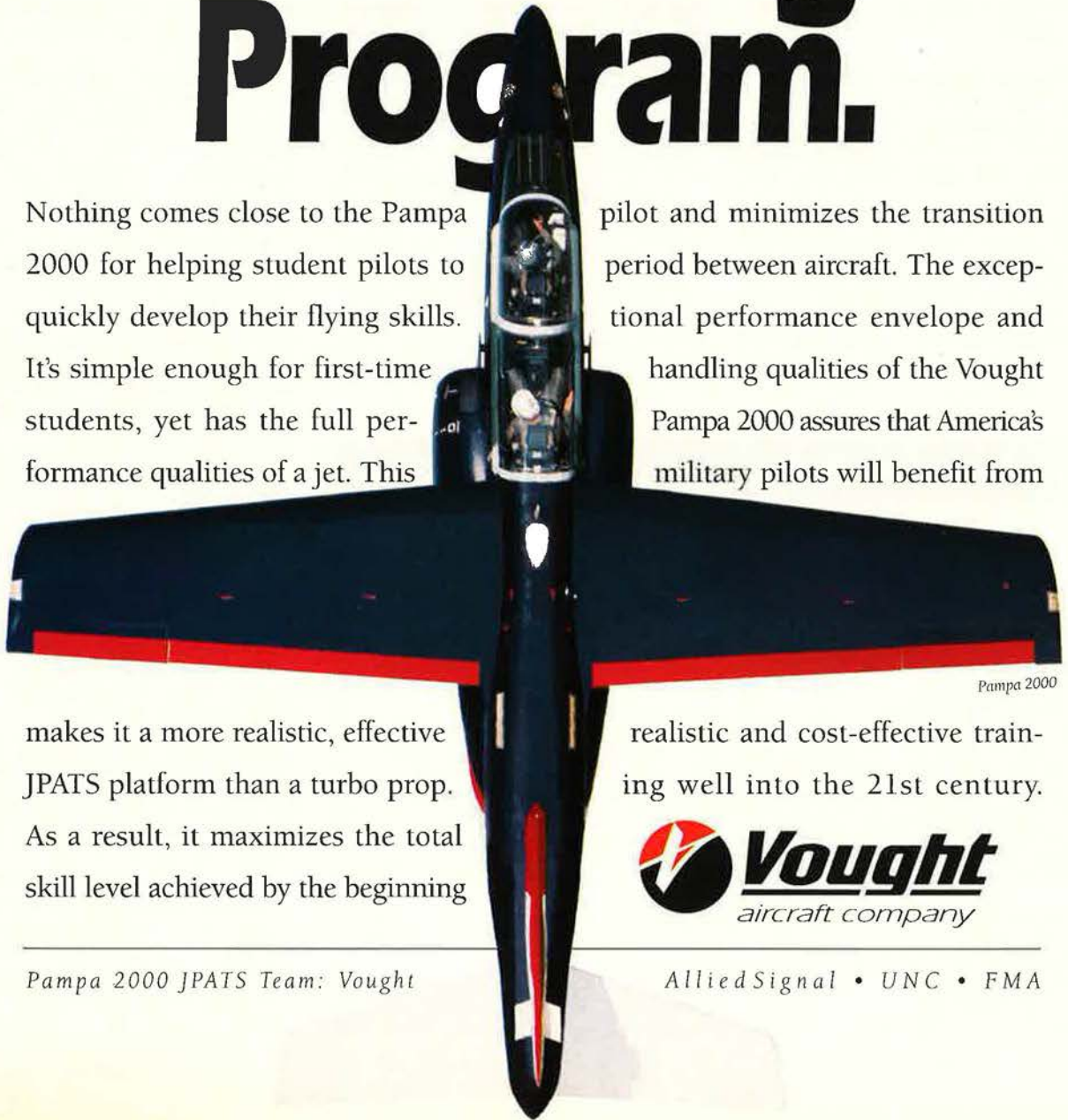
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sory Committee on Women in the Services, a nonsalaried position. Her duties were to begin January 1. The committee advises the Defense Secretary on policies and matters relating to women in the services.

Ms. Powell was appointed to DACOWITS in 1992 and served on the 1993 executive committee as chair of the subcommittee on force utilization. She replaces Ellen P. Murdoch of Madison, Wis.

Ms. Powell received a B.A. in management from the University of Redlands in California. She is an official of the Port of Long Beach, Calif., and is responsible for the enforcement of the port tariff and lease compliance.

DACOWITS, established in 1951, is composed of thirty-six civilian members selected for their achievements in business, professions, and civil or public service, with due regard for the equitable distribution of fields of interest and geographical location, DoD said.

DoD Eases Downsizing's Impact

Fourteen states and other communities will benefit from the Pentagon's distribution of funds intended to ease the strain of downsizing on local economies.

Defense Secretary Les Aspin said in October that the selected sites would receive from \$40,000 to \$200,000 to help plan current, future, and potential military downsizing actions. The states selected are Arizona, California, Colorado, Connecticut, Florida,

Indiana, Maine, Maryland, Massachusetts, New York, Pennsylvania, South Carolina, Virginia, and Washington.

The Department of Defense said that the grants will strengthen the states' ability to support local adjustment activities and will help minimize the potential impact on their overall populations. The funds have been made available through the Fiscal 1993 Defense Authorization Act.

News Notes

■ The last training mission in a Cessna T-41A Mescalero was completed in October, ending the career of the aircraft that began service in 1964. The 1st Flying Training Squadron at Hondo Airport, Tex., will be training prospective pilots in the new Slingsby Aviation T-3A Firefly next month.

■ Congress approved a \$200-per-month increase in the pensions of Medal of Honor recipients in November. The change raised the monthly pension from \$200 to \$400. There are 202 living Medal of Honor winners.

■ Air Force Capt. John M. Barelka, an Ohio native, was killed in November at Nellis AFB, Nev., when his F-16 crashed near a Nellis range. The accident, which occurred during a routine training mission, is being investigated. An Air National Guard F-16 pilot, 1st Lt. Julian L. Clay of Colorado, fractured his leg after ejecting from his F-16 before it crashed fifteen miles outside Laramie, Wyo. He had been on a routine low-level

training mission. This accident is also under investigation.

■ After being completely restored, the Northrop N9M Flying Wing was returned to the "Planes of Fame" air museum at Chino Airport, Calif., in October. The aircraft is the sole survivor of four sixty-foot-wingspan development/trainer aircraft and thirteen 172-foot-wingspan heavy aircraft built as part of an ambitious program to develop the flying-wing concept into a strategic bomber. An earlier N1M Flying Wing is on display at the Smithsonian Institution's National Air and Space Museum in Washington, D. C.

■ The family of the late Francis Gary Powers, the U-2 pilot shot down over the Soviet Union in 1960, donated several of his belongings to the National Air and Space Museum in November. The artifacts include Powers's diary, openly kept during captivity in a Soviet prison, as well as a secret journal, a rug he made while in captivity, and his flight suit. Powers died in 1977.

■ In November, Singapore requested the purchase of up to eighteen new-production F-16C/D aircraft at a cost of \$890 million. In addition, the government is seeking fifty AIM-7M and thirty-six AIM-9S air-to-air missiles.

■ The Air Force promoted 606 officers and 2,393 enlisted members in November. New insignia will go to eighty-three colonels, 202 lieutenant colonels, 321 majors, seventy-five chief master sergeants, 160 senior master sergeants, 530 master sergeants, 570 technical sergeants, and 1,058 staff sergeants.

■ President Clinton signed ratification papers in November for the Open Skies Treaty, which allows unarmed surveillance flights over the territory of participating nations.

Purchases

The Air Force awarded Lockheed a \$361 million face-value increase to a firm fixed-price contract for eighteen C-130 aircraft. Expected completion: December 1994.

The Air Force awarded Pratt & Whitney a \$15 million face-value increase to a cost plus award fee contract for F-22 aircraft program by extending the total program until March 2001.

The Air Force awarded McDonnell Douglas a \$63 million face-value increase to a fixed-price incentive firm contract for continuation of long-lead funding for Lot VI C-17 aircraft (eight aircraft). Expected completion: July 1995. ■

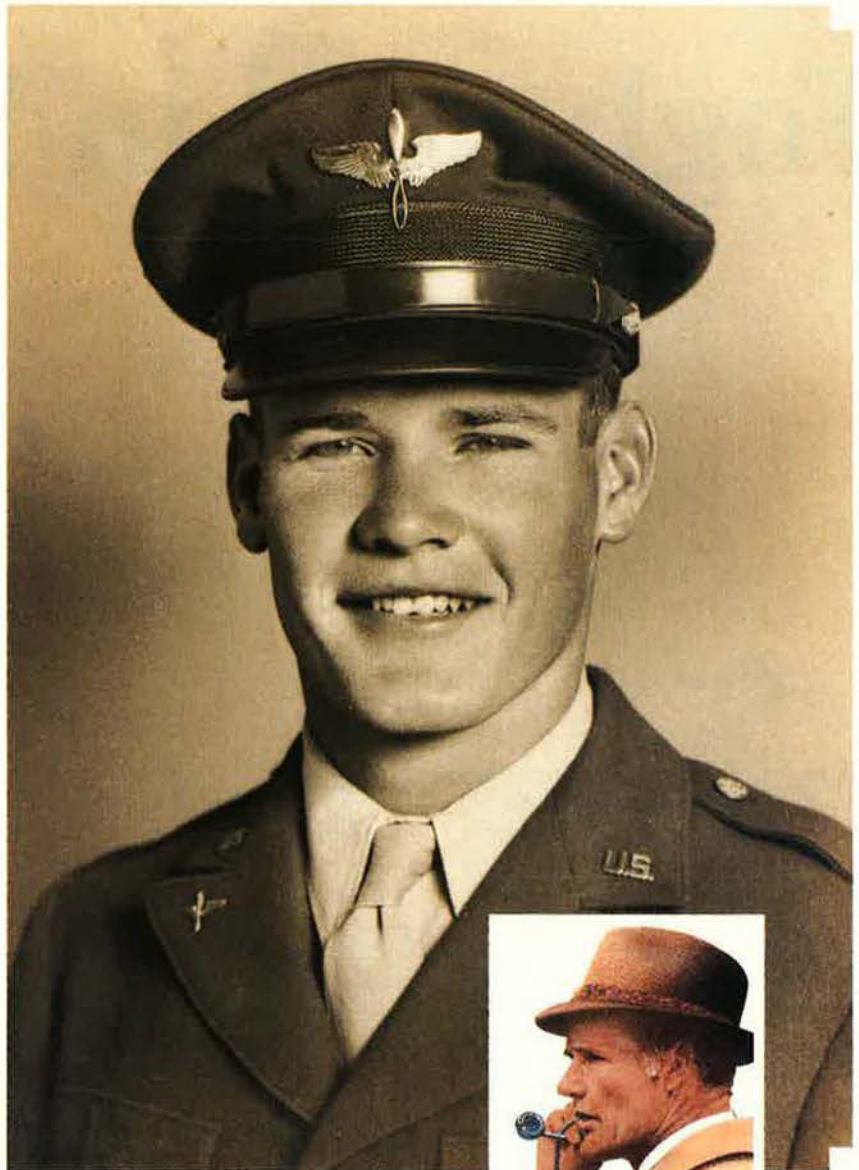
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Once dominant in space, the United States is drifting and seems unable to find its bearings.

Fogbound in Space

By John T. Correll, Editor in Chief

THE US military space program still has its spectacular moments. Last April, an Air Force F-16 and a Navy EA-6B swept low across the China Lake test range in southern California, using signals from space to hunt a pair of mobile radar targets. The targeting data were downlinked to the fighters from "national systems"—a euphemism for secret intelligence satellites—in space. Pressing their attack with that guidance alone, both aircraft fired perfect shots from beyond visual and radar range with their High-Speed Antiradiation Missiles (HARMs).

In August, another Navy EA-6B and a P-3 maritime patrol aircraft used similar signals from space to locate a small target ship moving off the California coast. Shooting over the horizon, they first disabled the craft's radar with a HARM, then blew a gaping hole in its side with a Harpoon missile.

This ability to hit a battlefield target seen only by a satellite in orbit was a totally new trick for fighter aircraft. The two demonstrations, part of programs code-named "Talon Sword" and "Radiant Oak," also reflect the new emphasis that US Space Command

and its service components put on support of combat forces. Space operations, once regarded as a novelty by the rest of the force, have become indispensable for communications, navigation, weather reporting, reconnaissance, command and control, and a good many other things.

A recently developed device called "Talon Hook" combines a tiny Navstar Global Positioning System (GPS) receiver with the emergency radio that aircrew members carry. If a flyer goes down in hostile territory, he can transmit his exact location to the rescue team via satellite with one short electronic signal that is nearly impossible to detect or trace. Up to now, rescue helicopters have spent long hours searching for downed aviators while enemy troops, monitoring radio transmissions, were looking for them too.

The spark plug for the operational orientation is Gen. Charles A. Horner, USSPACECOM commander in chief, who became an enthusiastic champion of space systems after seeing their value in the Persian Gulf War, when he was air boss. That conflict made space believers of a lot of people, not all of them friendly.



Payloads in Orbit

(As of September 30, 1993)

Argentina	1
Australia	6
Brazil	4
Canada	16
China	10
European Space Agency	24
France	25
France/Germany	2
Germany	12
India	9
Indonesia	6
International Telecommunications Satellite Organization	43
Italy	4
Japan	49
Luxembourg	3
Mexico	2
NATO	7
North Korea	2
Portugal	1
Saudi Arabia	3
Spain	3
Sweden	3
United Kingdom	20
United States	626
Former Czechoslovakia	1
Former Soviet States	1,272
Total	2,154

Large nations no longer have a monopoly on data from space. At present, smaller countries buy their satellites on the world market and pay to have them launched, but the number with capability to build and launch their own systems will almost surely increase.

Source: TRW Space Log.

"We are not the only nation learning lessons from Desert Storm," General Horner told the Senate. "Other countries are no longer content to stand on the sidelines and admire our military prowess in space." By the turn of the century, dozens of nations are expected to have their own satellites, space launchers, or both.

Even during the Gulf War, the US military space program was not as hardy as it looked when the satellites were helping roll up the score. And for the most part today, the armed forces and Space Command are wringing the last bits of advantage out of old systems put into orbit by obsolete launchers.

The worst problems derive from the ailing national space program, of which the military space program is an inescapable part. The United States is the only nation that ever put men on the moon. In subsequent years, however, it lapsed into a syndrome of mistakes and indecision that, all too conceivably, may leave it on the sidelines of space in the twenty-first century.

The Glory Fades

In 1978, flush with the glory of the Apollo moon shots, the United States committed the future of its space program almost exclusively to the space shuttle, three years before it flew its first mission. Fortunately, the Air Force—over NASA's objections—kept a backup program to convert a few ICBMs for use as expendable launch vehicles. By the time the shuttle's limitations and liabilities became apparent in the 1980s, though, other nations had a head start in the development of efficient new rockets to put practical payloads into orbit.

Various plans to catch up, notably the Advanced Launch System and the National Launch System, died in the conceptual stages. We are still marking time. The Pentagon's "Bottom-Up Review" last summer rejected options to develop new launch vehicles in favor of keeping the present ones (Delta, Atlas, and Titan IV were specified) in service through the year 2030. Two new working groups organized by the White House are sup-

posed to study the situation and report back in June. It remains to be seen whether they will discover anything missed by the multitude of panels and commissions that studied the problem before.

As recently as 1982, the United States had ninety percent of the world space-launch market. The share has dropped to thirty percent and is still sinking. The chairman of Arianespace, the marketing arm of the European Space Agency, predicts that in ten years his competition will come from Russia, China, and Japan—not from the United States. The cost to put a pound of payload, military or commercial, into orbit with a US launcher is at least double the cost of foreign launchers. As business gravitates overseas, the prorated cost of a US launch goes up. In a chilling admonition last year, the Senate told the Department of Defense to consider using foreign boosters to launch national security payloads.

The US launch schedule is an embarrassment. Only four percent of the shots get off on time. American space probes are custom-assembled on the pad, where they typically spend months—compared to an average of ten days on the pad for launches by the European Space Agency's Ariane rocket. The armed forces have pointed often to the need for "operationally responsive" launch—meaning the ability to put up a satellite as required within a reasonable time from a standing start—but that is not possible today.

Satellite technology is slipping away, too. A survey last summer found the United States ahead in only five of eighteen critical technologies and likely to be trailing Japan and Europe in most areas within fifteen years.

The prospect for improved military satellites is uncertain. Current systems for missile attack warning, for example, were not designed to meet the main threat now emerging—theater ballistic missiles—and the capability to detect and counter them is marginal. Nevertheless, funding for follow-on systems will be difficult to get in the austere 1990s.

A chronic problem with the space program is indecisiveness. The nation is torn between practical applications—medium-size payloads in Earth orbit—and more exotic boosters to reach deeper into space. The battle

between short-range economy and long-range gain is constant. There is no consensus on whether to pursue expendable launchers, reusable ones, or both.

Trucks and Race Cars

The dramatic debut of the year was the successful hover test in August of the "Delta Clipper," a one-third-scale prototype of a reusable spacecraft built by McDonnell Douglas. The small rocket lifted vertically off the pad in the traditional manner, hovered momentarily, moved sideways along the field, then settled smartly back down on the pad in a vertical position.

The full-size Delta Clipper, if it ever becomes operational, would carry 20,000-pound payloads to low Earth orbit and return to Earth intact, with the same body and lift engines. The prototype is currently the leading example of single stage to orbit (SSTO) technology. Among its notable enthusiasts has been NASA Administrator Daniel Goldin, who had called for an experimental SSTO vehicle to be flying by 1995. Last fall, however, he backed away from that position, saying his agency had gotten "too far out in front," and deferred to White House policymakers, who are still studying the question.

General Horner has avoided advocacy of specific launch solutions but says the attraction of SSTO is lower cost. "The reusable is a more expensive vehicle in up-front costs, but if

The High Cost of Launch

	Pounds to Low Earth Orbit	Cost per Launch (FY 1993 Dollars)
Titan II	2,000-4,000	\$40 million-\$45 million
Delta II	5,000-11,000	\$45 million-\$50 million
Atlas II	12,000-18,000	\$60 million-\$70 million
Titan IV	30,000-50,000	\$170 million-\$220 million

Launch costs vary with circumstances—and circumstances definitely vary. Estimates similar to those on this chart, however, are used extensively within the space community to compare the four main US expendable launchers. When a payload cannot be accommodated on Atlas II, it's an enormous jump in cost to put it on Titan IV. Costs for a space shuttle launch vary, too, but a figure of \$650 million might be used for comparison here. Space and weight penalties attributable to the presence of a crew on the shuttle mean that the cost per pound of payload launched will be high.

Source: Space Transportation Propulsion Team.

you can get five or ten flights out of it, it amortizes," he says, adding a caution that "we got burned on the space shuttle on that. Remember, it was going to be low-cost, but it turned out to be high-cost, so we've got to be a little bit careful."

Another alternative is Spacelifter, proposed by the Aldridge Commission in 1992 as a family of low-cost launch vehicles. The National Space Council recommended that Spacelifter concentrate on payloads of 20,000 pounds or less to low Earth orbit, since they account for eighty-five percent of the launch requirements. So far, Spacelifter is more of an idea than

a program. It has not been defined, nor is it funded. In Washington shorthand, however, "Spacelifter" is widely understood as referring to an expendable system based largely on existing technology.

In October, a group of congressional staffers from five different House and Senate committees seized center stage of the space-launch debate with a between-the-eyes briefing that said "what the nation needs is trucks" (rugged, cheap, reliable) but "what it builds is race cars" (complicated, fragile, high-strung). "Foreign launch systems are *not* beating US launch systems because they are high-tech," the staffers said. "To the contrary, foreign launch systems appear to be designed for simplicity, ease of assembly and processing, low cost, with forgiving margins and operational robustness."

Charging that "US launch vehicles attempt to drain every ounce of performance out of their design," the staffers pointed to "the recent Titan failure" as an example. (A Titan IV carrying three satellites blew up in flight August 2.) Because of the vehicle's "performance-driven design," the staffers said, the thickness of insulation in the solid rocket motor varied, depending on the duration of flame exposure expected for each section. Because of a defect, the flame reached an area of the motor case sooner than it should have. "If the motor insulation had been a constant thickness, the motor would have had less performance, but it would have been less costly to build, and the



Lightweight spacecraft such as this Ball Corp. satellite are tailor-made for small, mobile launch systems. The US must replace existing space launchers with less costly, more responsive ones or run the risk of giving up its leadership in space.

Personnel-Intensive Operations

Launch Operations	Size of Launch Crew	Days on Launch Pad
Ariane IV	about 100	10
Delta II	300	23
Atlas-Centaur	300	55
Titan IV	more than 1,000	100
Launch Base and Range Operations		
Kourou Space Center	about 900	
Cape Canaveral AFS (excluding NASA)	11,000	
NASA Kennedy Space Center	18,000	

Roles and missions vary at the launch bases, accounting for some of the differences shown here. In general, though, US launch operations are characterized by the large numbers of people required and by procedures that keep space vehicles on the pad for extended periods. According to congressional staffers, NASA spends between 500,000 and 1,400,000 man-hours processing a space shuttle orbiter before each flight.

Source: Congressional Staff Briefing, October 1993.

failure would not have occurred," the staffers said.

The Bull's-Eye

Space Command would prefer to concentrate on delivering medium-size satellites to the basic terrestrial orbits. That would cover the vast majority of its requirements. "I think we have to hit the bull's-eye first, and that's the medium lift," General Horner says.

The availability of an efficient medium lifter might even influence the people now designing large payloads "to size down the big ones to make them medium," General Horner believes. Space Command is discovering already that some payloads can go on smaller launchers. During last year's Bottom-Up Review, contractors said they could rework the Follow-On Early Warning System (FEWS) to ride on a medium lifter instead of the larger and more expensive Titan IV.

The way the US system has traditionally worked, payload designers build the satellite to their own specifications, then look for a rocket that can be modified to launch it and a control system that can be modified to fly it. This is in contrast to the European Space Agency operation at Kourou in French Guiana. There, a ready-to-fly satellite is delivered to the pad, where it can be mated quickly with a standard, ready-to-fly rocket.

The first step toward solving launch costs, General Horner says, is to stop making every shot a custom event and establish standards and procedures. "We have to enforce a discipline in the design of the satellite that recognizes what lift is available and what control system is available," he says. Standard

sizes, fittings, couplings, and procedures have long been the rule in other operational regimes. "We no longer build a new aircraft or install unique components each time one launches. Aircraft launches, maintenance, supply, etc., follow standard practices developed over the years. The same attitude, the same approach, must now be taken with space systems."

(The experimental orientation is still strong in space culture. "In space,

we still count our successes," General Horner notes. "We still cheer when we get a successful launch.")

The congressional staff briefers also called for payload standardization and further proposed that the government appoint a launch czar, empowered to say, "If you want your payload to fly on my launch vehicle, your payload must have a standard interface with my launch vehicle. You may not 'build' your payload at my

The one-third-scale prototype of the McDonnell Douglas single-stage-to-orbit (SSTO) Delta Clipper reusable spacecraft made its dramatic debut (right) in a successful hover test last August. The model lifted off, hovered, moved sideways, and settled back down on the pad. A full-size Delta Clipper is in the works.



launch pad. You must process and 'encapsulate' your payload away from my launch pad. You may not designate a specific vehicle 'tail number' to be used to launch your specific payload. You may not make performance demands on my launch vehicle."

Another aspect of General Horner's campaign to reduce idiosyncrasies and establish routine in the space program is that enlisted airmen in the Falcon AFB, Colo., control center now "fly" satellites, including Navstar GPS. "In the past, it was felt that only officers could do that job," General Horner says. "Before that, it was felt that only people who designed the satellite could fly it. What it means is that if you get satellites that are standard design, and you get satellite control software that is standard design, then quite frankly it doesn't matter what the satellite is. You just develop procedures for it—checklists, like we do for airplanes or tanks or ships—and you start operating your satellites in a disciplined, standardized, military manner."

The Ballistic Missile Problem

In testimony to Congress last year, General Horner declared US Space Command's top priority to be FEWS, to replace the Defense Support Program (DSP) satellites designed to detect Soviet strategic missile attack during the Cold War. Thanks to some last-minute modifications, DSP did surprisingly well at warning of Scud missile attack in the Gulf War.

"The modified DSP functioned near the limits of upgraded design capability throughout the Gulf War and benefited from exceptionally unique and favorable geographic, weather, and operational conditions—conditions that are unlikely to be duplicated in any future conflict," General Horner testified to the Senate last year.

Something better is needed for the main threat now emerging, the proliferation of theater ballistic missiles. "It's a tribute to air superiority that the last time an American soldier was killed by air attack was in April 1953," says former Secretary of the Air Force Donald B. Rice. "But the last time an American soldier was killed by ballistic missile attack was February 1991."

Theater ballistic missiles are a relatively inexpensive form of military force. The Pentagon estimates that the typical adversary in a major regional conflict would have between



Security police stand watch at a Defense Satellite Communications System ground antenna at Falcon AFB, Colo. Air Force specialists at the Falcon control center "fly" a variety of satellites in operations that are increasingly routine.

100 and 1,000 Scud-class missiles, some of them likely to be carrying nuclear, chemical, or biological warheads. The US has no active plans for defeating these missiles with weapons from space, but as operations in the Gulf War demonstrated, timely warning and terrestrial defenses can counter some of the attacks.

Space Command wanted FEWS, which is ten times as sensitive as DSP, to pick up theater missiles as they launch. "FEWS will see dimmer and shorter-burning targets and will detect missiles DSP cannot see," General Horner said. Almost everyone agreed with that assessment and with the problem as stated. The difficulty was money. General Horner suggested last summer that the last three DSP satellites be canceled, if necessary, to help pay for FEWS.

A cuing satellite named Brilliant Eyes also figured in some proposed solutions. After the early warning satellite detects a launch, Brilliant Eyes would take over, track the warhead, and direct an intercept at extended range.

The issue took a surprise turn in September when the former DSP program manager was quoted in the news media as saying an upgraded DSP system could do the job nearly as well as FEWS and for less money. Space Command stood by its stated requirement for FEWS. General Horner told an Air Force Association symposium October 29 that DSP "does the strate-

gic mission very well, but it's physically impossible for it to meet the theater warfighting need. We have means of taking DSP and making it better, but all of them are Band-Aids."

News media reports, fueled by under-the-table allegations, continued to depict the Air Force as suppressing data on alternatives to FEWS. Support for the program was already spotty in Congress and among Administration policymakers. Pentagon topsiders decided in November to eliminate FEWS funding for budget reasons. According to an internal Air Force memo obtained by the Los Angeles Times, Under Secretary of Defense John Deutch cut off appeals to restore the program, saying, "Let me start over. . . . FEWS is zero."

First in Space

Among the armed forces, the Air Force is foremost in space. It provides ninety-three percent of the personnel in US Space Command, conducts nearly all of the military launches, controls the major military systems in orbit, and puts up most of the money.

The Department of Defense has thought about giving the military space mission to the Air Force outright but has shied away from doing so, partly because the other services would oppose such a move. Another reason, explained in a Pentagon response to a consolidation proposal from the General Accounting Office, is "to maintain a strong cadre of service

expertise in space operations as the use of space in warfighting expands dramatically.”

In the 1950s, both the Army and the Navy were involved more deeply in space than the Air Force was, but their main programs transferred to NASA when it was formed. It soon became obvious that somebody needed to handle the military end of things, though, and in 1961 the Department of Defense designated the Air Force to develop boosters and integrate payloads. The Air Force was also given stewardship of the National Reconnaissance Office, which has operated classified satellites for both the military and intelligence communities for the past forty years. Today, the Army and Navy Space Commands are far smaller and more specialized than Air Force Space Command.

Congress complains periodically about dispersion of the military space program. In September, the House Appropriations Defense Subcommittee cited the “lack of clearly defined responsibilities for space programs at senior levels in the Pentagon” and groused that the committee had gotten statements from eight defense organizations, none of which had a charter to speak for the department as a whole. The committee suggested making the Secretary of the Air Force the executive agent for military space programs, with responsibility covering payloads, launch, ground infrastructure, acquisition, and R&D.

For his part, General Horner seems more concerned about duplication than about service primacy. As new satellites become operational—Navstar GPS replacing the Navy’s Transit, for example, or when Milstar assumes the central communications job for all users—much of the duplication in launch and control will vanish by attrition. “With regard to the product of satellites, that issue is more difficult because each type of satellite has different products and different functions,” General Horner says. “There may well be a role for a service to work a payload. When you think about intelligence and things like that, working a payload may well belong to an agency outside the Air Force. That doesn’t bother me because that’s not duplication.”

Since its creation in 1985, US Space Command has always been headed by an Air Force officer—although not always the same officer who headed Air Force Space Command. No successor has yet been named to follow General Horner, who reaches mandatory retirement in June.

Everybody’s in Space

An even more complicated issue is sorting out the relationship between the military and all of the other organizations involved in the space program. The assorted civilian and military operations depend on much the same launch systems and infrastructure. They often share data.

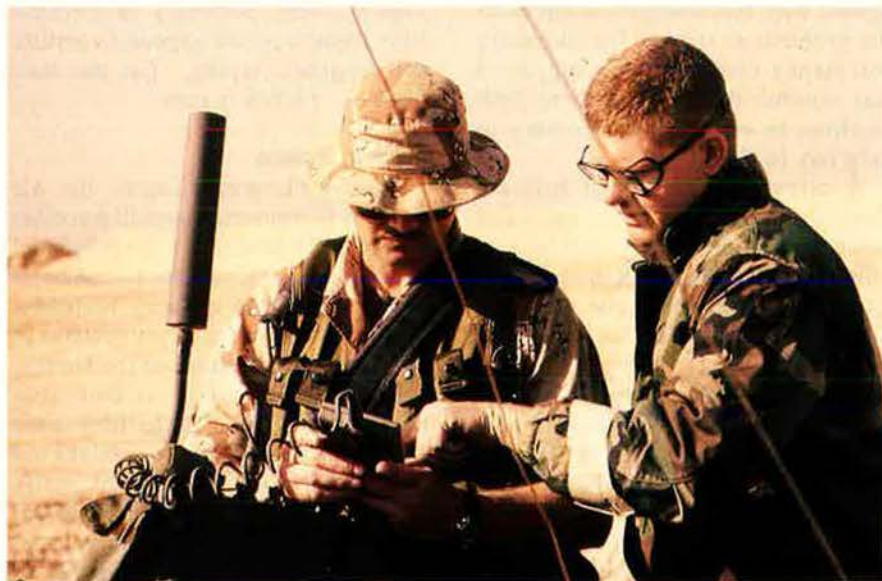
Aware that Congress will not fund parallel programs, federal agencies are looking seriously at consolidations and dual use. The Air Force, for instance, may turn its meteorological satellites over to the National Oceanic and Atmospheric Administration (NOAA), with which there are some overlaps in working the weather problem.

A high-profile example of dual agency use is Navstar GPS, the constellation of military satellites that gives users on the ground or in the air a precise fix of their location anywhere on earth. Navstar practically became a household name during the Gulf War, and civilian applications are spreading fast.

In a demonstration by the Federal Aviation Administration in September, a business jet followed GPS signals for twelve miles along the contours of the Potomac River to land at Washington National Airport. “This is probably one of the most important advances in the history of aviation navigation,” an FAA official declared, looking ahead to a time when Navstar may provide the basic landing system for airports around the world.

Space Command will retain the capability in wartime to distort the GPS signal somewhat for those without cleared access. This is primarily so the enemy cannot use it for precision attack. On the basis of his experience in the Gulf War, General Horner discounts the concern that Space Command might not be allowed to distort the signal. “When men and women are dying on the battlefield, the nation is not going to have a problem saying to the civilian users of GPS, ‘Next week, don’t make any low approaches in fog.’ There are some aspects of GPS that both sides are going to enjoy in war, [such as] the navigation side of it. We can’t stop that. I don’t think that’s a critical aspect.”

The military used remote sensing information from NOAA’s Landsat for mapping in the Gulf War and for aerial missions over the Balkans. Landsat illustrates one of the difficulties inherent in a scattered space program: Different users have different requirements. Landsat satellites pass over a given spot along the equator every sixteen days. They provide broad-scope resolution, and it usually takes several weeks to get the information into the user’s hands. That isn’t al-



Ground troops in the Persian Gulf War get a precise position fix from Navstar GPS. Civilian applications of GPS are spreading fast. Space Command can distort GPS signals to keep wartime enemies from taking advantage of them.



A Delta II rocket blasts off from Cape Canaveral, Fla., with an Air Force GPS satellite aboard. Current expendable launch systems are ICBM derivatives not designed to meet today's space-launch demands. The last space engine development was the Space Shuttle Main Engine in 1971.

ways tight enough or fast enough for military purposes.

The armed forces also make extensive use of commercial communications satellites. They even get some data from foreign platforms, such as the French SPOT remote sensing satellite. A major example of data sharing is military use of information from satellites owned by the Central Intelligence Agency and other secretive organizations. The Defense Department's Tactical Exploitation of National Capabilities (TENCAP) program was devised to ease the access. The flow is running better than it once did, but, as General Horner says, "success in TENCAP is turning out the lights," marking a time when the product is forthcoming without a special program.

The Department of Transportation is a player in the program, too, concerned about US market shares and the commercial requirements for space transportation. A recent Transportation panel called for emphasis on medium-size payloads launched to geosynchronous transfer orbit for about \$6,000 per pound (half the cost of a US launch today) with ninety percent probability that the launch will occur within ten days of schedule. That pre-

scription sounds remarkably like Space Command's.

Most of the money in the federal space program is spent by two agencies: the Department of Defense and NASA. Their relationship from the beginning has been a mixture of cooperation and competition. It's doubtful that NASA's shuttle would ever have gotten off the ground without the presumption that it would carry defense payloads, and a fierce turf fight ensued in the 1980s when the Air Force wanted to develop expendable launch vehicles as a backup. The shuttle still carries some national security payloads but not as many as it did before the *Challenger* disaster. (As of November, the Defense Department had no payloads manifested for the shuttle.)

NASA and military interests are interlocking but not identical. Whereas the services are mostly concerned with working payloads in Earth orbit, NASA's vision tends toward larger, long-reach systems and programs that include the space station and a manned mission to explore Mars.

The National Space Council, chaired by the Vice President, was a referee of sorts for the national space program, but it was disbanded last year. What's

left of it has been folded into the Office of Science and Technology Policy. It is not yet clear what emphasis and spin that body will put on space. During the 1992 election campaign, the Clinton-Gore team called for restoring the "historical funding equilibrium," charging that the Reagan and Bush Administrations spent too much on military space programs compared to civilian space projects.

The Next Engine

If and when the United States gets going on new space systems, one of the first things it will need is better engines. Propulsion generally accounts for about twenty-five percent of a launch vehicle's cost and has a strong influence on how the rest of the system is developed.

Current expendable launch systems are derivatives of ICBMs. They have served the nation well—particularly in the dark days following the *Challenger* disaster—but they are stretching to do a job not envisioned in their original design. The last real space engine development was the Space Shuttle Main Engine (SSME) in 1971.

The congressional staff briefers likened the SSME to "a three-ton Swiss watch," calling it "a marvel of American engineering, producing more thrust per pound of dead weight than any other rocket engine in the world. On the other hand, it is temperamental, takes years to build, and is prone to developing cracks in turbine blades, pump housings, etc. It is routinely operated at a throttle setting of 104 percent. It takes three man-years just to inspect those engines after each use."

The best preview of the next launch engine may be one developed by the Space Transportation Propulsion Team. This is a three-company consortium (Aerojet, Pratt & Whitney, and Rocketdyne) formed originally to work on the National Launch System before it was canceled.

The congressional briefers cited this engine—built to trade off weight and performance for reliability and cost—as typifying "the right philosophy" in designing systems to cure the US space problem.

Given the overall drift of things, it should come as no surprise that the consortium engine is not currently an item in any federal department's budget, and the team working on it has been cut to ten people. ■

“Synthetic environments” are fast moving out of the realm of arcade games and into serious applications, including use by the armed forces.

Virtual Warriors

By Frank Oliveri, Associate Editor

THE VIRTUAL reality movement is spreading fast, especially among younger people who have grown up in the age of video. Some VR enthusiasts see parallels with the proliferation of personal computers in the 1980s and predict that, within a decade, virtual reality will be a routine part of everyday life.

The heart of any virtual reality system is a computer-generated “synthetic environment.” A human typically enters this synthetic world by putting on a special helmet, but it can also be done by means of some other device, such as a “remote presence” glove.

Some environments are presented more realistically than others, but the more elaborate ones substitute wrap-around sights and sounds for natural surroundings outside. Move your head to the north, and you are looking northward in the artificial environment. Manipulate a control stick, and the image in the virtual environment reacts appropriately. In VR, the human feels he is actually occupying space in this artificial world.

The best-selling virtual reality devices today are in the entertainment field, but there’s much more to the



A unique payoff of the Fusion Interfaces for Tactical Environments (FITE) simulator (opposite) is its ability to be configured to present information in a manner of the pilot's choosing. The Air Force is experimenting with a number of different helmet designs in its VCASS program (above).



movement than arcade games. VR also is said to hold great promise for the military and aerospace fields. The Air Force joined the movement years ago, experimenting in the 1980s with a VR helmet—big and clunky by today's standards—in a major program called the Visually Coupled Airborne Systems Simulator (VCASS). Other efforts were added under the banner of the Super Cockpit program.

Being There

Scientists say it will take thirty years or so for the military to achieve a full VR cockpit. However, "we have the capability of doing that today in a visual environment with at least some . . . sound localization," said Dr. Robert Eggleston, an engineering research psychologist and one of the resident VR gurus at the Air Force's Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio. "The level of sensing and interactivity is fairly crude at this point, but the ability to really sense your presence in an artificial world and behave in that world" is closer to reality than it is to science fiction, he said.

The Air Force sees the future widespread application of VR systems

reducing pilot work load and improving aircraft capability, reliability, and maintainability. Just as the service strove to reduce pilot work load in the new F-22 fighter, it is now striving to reduce the potential for pilot overload in future aircraft. Today, pilots trying to locate and identify potential threats must use a radar, radar warning receiver, radio communications, and even old-fashioned eyeballs before they can take defensive or offensive action.

In a full VR cockpit, the pilot might be cued by a localized sound that goes off in his helmet and alerts him to the true location of an enemy aircraft. He then could turn his head in the direction of the sound, and his helmet would track with his head's movement to present a computer-generated view of the corresponding airspace. In this way, the system would lift much of the burden of inductive reasoning from the shoulders of the pilot and allow him to make quicker, better-informed decisions in stressful situations.

Judicious use of VR could also reduce the pilot's need for proficiency in mechanical control of the aircraft. The reduction or elimination of displays, buttons, switches, dials, and even

throttle-and-stick controls would permit him to concentrate more closely on the actual flight of the plane. Getting rid of these devices would probably greatly improve the reliability and maintainability of fighters and bombers, resulting in increased sorties.

Horizontal Pilots?

The all-aspect, opaque helmet system might provide a far more detailed view of the world outside the canopy, scientists say. If so, the pilot's view from the aircraft would cease to matter and one might dispense with the canopy altogether. This would protect against blinding lasers. If a pilot no longer needed to look out of his cockpit, he could be placed in a more reclined or even a horizontal position, which enables pilots to pull more Gs and designers to build more maneuverable aircraft.

Scientists in the military VR field are working on two basic concepts. The first would use VR to link the pilot to his total weapon system through visual and aural cues. This promises to be a relatively near-term application of VR. The second concept calls for using VR to create new and very different types of workplaces.



With a look at the old VCASS helmet, it becomes obvious how far the Air Force has come in helmet technologies. Helmet size still must be resolved before virtual reality systems make their way into cockpits.

Visual VR systems are the simplest to develop and have already reached commercial markets as entertainment systems. Visual systems allow an individual to see synthetic images of relatively high fidelity that represent actual or simulated objects. In a high-quality virtual world, one might see a synthetic wooden table or a synthetic unicorn, and both would look real.

Humans have the ability to hear a sound and determine its location or direction. This can now be simulated in an aircraft. Auditory development, otherwise known as 3-D sound or localized sound, will soon be making its way into fighter cockpits.

Air Force scientists are also working to develop VR systems that would allow a pilot to feel a control stick or throttle in his hand when, in actuality, no stick or throttle existed. Scientists maintain that touch is the most complex of the senses and therefore the most difficult to understand and simulate. Modeling sight and sound are far easier because the eyes and ears are single sensors. The sense of touch is achieved through the combined input of numerous sensors.

The second general concept of virtual reality calls for the electronic meshing of computer-generated sights, sounds, and touch sensations to create a virtual environment that seems to surround a person.

In a virtual environment, where almost all sensory information is linked, you can see an image of a coffee cup

on a table, said Dr. Eggleston. You can walk to the table and grasp the cup. You can feel the cup's weight, shape, and rigidity, even the warmth of the coffee. "Now [you're] actually engaging as an occupant in that environment," Dr. Eggleston said. He suggested thinking of the virtual world as a collection of simple workplaces.

In this environment, a person can actually enter data into a virtual computer. Work can be done on several different projects at once. "It's kind of like going into a huge conference room," said Dr. Eggleston. "You're actually engaged in productive work in this total virtual state."

Current VR systems lack the capability of effectively combining these multisensory factors. Most systems today have only a visual component. Some systems are auditory only. Others are a combination of visual and auditory, and some work with tactile systems as well. "We're really at the front edge of the technology that's going to, hopefully, bring all these different subsystems together, so you have a virtual environment that, from a human perspective, . . . seems very much like a real environment," Dr. Eggleston said.

Networking

These systems will require sensors attuned to human behavior. They will be able to track the movement of the head, for example. Sensors must also track hand and arm movement and,

later, full body movement. This is important for human interaction with computer-generated objects. Computer power is needed to build the graphics whose images must be updated in milliseconds. If VR is to realize its full potential, a network must be created spanning large areas so that thousands of human players can interact with other players and synthetic objects. The most significant technology requirement is the ability to model the workings of the human sense system. This is the greatest challenge. In a VR environment, if you can see the image of the throttle, you must be able to reach out and touch it where it is.

"The complexity associated with how that information is conveyed and processed by the human is not terribly well understood," Dr. Eggleston said.

Dr. Grant McMillan, an engineering research psychologist in Armstrong's Human Engineering Division, said that, because of the power required for an extremely high-fidelity system, the level of modeling fidelity will vary for different systems. The major variable will be mission requirements, he said, noting that the fidelity required for a front-line combat system would not necessarily be required for a training system.

The Air Force and other military services are studying creation of a large battlefield gaming area—a simulation network. For example, an F-16 pilot from Shaw AFB, S. C., would put on his helmet and find himself in the cockpit of his aircraft, throttle and stick in his hands, his head-up display (HUD) and other instruments before him. He would have a full world view and could fly air-to-air and attack missions against other targets in this artificial environment. His wingman, who would also be linked into the network, could very well be located at Hill AFB, Utah. They could be tasked to attack an armored unit and its air defense systems, manned by personnel from Fort Irwin, Calif., in their virtual environment. The attack could be coordinated with aircraft from a naval carrier, flown by Navy aviators at Norfolk or San Diego.

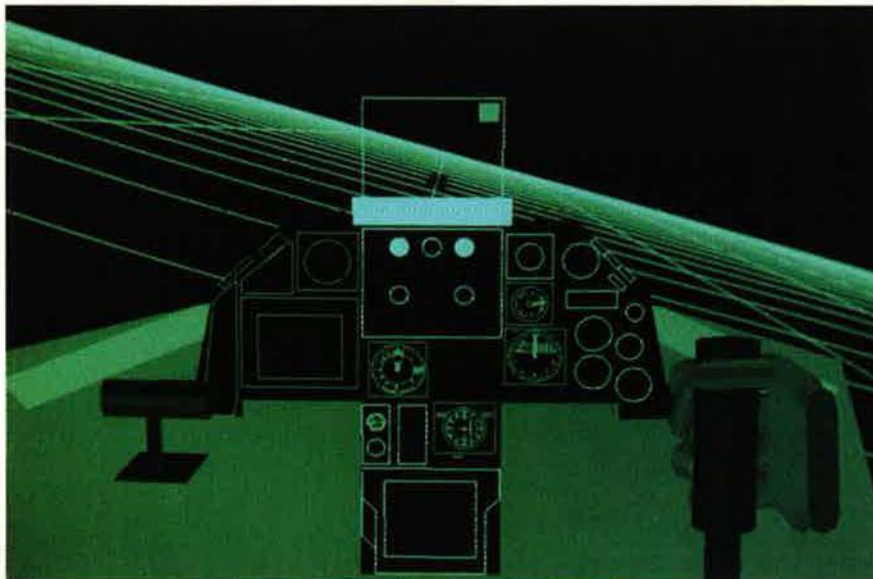
This system would allow Air Force pilots to train on a virtual version of a fighter aircraft still in development, Dr. Eggleston said. The developmental fighter could be flown in tandem or against existing operational fighters in this VR environment. In the simu-

lation network, one pilot could be flying a computer-generated version of a new-development fighter while his wingman flew a VR version of an existing fighter. On an even grander scale, the simulations could link elements of all the services, providing a superior training tool for generals who might conduct a large battle.

Linking Pilots and Aircraft

Scientists are looking closely at the application of VR technology to future fighter cockpits. VR, in the near term, would enhance the pilot-aircraft link. VR helps combine the basics in a way that makes it easier for a pilot to make logical decisions. Presenting information that appeals directly to sight, sound, and touch is far more flexible and adaptive than some existing methods, according to the report "Applying Virtual Reality Technology to Cockpits of Future Fighter Aircraft" by Michael Haas of the Human Engineering Division and Lawrence Hettiger, senior human factors engineer for Logicon Technical Services, Inc.

These virtual links may enhance weapon system performance during tactical engagements by displaying current information to the pilot and taking control of the aircraft. The system would employ both virtual and conventional control and display devices. The Fusion Interfaces for Tactical Environments (FITE) laboratory at Armstrong Laboratory uses this technique.



This older VR visual shows what a pilot might see in a virtual world. Current systems provide higher-fidelity images. The hand-on-side-stick image is achieved through the use of special sensor-equipped gloves.

Flying With Brain Waves

Will pilots of the future be able to actuate flight controls on their aircraft with brain waves alone?

Engineers and scientists at Armstrong Laboratory have created a prototype cockpit that makes this seemingly far-fetched idea appear possible. The cockpit is set on an axis. In tests, individuals have been able to control the bank of the cockpit by evoking or suppressing electrical emissions from their brains.

Technicians attach two electrodes to the lower back of the pilot's head and one beneath his right ear. The wires are plugged into jacks in the cockpit model, which then is sealed.

Before the pilot lie two fluorescent tubes, one on either side of a tracking display. The tubes flash thirteen times per second, producing a measurable electrical response in the visual cortex in the cerebrum. Essentially, the pilot controls the cockpit by increasing or suppressing his response to the light while a computer responds to the brain's electronic signals. An increase shifts the cockpit's direction to the right; a decrease shifts it to the left. Ignoring the lights holds the cockpit in a steady state.

At first, most test subjects respond incorrectly, either suppressing or evoking too much. Eventually, most subjects learn how to respond correctly.

The field is in its infancy; there are probably fewer than a dozen specialists engaged in serious, full-time work. "We're talking about using people's thoughts, or brain activity, to actually control something external," said Dr. Grant McMillan, an engineering research psychologist in Armstrong's Human Engineering Division. "What everybody is doing right now is looking for unique patterns and brain activity signatures that people are able to exercise some control over.

"In all honesty, brain-actuated control, at its current state of development, is not good enough to use in any military system," said Dr. McMillan. "It's not rapid enough, accurate enough, or reliable enough. So what we're really focusing on right now is how good we can get it. If we can get the reliability and accuracy up to the desirable level, then the potential is there to use it in military systems, in aircraft. Aircraft are just full of knobs and dials and switches and, potentially, this can reduce the pilot's manual work load by controlling some of these systems by mind actuation rather than having to reach around."

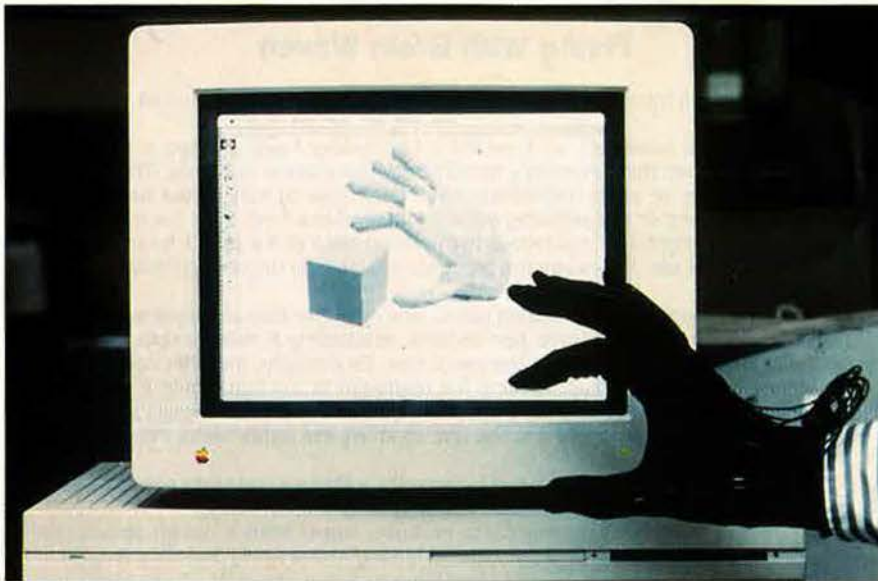
The FITE simulator uses an F-16 cockpit shell filled with six liquid crystal displays augmented by a tactical, all-aspect, helmet-mounted display, which provides an instantaneous, monocular, 20° field of view wherever the pilot aims his head. There are

four flat screens around the cockpit on which out-of-window images are projected. The system also provides 3-D sound and some basic touch responses in the stick control.

The cockpit can be configured to present information in whatever manner the pilot prefers. Allowing pilots to configure "designer" cockpits helps engineers understand how information is best perceived.

"We want the pilots to tell us what they want in their cockpits," Mr. Haas said. "It brings the users into the design environment and lets them create a design for themselves. If we bring in different pilots, we will end up with different cockpits. The real question is, is there any value to having a personalized cockpit, or is it a better idea to train the pilots to one standard cockpit?"

The VCASS, another VR prototype at Armstrong, uses a helmet that has an all-aspect view of a virtual environment wherever the pilot looks. The graphic view of the terrain is similar to a forward-looking infrared image in all directions. HUD data and other information can be projected into the view path. Its controls are conventionally operated, but VCASS, origi-



Here a hand manipulates a cube that exists only in the virtual environment. Sensors in the glove note the angle of the joints in the hand, enabling the computer to replicate the hand's movements.

nally built to test various helmet technologies, provides the true feel of an electronic environment because of the wide field of view the system provides.

Armstrong has examined a number of different uses of VR in fighters. "We've built a crude illustration of a cockpit where you have a virtual hand controller and virtual throttle that were physically not there but were recording gestures you made with your hand to give you control authority over the airplane," Dr. Eggleston said.

In a study conducted by Dr. Eggleston using a virtual hand controller and a conventional stick controller, volunteers are placed in a simulated F-16 cockpit with a side-mounted stick controller, which can be removed and replaced by a Nomex flyer's glove with an orientation tracking system affixed to the back.

In this compensatory tracking test, the controller, who is looking at a monochrome television monitor, must attempt to keep an "X" centered within a larger circle. The system is unstable, and its rate of change varies. The operator attempts to minimize error induced by his or her own actions as expressed through the stick or virtual controller.

Results from the test revealed that, by merely gesturing with the gloved hand, participants could maintain control on a par with that achieved by using the stick.

Air Force technologists see future



The Air Force has made improvements to this VCASS prototype helmet. Note the size disparity compared to the helmet on p. 32. Future VR helmet systems may not require a transparent visor.

operational applications that are certainly strange but have potentially high payoffs.

They see the pilot entering a cockpit without gauges, displays, dials, or control devices except, perhaps, a handle for the ejection seat. The pilot dons his helmet and pulls down an opaque visor, totally shutting off his ability to see or hear the real world. His eyes see the synthetic runway rushing under his plane. He takes off. Inside his helmet, aircraft systems present the pilot with all necessary

flight information. As he gains altitude, he sees the Earth falling away. He hears the generated sound of his aircraft engines. A warning alarm goes off in his helmet at five o'clock, and he looks over his right shoulder. The image on the visor surface changes as his head moves. He sees the unmistakable, color-coded image of an enemy fighter.

With a flick of the pilot's wrist, the fighter shifts to an extreme angle of attack and then breaks right. He arms his short-range missile (again with simple wrist movements), maneuvers into position, and fires. He watches the synthetic missile separate and accelerate toward the threat aircraft. He banks again and sees the synthetic explosion, corresponding to the real explosion occurring simultaneously two miles away. At every step of the way, the sights, sounds, and tactile sensa-

tions have been crisper and clearer than those received through the natural senses. Every bit of the action has taken place inside his helmet.

What if the traditional concept of an aircraft cockpit is put aside? "As the technology comes along, you can have a totally virtual cockpit," Dr. McMillan said. "Maybe at some point it won't even be a cockpit at all. There's nothing that says that you have to have a joystick and a throttle. Nothing says you have to have a panel of gauges that are set up the way we do now." ■

Russians on NATO

"This expansion [of NATO] would bring the biggest military grouping in the world, with its colossal offensive potential, directly to the borders of Russia. If this happens, the need would arise for a fundamental re-appraisal of all defense concepts on our side, a redeployment of armed forces, and changes in operational plans. [Such an eastward expansion of NATO would spark] the restructuring of the armed forces, a reconsideration of the structure of the theaters of military activity, the creation of additional infrastructure, the relocation of major military contingents, and changes in the character of combat training. . . . NATO today is not the NATO of the Cold War period, but this does not remove the question of the military-security interests of the Russian Federation."

Yevgeni M. Primakov, chief of Russia's intelligence service, at a November 25, 1993, press conference condemning proposals to extend NATO membership to former members of the Warsaw Pact.

Command of US Forces

"I construe [it] as not restricting my constitutional responsibility and authority as commander in chief, including my ability to place US combat forces under the temporary tactical control of a foreign commander where to do otherwise would jeopardize the safety of US combat forces in support of [United Nations missions]. Such US combat forces shall, however, remain under the operational command and control of US commanders."

President Bill Clinton, November 11, 1993, in an official statement of reaction to an act of Congress, sponsored by Sen. Robert C. Byrd (D-W. Va.), intended to stop him from placing US combat troops under United Nations command.

Nunn Sees Warning Lights

"I am concerned about the impact of [budget] reductions on our near-term readiness and on our ability to maintain our qualitative and techno-

logical edge. We will depend on these advantages around the world in any kind of confrontation we may have. With the reductions called for in the defense budget over the next several years, and with the reduction we have made this year to the President's budget, . . . we have to begin to be concerned about the ability of our military forces to carry out their assigned missions. The warning lights are flashing in terms of our military strategy vs. our resources and . . . our commitments vs. our capabilities. This is something we are all going to have to watch very carefully."

Sen. Sam Nunn (D-Ga.), chairman of the Senate Armed Services Committee, in a November 17, 1993, floor speech during Senate debate on the Fiscal 1994 Pentagon budget.

Foothold for Further Conflict

"With eighty percent of the world's population [living] within 500 miles of international waters, US naval forces are frequently the preferred force for managing international instability or for creating a foothold for further, more substantial conflict requiring our Army and Air Force."

Adm. Frank B. Kelso II, Chief of Naval Operations, in the July 1993 report "Force 2001: A Program Guide to the US Navy."

North Korean Nukes

"The Administration is pursuing a dangerously weak policy toward North Korea. North Korea continues to stymie the efforts of the International Atomic Energy Agency to conduct inspections of its nuclear facilities. The Administration responds with offers of carrots rather than sticks to induce better behavior in a renegade government that is eagerly looking for weakness in our response. We should show North Korea that testing our resolve is not a productive exercise. We should insist that North Korea discontinue its nuclear weapons programs immediately; these efforts are a threat to the entire Pacific region. We should insist that North Korea comply with the inspections required under the NPT [1970 Nonprolifera-

tion Treaty]—and comply immediately. Economic and trade sanctions should be considered seriously. We should not cancel planned military exercises with our South Korean allies. . . . Proliferation is far too dangerous a threat to US interests to be underestimated by accommodating diplomacy."

Sen. John McCain (R-Ariz.), Senate Armed Services Committee, in a November 17, 1993, floor speech on the danger of nuclear proliferation.

Russian Doctrine

"The Russian Federation has jettisoned the old doctrine of 'no first use.' Frankly, the United States and its allies never took the old Soviet doctrine as a serious indication as to what the USSR might actually do with its massive arsenal of nuclear weapons. In the new doctrine, Russia has said essentially that it will not use nuclear weapons against nonnuclear weapon states who are parties to the NPT. In fact, the nuclear doctrine announced in this statement is not very different from our own."

"Let me comment on the aspect of it relating to the deployment of Russian troops outside of Russia itself. . . . The doctrine also makes provisions for Russian troops to operate in certain situations, presumably in terms of peacekeeping along the periphery of the old Soviet Union. Our preliminary understanding is that this new doctrine has a very important proviso: . . . such operations—that is, operations by the military along the borders of Russia—will be only in cooperation with the other states involved. . . . Russia must be part of the solution and not part of the problem with respect to the regional conflicts. Nothing that we have seen in this new doctrine—as I say, we're just beginning to study it—contradicts that crucial principle."

Secretary of State Warren Christopher, November 4, 1993, reacting to reports of a new Russian military doctrine that sanctions use of troops beyond Russia's borders and abandons a pledge not to make first use of nuclear arms. ■

The Widnall Perspective

**The new Secretary
of the Air Force
clearly knows her stuff
and is off to a
strong start.**

By James W. Canan, Senior Editor

IT DAWNED on MIT professor Sheila E. Widnall in the late 1970s, while serving on the Air Force Academy Board of Visitors, that she would like to be Secretary of the Air Force someday. She held the thought through the years—"It kept flickering," she says—while adding to her impressive credentials. When the call came from the Clinton White House last summer, she was well prepared for a job that she describes, with no exaggeration, as "a dream come true."

Dr. Widnall admits to having been "a little bit apprehensive—after all, the Air Force is a very big organization." She quickly got over it. Air Force uniformed leaders "accepted me warmly—we all seem to work very well together," she says, and she enjoys an "excellent" and "well-matched" working relationship with Gen. Merrill A. McPeak, Air Force Chief of Staff. Three months into the job, she found it "even better than I thought it would be."

She does not expect everything to come up roses. Some say that Dr. Widnall, as the first female service secretary in history, may have more to prove, even now, than would a service secretary of opposite gender. More-

over, times are harder for the armed services and those who head them. Heavy operational demands, dwindling forces, and shrinking resources cause many problems for which there are, she says, "no easy fixes."

Dr. Widnall also has a tough act to follow. Her predecessor, Dr. Donald B. Rice, now president and chief operating officer of Teledyne, Inc., got high marks for his leadership in reorganizing the Air Force, helping prepare it for victory in the Persian Gulf War, and authoring its timely "global reach, global power" strategy for the post-Cold War world.

When Secretary Widnall took office, the Air Force was riding high but showing signs of a letdown amid morale-threatening personnel cuts, budgetary woes, and political uncertainty. In great measure, its fortunes now rest with her. The times are "very challenging, to say the least," she declares.

The Force Comes First

She puts a premium on the well-being of Air Force men and women in and out of uniform. At her Senate confirmation hearings last summer, she said, "I have seen the deep com-



mitment of Air Force people on active duty, in the Guard and Reserve, and in the civilian ranks. . . . Their welfare will be my first and last concern.”

She also takes a hands-on approach to issues on the hardware side of the house and is deeply concerned that the nation’s pool of experienced and knowledgeable aeronautical engineers is drying up.

“My responsibility,” Secretary Widnall says, “is to provide the forces—a well-trained, well-equipped Air Force—to carry out [Clinton] Administration policies.” As defined by the Goldwater-Nichols Defense Reorganization Act of 1986, her role, she says, is to “organize, train, and equip” the Air Force, “as opposed to being involved in operational decisions. . . . It’s a two-hatted role. [I] fit in between OSD [Office of the Secretary of Defense] and the Air Force, advocating Air Force programs to OSD and communicating OSD strategy and goals to the Air Force.”

Is the Air Force in danger of becoming a hollow force, adequate on paper but lacking the systems, spare parts, and personnel required for its mission?

“I don’t see that happening,” Dr.

Widnall declares. “Our goal in everything we’re doing—reducing the budget, drawing down the infrastructure—is to avoid hollow forces. We will do everything we can to make sure it doesn’t happen. That is our number one priority.”

Personnel concerns quickly caught her up. She made the rounds of Air Force bases, hearing out the troops. She also waded into “a lot of important issues” on the hardware front and “found that my technical background is an enormous benefit” in briefings on “new aircraft, space launch, satellites—whatever the topic.”

Her aeronautical expertise enables her not only to understand Air Force programs and “ask the right questions about them” but also to explain and defend them on Capitol Hill. “I meet with Congress a lot,” she notes, “and it’s very important that I’m able to discuss with the members and their staffs, in considerable detail, the contents of our programs and where they’re going. . . . I’m devoted to getting on top of every single one of the programs, to understanding the nature of the criticism that we take for some of them, and to making sure that I can stand behind what we’re doing.”

The Right Stuff

Dr. Widnall’s background is replete with the right stuff. Her work in fluid dynamics, with emphasis on aircraft turbulence and vortices (spiraling airflows) created by helicopters, has brought her international recognition. She is a past president and chair of the American Association for the Advancement of Science, past member and chair of the Air Force Academy Board of Visitors, and former trustee of Aerospace Corp., Charles Stark Draper Laboratories, Lincoln Laboratories, and the Boston Museum of Science. She also served on the advisory boards of Military Airlift Command and Wright-Patterson AFB, Ohio, home of Air Force Materiel Command.

A native of Tacoma, Wash., Dr. Widnall matriculated at the Massachusetts Institute of Technology School of Engineering in 1956, when few women took to the engineering profession. She earned undergraduate and graduate degrees at MIT and became, in 1964, the first MIT alumna to join the faculty of its prestigious School of Engineering. She eventually became a professor of aeronautics and astronautics and, in 1979–80,

the first woman to chair the entire MIT faculty.

Dr. Widnall was MIT's associate provost, responsible for its academic integrity, federal relations, international educational programs, and policies on faculty tenure, promotions, and retirement.

She says her appointment as Air Force Secretary "tied together two strands of my life that were diverging—my aeronautics background and my involvement in public policy, in science-and-government sorts of issues."

On her visits to air bases, she soon learned, she says, that "the number one concern of uniformed and civilian members [of the Air Force] is job security in the defense drawdown—you watch your buddies leaving, and you wonder about your own prospects."

She also found that Air Force personnel put a premium on "job satisfaction and quality of life for their families." Family concerns "bear directly on retention," she says. "If a family is unhappy with Air Force life, we stand to lose the family member."

Exacerbating such concerns is the Air Force's demanding operations tempo all around the globe. Dr. Widnall made an issue of this early on. At AFA's National Convention in Washington, D. C., last September, she noted that the Air Force, in attempting to alleviate family stresses, had come up against "new challenges," notably the "large pool of people whose work load has skyrocketed in the post-Cold War world." She gave a detailed account of that work load as it affected a wide range of combat and support personnel.

"You can't work twelve hours a day [on deployments] for . . . months on end without thinking hard about your quality of life, family, and whether you want to stay in [the Air Force] or not," she asserted.

Making Things "Bearable"

There isn't a whole lot she can do about the operations tempo, which is out of her hands, but she is "intent on helping make it bearable." She keeps track of what the uniformed leadership and operational commanders are doing to lighten the load on aircrews and other personnel "who are away too much" and to help their families, which she deems "equally important."

Dr. Widnall monitors the retention

**"I want to
make sure that great
work and great
risks are rewarded and
that great minds
are challenged."**

rates of deployment-burdened personnel "to make sure we keep critical career fields manned" in the wake of departures from the service.

There are things she can do, she says, to "improve the quality of life for the families that remain at home," in such areas as base housing, education, and day care, and she is "bearing down on that."

"Go to any Air Force base," she says, "and you'll find housing that badly needs to be renovated. There's a lot of it. Dormitories, too. They range from quite reasonable to perfectly dreadful. We've put a priority on upgrading them.

"There will be some emphasis on protecting, if not strengthening, the funds we have for quality-of-life [programs]," the Air Force Secretary declares. "I'll press for pay and benefits that reflect the worth of our members."

She is determined to "make the best use of all our diverse talent—I want the diversity of our [Air Force] members to be our strength. I want to make sure that great work and great risks are rewarded and that great minds are challenged."

Diversity clearly means a lot to her. "It's happening everywhere in our society. We are an increasingly diverse nation, and we [in the Air Force] need to be open to that, to accepting and utilizing the talents of all people."

She says the Air Force must seek recruits of all races and both sexes everywhere in the US, not only in regions where recruiting comes easiest, because "this is the *United States* Air Force." By 2050, today's minorities, taken together, are expected to make up almost half the US population, and the Air Force must reflect the trend, she claims.

"Diversity keeps an organization relevant," Dr. Widnall asserts. "It raises quality. It stimulates a range of views and options. It establishes the institution as a player in public policy and in the life of the nation."

She may be her own best example of diversity in the Air Force, but she never says so. She uses the light touch and is often humorous with reference to her gender, noting, for example, that men at Randolph AFB, Tex., called her sortie there in a T-38 with a female pilot an example of "unmanned flight." She is dead serious, though, about giving other military women their due and about bringing more women into the Air Force and letting them spread their wings.

A Banner Year

She calls 1993 "a banner year for the Air Force—the year combat cockpits opened to women" as a result of long-awaited relief from the combat-exclusion law. By last October, three active-duty women and one from the Air National Guard had begun fighter training. Three more women are scheduled for fighter training in 1994 and two the following year.

She notes other 1993 milestones: Air Force Lt. Col. Susan Helms became the first US military woman to fly in the space shuttle, and Air Force Lt. Col. Patricia Fornes became the first woman to command a missile squadron—twenty-five years after her father had commanded that very same squadron.

As Dr. Widnall sees it, women have made "steady progress" in the Air Force in recent years. Women constituted fifteen per cent of the enlisted force and more than fourteen percent of the officer corps in 1993, compared to 12.3 percent and 11.4 percent, respectively, in 1986.

"Since 1989, our population of new female pilots has nearly doubled," she says. "That means we have a lot more brand-new captain female aviators. In seven more years, we'll have a lot more women majors who are avia-

tors. It's a long-term process, but the seeds have been planted for women to go the distance, to command operational units, and to reach flag rank.

"It's up to all of us [women] to sustain these gains—to be recruiters, mentors, and role models," she says.

Secretary Widnall believes the Air Force must make much better use of mentors—older professionals imparting knowledge to younger ones—in the scientific and engineering arenas "to capitalize on the skills of all available technical talent." She wants "more young professionals" on the Air Force Scientific Advisory Board because "boards like these should, first, solve today's problems and, second, seek out and mentor professionals of the future.

"If we don't pay attention to the second, we eventually won't be able to do the first," she declares.

This brings her to a sore subject that has given her "some sleepless nights"—the widening gaps of age and experience between the older and younger generations of US aeronautical engineers. She calls this "a workforce trend that's shaping the nation's aerospace future," likely for the worse.

"I think it's a national security issue," Dr. Widnall says. "I worry a lot about it."

She brought up the issue in an address to the National Aviation Club not long after taking office. It looms, she said, because US aeronautical engineers are divided into "two experience pools," the result of "very low enrollments in the profession after the Vietnam War" and consequent cutbacks of aerospace programs in academia.

In one pool, she said, are "senior people who entered the field in large numbers after World War II, . . . geniuses who pushed the cutting edge in aerospace, whose designs helped win the Cold War." In the other are "younger people [who] are very smart—facile with computers, educated in the sciences—but their experiences are different from [those of] senior technical staffs and managers."

A Capability Gap?

She asserted, "We need to keep the age gap from turning into a capability gap. Today's entry-level designers and engineers will determine the kind and quality of military systems to be fielded in the next century."

Dr. Widnall referred to a RAND Corp.

The widening gaps of age and experience between older and younger US aeronautical engineers is "a national security issue."

study that shows, she said, that "fully forty percent of industry's aeronautical engineers are over the age of fifty. This cohort of highly experienced people is approaching retirement age. Further, the decline in the post-Cold War business base is causing some to leave early."

The RAND study also shows declining numbers of aeronautical engineers by age groupings. Twenty-five percent of them are in their forties, twenty-two percent in their thirties, and only thirteen percent in their twenties.

A big reason for the drop-off is that opportunity rarely knocks for aeronautical engineers these days. Dr. Widnall expects only four new military aircraft designs to be flight-tested in this decade, in contrast to forty-eight in the 1950s.

"By the time today's young engineer reaches the top levels of an aerospace firm in the year 2010, he or she will have participated in the design of maybe one new aircraft," she says. "It's hard to keep the experience base for military aircraft design capability if you don't have designs to work on."

The pickings are lean. "With the [Navy] A/F-X and the [Air Force] Multirole Fighter off the books, the [Air Force] F-22 is the only major development in the works, and the [Navy] F/A-18E/F is the only major modification," the Air Force Secretary notes.

She sees future technology-demonstrator aircraft, such as those expected to result from the Pentagon's new five-year Joint Advanced Strike Technology program, as possibly "a partial answer" to the problem, noting that such aircraft "can be built and tested for an order of magnitude less than the cost of a full-scale system."

Asked whether the Air Force can expect new models of fighters to come along after the F-22, Dr. Widnall replied, "I'm sure we'll build them, but we won't build many."

The Air Force Secretary questions whether "we're going to be able to design new aircraft down the road with the same kind of confidence that we've had," given their infrequency.

"The key issue is judgment," she says, "and the question is, how do engineers acquire judgment in something as complicated as designing aircraft, if they don't have the experience and the opportunities?"

She was asked, in an interview, whether the computer-savvy younger generation of aeronautical engineers will be required to exercise all that much judgment, considering the help they now get from advances in computer-aided design and computational fluid dynamics.

"Yes, they will," Dr. Widnall replied. "We should use the computer for all of the wonderful facility that it gives us. It is a great improvement over the past. But what we have to do is figure out how to marry the wisdom and judgment of the more experienced generation with the [computer] facility and capability of the less experienced generation.

"Experience gives [aeronautical engineers] the kind of seasoning and sensibility that enables them to be skeptical of what the computer may give them and to ask it the right questions. . . . The extent to which our future aeronautical engineers are brought into meaningful work depends on the willingness of seasoned engineers to serve as their mentors [and] to reach out to them more aggressively."

Teamwork is the key to accomplishing today's technical tasks "in a much more efficient and effective way, with groups of people working together, rather than the lone entrepreneur—the lone scientist or engineer—[seeking] the individual technical breakthrough," Dr. Widnall declares. ■

New rules and new aircraft reflect a changing Air Force at this year's air-to-ground competition.

New Faces at Gunsmoke

Photographs by Ross Harrison Koty

The 1993 Gunsmoke gunnery competition, held last October at Nellis AFB, Nev., was the first Gunsmoke to feature B-1B and B-52 heavy bombers. More stringent rules enacted to better evaluate combat readiness resulted in slightly lower scores, and changes proposed for the 1995 event promise an even more demanding competition. Seventeen teams from the Air Force, Air National Guard, and Air Force Reserve participated.



Above, an F-111 crew chief from the 27th Fighter Wing, Cannon AFB, N. M., prepares for a morning launch. At right, an A-10 pilot from the 103d Fighter Group (ANG), Bradley ANGB, Conn., signals his crew chief during an integrated combat turn. Above right, an F-16 from the 388th FW, Hill AFB, Utah, heads for the range. Opposite, judges quiz a load crew from the 319th Bomb Wing, Grand Forks AFB, N. D., about loading procedures for its B-1B.







B-1B crews at Gunsmoke were eager to show off their newly acquired conventional capability. Above, during the munitions loading competition, judges observe a crew from the 319th BW loading 500-pound bombs into one of the B-1B's three conventional modules.



The 93d Bomb Wing, Castle AFB, Calif., was one of the first two B-52 wings to compete at Gunsmoke. Each B-52 team comprised fifteen aircrew, three aircraft, and forty maintenance personnel. Above and left, crews of the 93d BW discuss strategy.



Gunsmoke judges hold the teams to exacting standards. At left, a judge monitors an A-10 maintainer from the 363d FW, Shaw AFB, S. C. Below, judges inspect an F-15E from the 4th Wing, Seymour Johnson AFB, N. C. Below right, another F-15E returns from the competition.



For the first time, the overall standings were based on the highest composite score among the operations, maintenance, and weapons-loading competitions. Fighters and bombers competed separately. The Air Force changed some rules this year to make the mission profiles reflect a more realistic combat environment.

Overall Competition Standings

(In order of highest composite of operations, maintenance, and weapons-loading scores)

Unit	Aircraft
388th FW, Hill AFB, Utah	F-16
86th FW, Ramstein AB, Germany	F-16
4th Wing, Seymour Johnson AFB, N. C.	F-15E
419th FW (AFRES), Hill AFB, Utah	F-16
150th FG (ANG), Kirtland AFB, N. M.	F-16
347th FW, Moody AFB, Ga.	F-16
3d Wing, Elmendorf AFB, Alaska	F-15E
917th FW (AFRES), Barksdale AFB, La.	A-10
432d FW, Misawa AB, Japan	F-16
103d FG (ANG), Bradley ANGB, Conn.	A-10
140th FW (ANG), Buckley ANGB, Colo.	F-16
363d FW, Shaw AFB, S. C.	A-10
93d BW, Castle AFB, Calif.	B-52
27th FW, Cannon AFB, N. M.	F-111
416th BW, Griffiss AFB, N. Y.	B-52
28th BW, Ellsworth AFB, S. D.	B-1B
319th BW, Grand Forks AFB, N. D.	B-1B

Arrival Competition

(The team that arrives closest to its scheduled time)

419th FW (AFRES), Hill AFB, Utah



Aircrews were judged in three areas: basic deliveries, tactical deliveries, and navigation/attack. Maintenance crews were judged continuously throughout the competition. Munitions crews were judged on precision, technical expertise, and safety as much as speed. This year, Air Combat Command limited the number of Gunsmoke veterans eligible to compete out of concern that certain units had developed "professional [Gunsmoke] teams."

Gunsmoke 1993 Winners

Award	Winner
Top Fighter Team	388th FW, Hill AFB, Utah
Top Bomber Team	93d BW, Castle AFB, Calif.
Top Gun (Fighter)	Maj. Gregory Brewer 140th FW (ANG), Buckley ANGB, Colo.
Top Bomber Crew	Capt. Dwayne Stich (crew commander) 93d BW, Castle AFB, Calif.
Top Bomber Crew Chief	SSgt. Scott Clevenger 416th BW, Griffiss AFB, N.Y.
Top Fighter Crew Chief	Sgt. Richard Bahr 363d FW, Shaw AFB, S.C.
Strafe	Maj. Russell Thomas 103d FG (ANG), Bradley ANGB, Conn.
Navigation/Attack	Capt. Christopher Weggeman 388th FW, Hill AFB, Utah
Dive Bomb	Maj. Gregory Brewer 140th FW (ANG), Buckley ANGB, Colo.
Low-Angle Bomb	Maj. Steven Verhelst 150th FG (ANG), Kirtland AFB, N. M.
High-Altitude Level	Capt. Dwayne Stich 93d BW, Castle AFB, Calif.
Low-Altitude Level	Capt. Dwayne Stich 93d BW, Castle AFB, Calif.



At left, a weapons specialist from the 27th FW, Cannon AFB, N. M., prepares ordnance under the watchful eye of a Gunsmoke judge. Air Combat Command is considering further changes in Gunsmoke, including a night bombing event and a laser-guided bomb competition, which would open the contest to F-117s.



F-16 crews cleaned up at Gunsmoke, winning the overall competition and taking five of the top six places. F-16 crew members won awards in the Top Gun (Fighter), Navigation/Attack, Dive Bomb, and Low-Angle Bomb categories. The 388th FW from Hill AFB, Utah, won the overall competition, with 90.94 percent of the total possible score.



The notion of turning US forces over to UN field command sank like a big blue rock.

American Troops— American Command

By Stewart M. Powell

FOR AMERICAN troops, it was one of the deadliest battles since the Vietnam War. The lightning raid was supposed to result in the capture of a Somali warlord's top lieutenants, but things went wrong. The raid flared into a sixteen-hour firefight pitting a hundred or so Army Rangers and commandos against many hundreds of Somali irregulars, who encircled them in the congested alleys and dilapidated buildings of Mogadishu.

The US force suffered casualties at a rate rarely seen since the 1960s. Nineteen GIs were killed and seventy-seven wounded. The Somalis shot down two helicopters and took prisoner one of the pilots, CWO Michael Durant. "We went to where all the hornets live, and we got stung," recalled a wounded Ranger, Sfc. Richard Lamb, who spoke from a hospital bed in Germany where he was being treated for head injuries.

The Rangers weren't the only victims. The October 3-4 battle claimed a major political casualty—President Clinton's ambitious plan to help create a United Nations peacekeeping force capable of intervening around the world with substantial help from American GIs. To be sure, the Mogadishu raid

had been a US-run operation, but the Rangers were cut to pieces trying to carry out a UN mission—the arrest of defiant warlord Mohamed Farah Aided, wanted for an ambush that killed twenty-three Pakistani troops. The battle was nothing short of disastrous for the President's policy.

"We'll get back to it at some point, and hopefully some sort of concept of collaborative action with the United Nations will emerge," remarked a senior State Department official in the days following the battle. "But it is not going to be what it was."

Public Disapproval

What happened? The public rebelled against the costs of participating in the "humanitarian" mission, particularly after being subjected to grisly televised coverage of Somali crowds desecrating the corpse of a US soldier. Many in Congress demanded withdrawal, and some called for the resignations of Secretary of State Warren Christopher and Defense Secretary Les Aspin. Republicans mounted a drive to limit the President's power to send US forces overseas and to virtually bar them from serving under foreign command.

SSgt. Michael J. Silvin of the 601st Security Police Squadron, out of Sembach AB, Germany, patrols Pleso AB, Croatia. He is part of the UN-sanctioned peacekeeping forces that have come under scrutiny in the wake of incidents in Somalia and Haiti.



Combat Camera photo by TSgt. James Bowman

Resistance to international peacekeeping ventures deepened when armed Haitian thugs on the docks at Port-au-Prince forced Washington to withdraw USS *Harlan County*, with its 200 US and Canadian combat engineers. The warship and troops had been sent as part of a UN mission to restore deposed Haitian President Jean-Bertrand Aristide to power. This setback, coming on the heels of the Somali debacle, led to intense scrutiny of the pending American participation in the UN-sanctioned peacekeeping attempt in war-torn Bosnia, an operation assigned to NATO commanders.

Within days of the stinging US setback in Mogadishu, a politically sensitive President Clinton staged an abrupt reversal of course on foreign policy. He set a date to end US participation in the wide-ranging UN mission to feed Somalia and forge a democratic nation from warring clans. Over the vocal objections of UN officials, he broke off the US manhunt for Aided. He brought home the bloodied Ranger battalion and ordered all US ground troops to be home no later than March 31.

Behind the scenes, the President also was retreating on a broad policy front.

White House officials quietly shelved Presidential Decision Directive (PDD) 13, their emerging blueprint for committing large numbers of American combat forces to UN command in a major, long-term embrace of expanding United Nations peace operations. The President's flip-flop was all the more remarkable in light of his campaign pledge to spread the costs of defending US interests by relying more extensively on UN operations.

The Clinton Administration's decision to back away from UN operations came as demands for peacekeeping were increasing. The fifteen-member Security Council has authorized more peacekeeping in the past five years than at any other time in the world body's forty-eight-year history. Sixteen operations have been launched over the last five years. By late 1993, the UN had put into the field 80,000 of its blue-helmeted troops in thirteen operations. Plans call for dispatching another 40,000 by early 1994.

Until Somalia, the time seemed ripe for such moves. The Cold War, with its stable, two-superpower face-off, was gone, and with its demise came an avalanche of regional conflicts. As a result, peacekeeping was much in vogue. Presi-

dent George Bush offered to make available US bases for multinational training and joint field exercises.

Frustrated by President Bush's supposed inaction in Bosnia, candidate Clinton had pledged to help create a permanent UN rapid deployment force to take on such assignments as "standing guard at the borders of countries threatened by aggression, preventing mass violence against civilian populations, providing humanitarian relief, and combating terrorism." Under his administration, he said, the US would take a "more active role" in the UN, sending US troops to a "voluntary" UN military organization.

The US Commission on Improving the Effectiveness of the United Nations urged the United States to support a quick-reaction force of up to 10,000 volunteers to help preserve international peace. "Peacekeeping is a growth industry," opined Rep. Jim Leach (R-Iowa), co-chairman of the commission.

Risk Reduction?

The Senate Foreign Relations Committee issued a report, "Reform of United Nations Peacekeeping Operations: A Mandate for Change," which

called on the White House to make a "new commitment to play a leading role in UN peacekeeping." As the US reduced its worldwide military role, it said, "the UN becomes an effective form of multilateral burden-sharing, reducing the risk from unilateral American action."

Washington wasn't alone. French President François Mitterrand offered 1,000 troops to a UN quick-reaction force. UN Secretary General Boutros Boutros-Ghali issued his forty-eight-page "Agenda for Peace," urging major nations to assign 1,000-member units to the United Nations to serve as "peace enforcement" forces. "This opportunity must not be squandered," Mr. Boutros-Ghali said. Nations must "take the hard decisions demanded by this time of opportunity."

In many ways, the US operation in Somalia was the test case for President Clinton's vision of putting American GIs under the operational control of a UN commander in near-combat situations. He had already decided to dispatch 300 GIs to the former Yugoslav republic of Macedonia to serve in a UN deterrent force commanded by Scandinavian officers. This move is part of an international effort to discourage Serbia from expanding the Yugoslav conflagration. In Somalia, however, President Clinton turned over command of 2,700 American logistics troops to the UN after withdrawing the bulk of a 24,000-strong force deployed by President Bush in late 1992.

The Clinton Administration didn't just hand them over. Washington relied on a variety of political and military levers to ensure that the US still maintained effective control of its men. As one of the five permanent members of the UN Security Council, the United States could veto any unacceptable UN initiative.

The senior UN representative in charge of the Somalia operation was an American, retired Navy Vice Adm. Jonathan Howe, who had been deputy National Security Advisor to President Bush. The UN commander of the multinational force of 28,000 was Turkish Lt. Gen. Cevik Bir, a NATO-oriented officer well known to the Pentagon. His deputy was US Army Maj. Gen. Thomas M. Montgomery, who also commanded the US contingent. The 750 Army Rangers and supporting aviation units had a separate chain of command, but General Montgomery had veto power over their operations.

Under Foreign Command

Moreover, the ground was not entirely untested. US forces had served under "operational command" of foreign commanders at least fifteen times this century, said Edward F. Bruner, a military specialist who studied precedents for the Congressional Research Service. Examples, according to Mr. Bruner, range from 2,000 GIs who served under a British general during the Boxer Rebellion in China in 1900 to three battalions of US Army troops that joined a seven-nation, British-led task force fighting the Russian Bolsheviks in 1918.

Some two million Americans fought under British or French generals in World War I, though Gen. John "Black Jack" Pershing, the American commander, insisted, in an important precedent, that his men serve with their units rather than as individual replacements.

During World War II, American units fought under British commanders in Italy, France, the Netherlands, and the China-Burma-India theater. The United States participated in such UN-sanctioned operations as the Korean War and the Persian Gulf War. In these, however, American officers held supreme command of the coalition.

Unlike these operations, more recent UN missions had become small and far-flung, with uncertain goals, and led by foreign officers groping their way in a tumultuous world where no one knew the rules. "Mission creep"

was a constant fear. The humanitarian operation in Somalia was transformed into an operation to seize Aideed, though there was little public debate. Everyone knew that, in Bosnia, any NATO peacekeeping on behalf of the United Nations was likely to plunge US forces into open-ended conflict in the blink of an eye. In Haiti, the UN mission to train the Haitian police and armed forces seemed sure to become a law-enforcement mission in a largely lawless country.

In future deployments, analysts said, UN commanders would have to make quick decisions in order to protect the lives of American GIs. Equally quick political direction would be needed from UN Headquarters in New York, where a bare-bones peacekeeping apparatus already was stretched to the limit by the complexity of post-Cold War operations.

The Security Council, which mounted only a handful of peacekeeping operations during the Cold War, still relied on the assessments of the secretary general when it came time to define the mission and the mandate for peacekeepers. The process lacked the rigorous military staff analysis that US commanders demanded. The secretary general chose the field commander and often named a parallel civilian representative on the scene. Once the operation was under way, the cumbersome fifteen-member Council served as commander in chief; the secretary general served as *de facto* chief



Combat Camera photo by SrA. Andy Dunaway

"Mission creep" has become a fear for UN operations like the one in Bosnia (above). In these far-flung missions with uncertain goals, UN commanders have had to work with separate chains of command for political direction and logistics.

of staff. The arcane system produced a bureaucratic labyrinth, featuring separate chains of command for political direction and for logistics.

Officers Balk

US military leaders understandably balked at committing combat forces to United Nations units commanded by foreign officers chosen by Mr. Boutros-Ghali to handle fast-changing operations. Not even the Administration's decision to let US field commanders override UN orders that were "militarily imprudent or unsound" reassured top American officers.

Fairly or unfairly, many senior officers and military analysts concluded that President Clinton's new emphasis on such operations reflected the new chief executive's lack of military experience. Some argued that the President did not seem to comprehend that, no matter how pure his intentions, the American public would hold him personally responsible for the welfare of US troops. The issue of allowing homosexuals in the military "embarrassed Clinton," observed Harry Summers, a retired Army colonel and noted military commentator. "Putting American men and women under foreign commanders could destroy him."

Warnings also came from no less than Gen. Colin L. Powell, who spoke out before he retired as Chairman of the Joint Chiefs of Staff. "Command means something to us in the military," he explained. "It means that the President of the United States as Commander in Chief never loses command or total control over those forces in a legal meaning."

The President got essentially the same warning from General Powell's successor, Army Gen. John Shalikashvili. "We must reserve the right," he said, "on a case-by-case basis, to make the judgment . . . to participate or not." Americans must always be assured that the command structure and rules of engagement are "sufficient to not only protect ourselves but also get the job done so American forces don't ever have to stand at the road junction watching some warlord mocking them," he said.

Lawmakers on Capitol Hill became equally adamant, for it would be their offices that would receive calls from the bereaved relatives of GIs killed in UN operations with no connection to vital US interests. The Senate, in a 96-2 vote, approved a nonbinding



Combat. Camera photo by SSgt. Ken Wright

American troops, shown here checking their chemical gear at Pleso AB, will not be sent into combat "in the absence of competent command and control," UN Ambassador Madeleine Albright assured the US Congress.

resolution demanding that the President consult Congress before placing troops under foreign command. Sen. Sam Nunn, the Georgia Democrat who chairs the Senate Armed Services Committee, interpreted the vote this way: "I think the Administration has been given a warning light."

The Chain Is "Inviolable"

In the wake of the raid in Somalia and the subsequent uproar, the White House wasted no time trying to defend its previous position. In addition to deep-sixing the classified PDD 13, the Administration brought forth a spokesman bearing a reassuring message. UN Ambassador Madeleine Albright told Capitol Hill that the White House was "not about to substitute elusive notions of global collective security for battle-proven and time-tested concepts of unilateral and allied defense," though that was, in fact, what President Clinton had been attempting to do. She added that American forces would only be submitted to the "operational control" of a UN commander in benign situations and that under no circumstances would Americans be sent into a combat situation "in the absence of competent command and control."

The former Georgetown professor added, "When large-scale or high-risk operations are contemplated and American involvement is necessary, we will be unlikely to accept UN leadership." In every case, she declared, "the chain of command from the President to the lowest US commander in the field will remain inviolate."

On another front, the Clinton Administration further demanded that the Security Council develop and enforce tough new criteria for undertaking future UN peacekeeping operations or else risk a US veto. Projected costs, benefits, feasibility, and the impact of UN intervention ought to be weighed in advance, US officials declared. Coming from the nation bankrolling nearly \$2 billion of the UN's expected \$6.8 billion in operating and peacekeeping expenses, the US declaration carried considerable clout.

Clearly, the White House had gotten religion on how the nation expects Washington to command and control US soldiers. With it came a new and more austere view of the utility of the United Nations in American foreign policy. For better or worse, the world body's key financier and principal provider of airlift, logistics support, and communications was stepping back. ■

Stewart M. Powell, White House correspondent for Hearst Newspapers, has covered international security affairs from Washington, D. C., and London since 1980. His most recent article for AIR FORCE Magazine, "Germany Seeks Its Course," appeared in the December 1993 issue.

Aspects of the Balkans operation may be a preview of how future regional crises will be handled.

The Fully Deployable Air Campaign

By Tony Capaccio

THE WEST's year-long aerial operation in the Balkans looks like a case study in a new breed of regional air campaign.

With the United States, North Atlantic Treaty Organization, and United Nations all playing pivotal roles in the effort, the air tasking order produced daily at 5th Allied Tactical Air Force headquarters at Vicenza, Italy, had to accommodate some unusual factors. Western pilots worked with UN spotters to find potential targets on Bosnian territory. The flyers faced an uncertain anti-aircraft threat, relatively primitive yet highly dangerous. Finally, operations were managed through a cumbersome and complex chain of command linking NATO and UN officials in a shared leadership.

These and other features of the Balkan activity, said Allied officers, could well become familiar aspects of aerial warfare in the post-Cold War era. The following assessment of these elements is based on reporting at 5th ATAF, USAF and Navy units in Italy, and NATO Allied Forces South headquarters in Naples.

In late fall, the Balkan operation was supported by a modest multinational force based at Aviano AB, Italy,



Combat Camera photo by PH3 Paul Hewthorn

Above is a module of an EC-130 Airborne Battlefield Command and Control Center aircraft used in air operations over Bosnia. ABCCC aircraft provide tactical information to attack aircraft like the A-10s opposite, from the 510th Fighter Squadron, 52d Fighter Wing, Spangdahlem AB, Germany.

near Venice. The USAF contingent included twelve A-10 attack aircraft from the 510th Fighter Squadron, twelve F-16C fighters from the 512th FS, and seven EC-130E Airborne Battlefield Command and Control Center (ABCCC) aircraft from the 7th Airborne Command and Control Squadron. Also on call were USAF F-15Es based at RAF Lakenheath, UK.

The US Navy's contribution was standing off in the Adriatic on board the carrier USS *America*. The naval



Combat Camera photo by SrA. Steve Thurow

element included twenty-two F/A-18s, fourteen A-6 attack planes, and fourteen F-14 interceptors. Also on hand at Aviano were eight Marine Corps F/A-18s.

Working with these American warplanes was a multinational fighter force consisting of eight Jaguars and ten Mirage 2000 jets from France, eighteen F-16Cs from the Netherlands, twelve Jaguars and six AV-8B Harriers from Britain, and eighteen F-16Cs from Turkey. Aerial refueling tasks were carried out by ten Air Force KC-135s, one British TriStar Tanker, and one French C-135FR.

Since early 1993, NATO airplanes had enforced Operation Deny Flight, a UN ban on flights in Bosnian airspace. UN Resolution 836, approved last summer, gave NATO the task of providing air support to UN peacekeeping forces if they were attacked. Everyone knew that the most dangerous missions would be conducting strikes on artillery sites, armor, troops, and other Serbian military targets.

The major targets were artillery pieces in and around Sarajevo. The Joint Chiefs of Staff reported to the Senate Armed Services Committee that the US could "clearly identify 100-

plus" guns to be targeted. Potential targets have been spelled out by a joint NATO/North Atlantic Council resolution.

"It talks generally about the siege of Sarajevo and other things that indirectly affect the siege, and then it talks about other areas besides Sarajevo," said USAF Lt. Gen. Joseph Ashy, commander of Allied Air Forces Southern Europe. "It's not only just artillery sites but a group of target sets we have worked on."

"We were confident we could put precision guided weapons on those positions," said Gen. Robert Oaks, commander in chief of US Air Forces in Europe. "An artillery piece is a resilient target, but, if you put a 500-pound bomb on a target, it is going to destroy it."

Keeping Current

"We keep target info very current," said Air Force Col. Dave Haas, deputy chief of Operations for NATO Allied Forces South headquarters in Naples. "We practice on things we might bomb the next day. We practice with the people we are going to operate with, same frequencies, same command and control, same call signs. . . .

We are very familiar with the environment."

The UN resolution highlighted the issue of how well NATO pilots could forge a tactical bond with the forward air controllers (FACs) on the ground in Bosnia. This would be crucial to the success of the operation.

From 15,000 feet, NATO pilots had a hard time spotting single pieces of artillery, single tanks, or solitary mortar units positioned in the craggy terrain and firing on a village or relief convoy below. For that, they had to turn to French, British, Spanish, or Canadian FACs to "talk their eyes" onto a prospective target or guide a pilot with lasers or radar beacons.

At first, things were rocky, but officers and pilots emphasized that round-the-clock training sharpened the skills of the FACs. "The system isn't really a whole lot different from what we do in the US military," said Capt. Chuck Peterson, an A-10 pilot with the 510th FS at Aviano. "We are doing the same kinds of things, talking to the same people. It's just that instead of talking to US servicemen, we're talking to French, Canadian, Spanish."

The system for providing close air support was ready within five days of

"See the One With the Red Roof?"

US Navy Capt. William Deaver, commander of Carrier Air Wing 1 aboard USS *America*, described a typical "talk-on" between a forward air controller and a pilot.

FAC: Do you see the big crossroads in the middle of town?

Pilot: Yes, I do.

FAC: Do you see the church? To the northwest of the church is a large soccer field. Do you see the soccer field?

Pilot: Yes, I do.

FAC: That is one 'unit' [an improvised measurement of distance]. From the center of town where the crossroads is, look to the south three units. Do you see that?

Pilot: Yes, I do.

FAC: Do you see the road running to the south of the large open pit?

Pilot: Yes, I do.

FAC: One unit to the west of that pit, down that road, are three buildings. Do you see them?

Pilot: Yes, I do.

FAC: Do you see the one with the red roof?

Pilot: Yes, I do.

FAC: That's your target.

the UN's resolution, said Colonel Haas. "The FACs had been trained in Germany," he reported. "It came together so quickly because command and control was already in place."

Lt. Col. Terry New, commander of the Air Force's 512th FS, said his F-16C unit trained with UN controllers in Germany before deploying to Aviano. "We've been able to train these guys to our way of business and get used to the way they do things."

"I'm proud of that particular aspect of it," said General Ashy of the training operation. "I've experienced it personally flying over Bosnia and seeing it with my own eyes to make sure I was satisfied. Having seen it, and getting feedback from all quarters, I think we have a good system."

NATO pilots and UN air controllers improvised a targeting system that started with the FAC directing a flyer to a landmark and progressed to giving specific directions to a certain location. Under this system, Western aircraft approached Bosnia and checked in with one of two NATO Airborne Warning and Control System (AWACS) E-3s patrolling the skies, after which they were passed off to an Air Force EC-130 ABCCC plane. The command post updated the fighter on ground conditions, including locations of surface-to-air missiles (SAMs) or anti-aircraft artillery (AAA). Fighters were then assigned by ABCCC operators to work with a UN FAC team.

"Working with the various FACs from various countries, the language has been a big challenge," said Maj.

Wally Hill, an Air Force intelligence officer with the 7th ACCS Deployed. "Lots of times we have to speak a lot slower. You might work with a Spanish guy one day and a Canadian the next."

Typically, Allied warplanes would spend forty-five to sixty minutes on station with a FAC before flying to another site. The FACs would start talking the pilot to a specific location. The idea was to test communication links, eye possible targets, and get familiar with each other's operating procedures.

Talk-Ons to the Target

The FAC provided latitude and longitude coordinates to get a pilot in the general vicinity of a target. "He'll use geographic points and distances he'll define early on to talk our eyes on the target, and we see if we can find it," said Lt. Cmdr. Dan Pederson, an F/A-18 operations officer of VFA-86 on USS *America*. "Sometimes they are difficult, sometimes relatively easy."

"We've overcome language difference by standardizing terminology," said Captain Bob Lanham, a pilot with the F/A-18D Marine Corps All-Weather Attack Squadron 533. "In the beginning it was hard. . . . They'd give us 'talk-ons' from the 'high ground to the low ground' and things you can't see from 20,000 feet in the air. We've gotten them away from using those and to using discernible things like bridges and rivers."

Occasionally, pilots and FACs improvised. "One day I was up there,

and I couldn't find what he wanted me to measure because of the clouds or something," said one Navy pilot. "I said, 'I tell you what I do see—a runway, a very short runway.' He said, 'Ah, mate! That runway is one unit. Now go four units north.' Bingo. There we were."

Colonel New pointed out another practical problem. "Most guys on the ground don't have an appreciation for what things on the ground look like from the air, especially from a fast-moving aircraft. I was working with a Spanish forward air controller. The guy was trying to talk my eyes on the target, and he was saying, 'Do you see the sheep in the field?' From that altitude, you could not see sheep in the field. You're doing well to pick up the same *field* he is talking about. Those are just little things we continue to work on."

The exercise was not intended primarily to find real targets but to help the pilot find ground sites. However, "it would be idiotic to assume we are not at least looking at targets over there that could be things we go against," said Captain Peterson. "As a general rule, for the flying we do in country, we exercise the radio links. We are not here to be a provocative presence. . . . We are staying up high out of everybody's hair."

"Some of them [targets] are real, and some of them are simulated," said Captain Lanham. "There are ones where you have an isolated bunker or column of APCs [armored personnel carriers] on a runway where you can hit it. You have others that are in the middle of a city or village, and [with] those you take a lot more care."

Colonel New said that his crews and the FACs took full advantage of the training ranges in northern Italy, where USAF pilots could "work with them in more realistic missions, where we actually get a chance to roll in and drop a bomb and get scored to find out if we are really doing what we think we're doing." A US Army officer was assigned to Colonel New's squadron to work with FACs and provide feedback.

The training paid off. "We've taken our 'talk-on times' . . . from fifteen to twenty minutes . . . to only two or three minutes," Captain Lanham said. [See box above.]

The pilots and FACs continued to refine methods for avoiding collateral damage. Colonel Haas noted that, even if a FAC reported that something was

"a good target," the NATO pilot had to be comfortable with it or he could refuse to drop his ordnance.

Teams of UN ground controllers fine-tuned their use of laser designators and radar beacons to guide NATO aircraft against Serbian targets, said aircrews and officials. Colonel Haas said that they had laser designators and Global Positioning System units to establish precise locations of targets.

"We are practicing all the things we think we have to do if we were to be called to engage any targets over there," including laser detection, said Captain Peterson.

Mobility and Camouflage

"Once you identify a target, with precision guided munitions today there isn't any question you can take out a target," stated General Oaks. "We've got the kind of airplanes that deliver



Photo by Tony Capaccio

A-10s from Spangdahlem (above) can use such weapons as the AGM-65 Maverick missile to neutralize enemy threats. They can also mark targets with rockets for F/A-18s like the one below, from Marine Corps All-Weather Attack Squadron 533.

Combat Camera photo by SrA. Andy Dunaway



those precision guided munitions. The challenge is if you have mobile targets and heavy camouflage or foliage that you can hide targets in. It degrades your accuracy but doesn't destroy it."

Laser-lighted targets can be detected by sensors on board Air Force AC-130 Spectre gunships based in southern Italy, but the F-16s from the 512th FS can't pick up a laser-heated target.

Senior air officers knew that, in an air attack, the A-10 would play a crucial role, so the airplane flew nearly 700 practice close air support sorties in the first few months of training. French Jaguars, which can carry the Atlas I laser pod, were also gearing for action.

Lasers speeded up the targeting process, Captain Peterson said. "If [the FAC] can get you to a general area, point a laser so that you get a spot on your HUD [head-up display]—a little diamond where the laser is reflecting—boom. You find the target that much faster."

The targets could be attacked with the A-10's 30-mm GAU-8 cannon or infrared-seeking Maverick missiles. "We have the capability to destroy a single artillery piece, a single tank, a single you-name-it," Captain Peterson said.

Lasers allowed fast-moving jets to pick up targets quickly without burn-

ing valuable fuel flying numerous orbits. "Simply talking a pilot on the target could take another fifteen minutes," Captain Peterson said. "Lasers add a big capability, but a good pair of eyeballs and a guy who knows how to talk you on the target can be just as effective."

Throughout the fall and winter, US, French, and British aircraft continued to enforce the UN's no-fly zone and to monitor potential targets around Sarajevo. NATO pilots patrolling Bosnian airspace said they faced an unorganized, sporadic, but dangerous threat from the warring factions' array of ground-to-air weapons.

The Serbs had a wide variety of weapons ranging from shoulder-fired SA-7 and mobile SA-2 missiles to AAA cannons. NATO planners said their systems did not appear integrated along the lines of prewar Iraq. "It's almost a point defense for different areas," said Captain Lanham, the Marine Corps F/A-18D pilot. "It doesn't seem integrated to us."

Fighting Complacency

"We kind of have an idea of where SAMs are," said Colonel New, commander of the 512th FS. "I guess the biggest thing we have to guard against is complacency . . . that we realize the threat is there and that it can reach out and touch us."

Captain Peterson shrugged when asked what concerned him most of the missiles and guns he faces during

sorties. "To be quite honest, I can't say we are quite worried about either one," he said. "We know they are all down there. Neither one is a higher priority."

The most troublesome weapon probably was the SA-7, a weapon much like the US Stinger missile that homes in on the heat generated by aircraft engines. None of the US fighters flying in Operation Deny Flight was equipped with gear that can detect SA-7s. The best protection was flying high and keeping eyes peeled for the missile's telltale smoke trail.

"They have SA-2s, SA-7s, SA-14s, possibly -16s," said Colonel Haas, the NATO operations officer. "We fly over there at all altitudes. There appears to be no active threat against us from any of the SAMs. In fact, we've watched the bigger SAMs really close, and they never once dropped into any kind of aggressive mode. They may have turned on their radars but never once went into attack system mode."

The SA-7 was different. "It may be in the hands of people who are not dedicated or tied to the political side, and . . . the drinking habits on the ground over there are not good," Colonel Haas said. "The fear is about who has control of them."

"SA-7s are a factor because they can be so numerous," said Captain Lanham. "One or two by themselves are not so difficult to defeat, but a lot of them can be a factor."

Two aircraft played crucial roles in keeping track of Serbian radar-guided missile batteries. One was the RC-135 Rivet Joint electronic intelligence aircraft that was monitoring Serbian missile radars. Information gathered by Rivet Joint was radioed to one of seven EC-130 ABCCCs circling Bosnia. The aircraft received virtually instant "threat updates," such as the position of SAM radars and whether they posed a threat.

The ABCCC planes blended these threat updates with the current status of all aircraft either approaching or flying over Bosnia. The location of the missile radars and effective ranges of their missiles were superimposed on maps displayed in the aircraft. The maps, in numerous scales, depicted ground units, terrain, lines of communication, cities, and aircraft.



Combat Camera photo by PH3 Paul Hawthorn

The scoops on the fuselage identify this EC-130 from the 7th Airborne Command and Control Squadron as more than an ordinary airlifter. It performs the ABCCC mission, transmitting the location of enemy missiles, artillery, and radar.

This tactical air picture, including the location and status of SAM units, was passed to the 5th ATAF at Vicenza, and, most important, to aircraft approaching Bosnia.

"The fighters would contact us, and we'd say 'A SAM just went active in this area,'" said Major Hill. "We can provide threat warning, targeting, and mission changes based on changes from 5th ATAF. ABCCC would get air pictures from AWACS, with missile threats overlaid, and we constantly monitor a NATO fighter's movement to keep him out of the missile's danger zone."

Slow Orders

Not nearly so efficient was the command setup for launching a ground-attack operation. In training missions last fall, NATO and UN forces needed several hours to execute the complex chain of command for the first air strike. Plans called for the first strike to be authorized by UN Secretary General Boutros Boutros-Ghali, but specific tests designed to hone the command-and-control network stretching from Bosnia to UN headquarters in New York demonstrated problems. They confirmed a suspicion among professional military officers that injecting the UN into combat decisions could be a cumbersome mess.

NATO's aircraft were ready to respond immediately, said Colonel Haas, but the "go or no-go" decision from the UN command takes longer than expected to transmit. "It still [takes] hours, several hours," Colonel Haas said of the time between the first call for air strikes and receipt of the UN order. "We've got to reduce the time of that. . . . Damage can be done in that time if artillery fire is coming in. But the capability to put the airplanes overhead is almost immediate."

Under the procedures as exercised by NATO flyers and UN forward air controllers, a request for air strikes is to be made by ground units to an air operations center in Kiseljak, Bosnia. It would be relayed to UN Commander Gen. Jean Cot's headquarters in Zagreb, Croatia, and then to UN headquarters. Simultaneously, NATO aircraft are to relay the request to Allied fighters flying nearly round-the-clock patrols. The request would also go to Naples and the 5th ATAF.

"We go through everything but rolling in on the target," Colonel Haas said of practice sorties thus far. "The situation could be mortars or artillery firing on them. It could be troops in contact, but we haven't seen much of that. It's usually the heavy weapons type of scenario we are seeing."

The decision-making chain would likely improve if UN troops faced grave danger, said Colonel Haas. "I think it will depend on how obvious a situation UN troops are in." ■

Tony Capaccio, an editor with Defense Week in Washington, D. C., covered the Balkan operations throughout 1993. His most recent article for AIR FORCE Magazine, "Bosnia Airdrop," was published in the July 1993 issue.



NATIONAL REPORT

Air Force Memorial Bill

A memorial in the nation's capital to honor those who serve and have served in the United States Air Force and its predecessors came a step closer to reality with Congressional passage of the Air Force Memorial Bill last November. Passage of this bill culminates a two-year effort by the Air Force Memorial Foundation, with the assistance of AFA and the Air Force Sergeants Association. The Foundation will now hold site selection meetings with the National Park Service. The Foundation's Site and Design Committee will also commence work. The most challenging part of the project, however, will be to raise the needed funds for construction and endowment, now forecast to be \$25 million.

New Airpower Video

AFA has distributed a new 12-minute video, "Airpower: Facing the 21st Century," produced in cooperation with Hughes Aircraft Co. The tape highlights the new threats the United States faces in the post-Cold War era, the dramatic restructuring of the Air Force to meet those threats, and the technologies that will allow the service to do more with less.

Copies went to AFA's field network, to Capitol Hill staffers, and to Air Force bases around the country.

National Health Care Reform Key in 1994

Since the President introduced the Administration's health care reform plan to a joint session of Congress last September, a number of other reform plans have been announced by members of Congress from both sides of the aisle. While there is universal agreement that without reform the cost of health care delivery will increase far in excess of inflation and thus become increasingly unaffordable, how to conduct that reform is likely to be contentious for some time to come.

AFA members have been represented on this issue from the beginning. From the White House to Capitol Hill, the Association and the Military Coalition have been active in presenting the needs of our diverse membership.

An analysis of proposed plans reveals a diverse mix of approaches. In the House, liberal democrats favor a single-payer system (a universal coverage plan in which the government collects insurance premiums and administers health care benefits for everyone). Conservative Democrats favor the President's plan, modified managed competition (individuals would be organized into large health purchasing groups to buy insurance; providers would vie for business). House Republicans favor modifications to the existing structure. In the Senate, most Democrats also favor the President's plan of modified managed competition. Moderate Senate Republicans support their own managed competition plan which does not require employers to pay a share of the premiums. Conservative Republicans favor the existing structure.

Key issues to watch as the debate unfolds:

- Uniform Benefits.
- Portability of Benefits.
- Pre-existing Conditions.
- Prescription Drug Coverage.
- Paperwork Reduction -- A Single Claim Form.
- Malpractice Reform.
- Revenue Sources.
- Employer Responsibilities.
- Spending Caps on Medicaid and Medicare.

Since DoD and the Veterans' Administration are the largest health care providers in our nation, their views on health care reform are taken seriously by all sides. The major dissatisfaction with the present plan is focused on uneven access to care and relatively high costs. Those who are able to use Military Treatment Facilities (MTFs) pay relatively little while those unable to gain access (overcrowding, location) face the insecurity of finding their own providers and paying out-of-pocket costs under CHAMPUS or Medicare. Major DoD issues to be addressed include how to best provide care for active duty dependents and retired members below and above age 65.

AFA Helps Defeat Attack on COLA

As the first session of the 103rd Congress neared its conclusion, Rep. Tim Penny (D-MN) and Rep. John Kasich (R-OH) sponsored an amendment that would have eliminated cost of living adjustments for military retirees under the age of 62.

AFA, in conjunction with the Military Coalition, opposed the Penny-Kasich amendment. Besides working the corridors of Capitol Hill, AFA helped stage a rally on the steps of the Capitol with House and Senate members and staffers who were against the measure. Ultimately, the amendment was defeated by a vote of 213-219.

Roles and Missions

In the Defense Authorization Bill, Congress directed that a new commission be appointed to further study the issue of roles and missions and to report back to Congress. AFA continues to work this issue. Last June, the AFA Advisory Group on Military Roles & Missions produced its first report, "Long-Range Airpower." The Advisory Group will address other areas in the coming year. Also of note, in a recent report by the Congressional Research Service, titled "Four U.S. 'Air Forces:' Overlap and Alternatives," AIR FORCE Magazine was cited nine times.

January 1991 in the Gulf was a high point.
Then came October 1993 in Mogadishu.

The Choppy World of Army Aviation

By David S. Harvey

TWO RECENT combat experiences symbolize the role and status of Army Aviation in the green-suit view of the world ahead. Both can be seen as key waypoints on the long, twisting course of the helicopter branch since 1947, when airmen in blue and green went their separate ways. Both dramatize the promise, problems, and prospects of a unit still struggling to define its identity in today's defense environment.

At 2:38 a.m. on January 17, 1991, AH-64A Apache attack aircraft commanded by Col. Dick Cody fired a salvo of precision guided weapons to open Operation Desert Storm. The targets—long-range surveillance radars—were the eyes of Iraq's coiled air defense. The Apaches got the job because it was vital to actually see each target go down. Only human observers in a helicopter could do that, and the Apache was the only type carrying the proper weapons—Hellfire laser-guided standoff missiles. Within minutes, the aircraft had, in the words of Gen. H. Norman Schwarzkopf, the coalition commander, "plucked out the eyes" of Iraq's defense.

Flash forward nearly three years to October 3, 1993. In downtown Moga-



The UH-60 Black Hawk is a workhorse of Army Aviation. Some are equipped for defense (above) with IR gear on the centerline just behind the main rotor engine, heat deflection devices on each engine, and chaff and flare dispensers. The AH-64 Apache (opposite) bristles with high-tech sensors and weaponry for attack.

Photos © Hans Halberstadt / Arms Communications



dishu, things would go as badly as they had gone well in the Persian Gulf War. A few UH-60L Black Hawk helicopters were attempting to support Army Ranger operations in the dangerous streets of the Somali capital when they took hits from RPG-7 rocket grenades and ZU-23 towed guns lurking in the shadows. Two helicopters fell, one dropping with its tail shot off, into the firefight raging in the streets. The pilot was captured. Nineteen Rangers died.

What lessons did these events hold for Army aviators? Why can they be seen as milestones?

In the Front Seat

In the first case, Army aviators could boast—with justification—that, at last, their time had come. Here were the Apaches, *Army* pilots, with an in-the-weeds front seat at the start of momentous events. Doctrine, training, and technology seemed finally to have come together for a payoff. No longer were helicopter drivers mere bearers of beans, bullets, and body bags, as detractors have so often alleged since Vietnam. They were fully a part of the calculus of modern warfare. Confronted with the devastating power of

the advanced attack helicopter, would the world ever be the same?

Desert Storm was fought along lines that the United States and its allies had prepared to follow for years. It was a surrogate central European engagement, replete with advanced technology and driven by conventional doctrine. The troubles in Somalia, however, posed fundamentally different problems, perplexing in their complexity and obscure in their tactical character. The same Army Aviation leadership that had grown confident in the desert had to come to terms with a bitter fact: Helicopters used improperly are among the most vulnerable of weapons. Their tactical failure exacts a disproportionately high price.

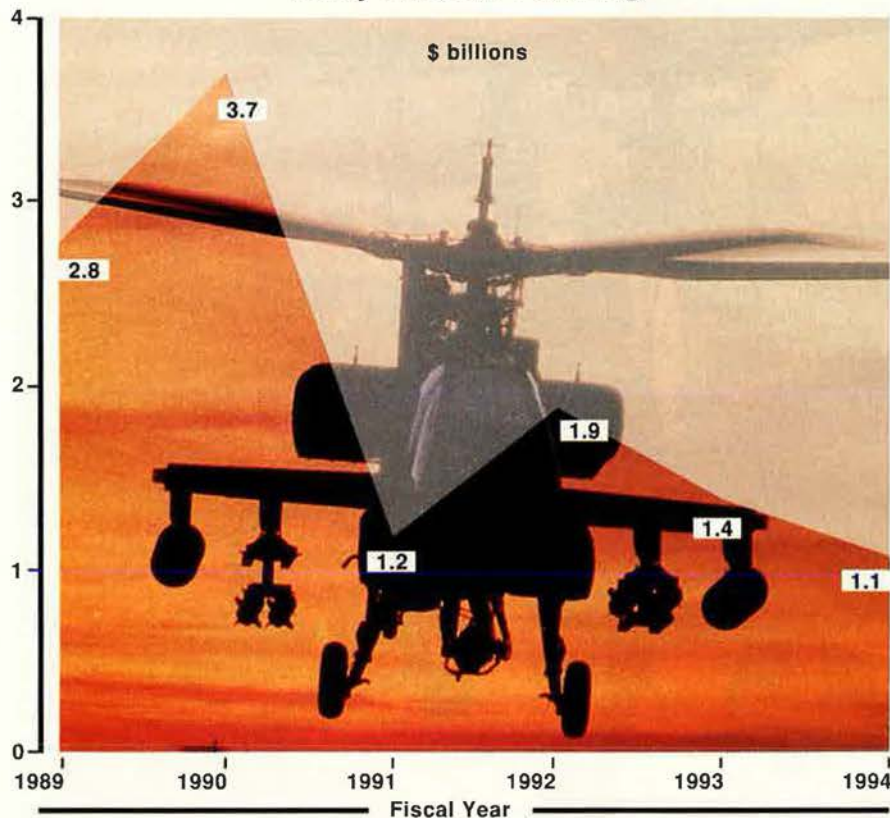
There were extenuating circumstances. Those Black Hawk pilots belonged to one of history's most highly trained nighttime flying units—the 160th Special Operations Aviation Regiment (Airborne), conditioned and equipped to claim "ownership" of the night. This elite night-fighting tactical unit was asked to bring its birds during broad daylight into the teeth of a tactical situation characterized by spotty intelligence, a confused chain of command, and nonexistent support

firepower. Was it any surprise the battle unfolded the way it did?

Nevertheless, many saw the Mogadishu engagement as a wake-up call about the predictably unpredictable "little" actions that helicopter aviation must be prepared for in the future. The significance of the Mogadishu engagement—not lost on Army aviators—is that they must have different and better tactics when next they go "downtown." No one doubts that Army Aviation has come of age. At the same time, all agree it is time to adapt.

Army Aviation leadership has never been able to lay down the burden of selling its potential to a sometimes unwilling and uninterested US Army. Progress has been slow but solid, one step at a time in terms of weapons choices, one general at a time in terms of senior positions. Aviators thought they had affirmed their identity in 1983, when they declared themselves a full "branch" of the Army. The move fostered aviation development on several fronts—logistics, training, doctrine—but most of all it allowed aviators to be the technological equals, in their own way, of Air Force or Navy flyers. The plan, drawn up during one of the high points of the Cold War,

Army Aircraft Funding



Source: US Army budget proposals.

Technological excellence was the plan for Army Aviation's helicopter fleet four years ago, but the end of the Cold War sent funding for Army helicopters, along with the rest of the US defense budget, into a steep dive.

was for the helicopter fleet to pursue technical excellence.

Old and New

The importance of some helicopters was more or less self-evident. This was the case with attack aircraft like the Apache, loaded with high-tech sensors and weapons. Transports like the upgraded CH-47 Chinook and the new UH-60 Black Hawk series would explore new parts of the "fastest with the mostest" ground envelope of the Army operational tempo. The OH-58D Kiowa Warrior—a specialized Bell product resembling a civilian JetRanger—was to serve as a catalyst for deep attack beyond the front.

Existing Vietnam-era helicopters—AH-1 Cobra attack planes and OH-6 Cayuse transports slated for eventual retirement—would also be upgraded with new sensors for night attack and upgraded weapons. And, of course, the venerable UH-1 Huey would soldier on.

To combat Soviet might, which looked highly mobile and dangerous, particularly when regarded from across the plains of central Europe, the Army Aviation fleet grew to nearly 8,000 aircraft by the mid-1980s. Though it displayed an odd balance of old and new, it was nevertheless a formidable force.

What changed for Army Aviation was the catalyst for every component of the US defense establishment: The Pentagon's budget took a steep dive. The collapse of the defense budget, sparked by the 1989 collapse of the Berlin Wall and the end of the Cold War, has hit the Army hard.

Amid the blizzard of statistics produced to describe the phenomenon, the chart above, showing the decline in Army aircraft funding from 1990 to the present, tells the story most vividly.

The chart shows that, four years ago, aviators could be said to be relatively comfortable. They had \$3.7 billion that year to spend on aircraft,

support, spares, and facilities. Then the party ended. The amount available for the same items in Fiscal 1994 has fallen to about \$1 billion, a drop of about seventy-five percent. A corporation experiencing similar cuts in funding for modernizing plant and equipment might conclude it was in the wrong business and exit the scene. Army Aviation cannot.

Army Aviation leaders had seen much of this coming, though they too were surprised by the scope and magnitude of the budget crunch. At the start of the downturn, they decided to close ranks around a precious asset—the Army's proposed RAH-66 Comanche armed scout helicopter. The Comanche represents nothing less than the next generation of helicopter warfighting power to take the Army into the twenty-first century as a savvy force squarely on the leading edge of information technology. It will contain compelling technology as an all-digital platform fitted with new-generation sensors and the ability to work as part of a combined-arms network. The first "pure" digital helicopter the Army has developed, the RAH-66 shares common electronics with the F-22 fighter and is officially the Army's premier research and development effort. First flight of the Comanche prototype is to take place in two years.

Shades of Billy Mitchell?

Going to bat for the Comanche has been a major commitment, with funding consequences for other programs within the aviation community and without. The debate has sometimes resembled the one that occurred as the horse gave way to the tank in the early decades of the twentieth century. Comparisons frequently are drawn between Army Aviation leaders and Billy Mitchell, the iconoclastic Army flyer who was forced to prove that ships are vulnerable to aerial bombardment by actually sinking one and was court-martialed for his pains.

The Comanche saga has been interesting. At one time, it was unofficial policy within the helicopter procurement community to denigrate the Apache. With its targeting system needing money, the AH-64D Longbow Apache was a funding rival. The Apache's technical problems didn't help. However, this intramural spat has been patched up. The 800-strong fleet of Apaches is funded for Longbow.

The plunge in US defense budgets meant the Army—like everyone else except the US Marine Corps—was forced to cut its end strength and force structure, and it took aviation spending down with it. The process may, after two tumultuous years, have begun to settle down now that the Pentagon has ended its Bottom-Up Review of defense needs and concluded that the Army needs to maintain ten active divisions and up to six reserve divisions. However, the cuts have taken a toll on aviation plans made during the Cold War.

Gone, for instance, is a plan to produce more than 2,000 Comanches (1,292 is the current approved number). Also gone are former “end strength” targets of more than 800 OH-58D Kiowas and more than 2,000 UH-60 Black Hawks and a proposed crack at retrofitting the CH-47D Chinook fleet with advanced electronics and four-bladed rotors. Dead—forever, don’t even mention it—is an initiative aviators once mounted for buying 231 V-22 tiltrotor aircraft. These are only the most visible manifestations of the carnage. Also gone are numerous R&D plans, weapons, and personnel billets—nothing has been spared.

One major problem for the Army has been the inefficiency steadily eating away at aviation budgets from the inside. The overriding headache was the sheer expense of running aviation units equipped with a mix of many different types of aircraft, making it



Photo © Hans Haberstadt / Arms Communications

A new Army initiative will trim the fleet by some 3,000 aircraft by 2015. Versions of the UH-60 (here, a Black Hawk of the 82d Airborne Division, Fort Bragg, N. C.) are proliferating as the Army makes the most of its current assets.

next to impossible to achieve economies of scale. A solution forced by the budget drawdown is the Aviation Restructure Initiative (ARI). Designed to target haphazard aviation organization, ARI will strive to concentrate common types of aircraft into their own units. Restructuring service units this way makes better sense from an operating cost point of view and will begin to squeeze out older, Vietnam-vintage aircraft.

Army officials say that, once the job is complete, the system will be

unclogged and other benefits will flow. One is a guarantee that two pilots “per helicopter seat” can be made available throughout the fleet. Another is to have two door gunners aboard each UH-60. Most important is the proposed increase in the number of armament, avionics, and mechanic personnel per aircraft. This will help alleviate unfavorable comparisons between Army crews and their Air Force helicopter counterparts. In Army Aviation, one hears grumbles that it is still hard to get timely maintenance attention, let alone the individualized “plane captain” service afforded blue-suit aircraft. New emphasis will be placed on improving the Army’s command, control, and communications helicopters. ARI units will be customized to suit both types of Army divisions, heavy and light.

Slimming the Fleet

The ARI plan is to slim down the fleet (some 8,000 aircraft) to around 5,000 by 2015. ARI will be instituted first in the active-duty force, starting in Fiscal 1995 with a three-year completion deadline. Reserve units will start restructuring in 1996 and won’t finish until 2000. When the ARI is finished, the Army’s Reserve and Guard units will have half of the aviation force structure.

Among Army Aviation generals, concern about the future lives on—to the point in 2001 when the new Co-

Photo © David Hethcox / Arms Communications



The CH-47D Chinook does a lot of the Army’s lifting. It is the only Army helicopter that can transport a 12.4-ton D5 bulldozer over short distances. Here, a Chinook moves a howitzer and its gun crew and ammunition.



The Vietnam-era Cobra gunship is the Army's most numerous antiarmor-attack helicopter. Its firepower includes a chin-mounted 20-mm or 30-mm gun and eight TOW antiarmor missiles. Below is an AH-1S Cobra from Fort Ord, Calif.

manche is to come into the force. At that point, the great leap forward promised by the Comanche's technical capacity will present planners with more operational choices. Meanwhile, toward mid-decade, the Army will be converting the Apache fleet to Longbow status. Today's planners dream of the day when Apaches and Comanches operate together. They say the result should be lethality on a scale never before seen in helicopters.

Where, then, is the aviation force headed in the grand scheme of restructuring US forces? Aviators have an adage that best sums up their role: Helicopter soldiers represent the "spirit of the cavalry." Despite the helicopters' Indian names, the saying has a lot going for it, a case argued well by Maj. Gen. David Robinson, head of Army Aviation at Fort Rucker, Ala.

"Breaking friction with the ground," he says, "is the next logical step in the Army's attack development." He refers to traditional cavalry operations—scouting, stealthy attack, force screening, and the like. They play an important role in the combined-arms philosophy of the Army.

Army Aviation leadership knows there's more to do. It has signed on for membership in the "digital battlefield" revolution, the Army's ambitious plan to build digital information superhighways between everything that moves, thinks, or shoots. Army Aviation bills the Comanche as the "quarterback" of this effort.



The problem looming for the aviators is the branch's somewhat shaky institutional standing in the service. There is sporadic talk within DoD these days about abolishing the branch, sending the helicopters back to be "just assets" at the beck and call of battalion and brigade commanders. This is mostly talk, but it diverts attention and drains energy.

Army aviators face cultural problems stemming from their status as

pilots in a world dominated by "ground-pounders," although these problems are displayed more as budget issues than as deep-seated philosophical challenges. The aviators still lack numbers at levels above the rank of two-star general. A round of retirements in 1994 could further deplete the ranks.

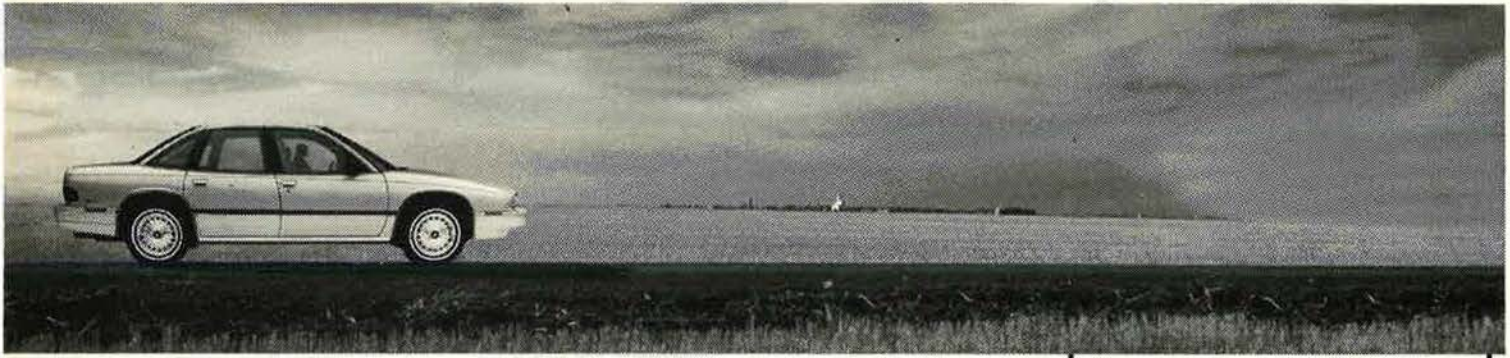
Army leadership knows there's a need for caution. The aviation branch recently lost control of the combined Aviation and Troop Command (ATCOM) in St. Louis, Mo. ATCOM is the nerve center of aviation acquisition.

The aviators have also lost the opportunity to be the proprietors of one of six "Battle Labs" that the Army has set up to test future warfare tactics. Instead, their contribution will be inserted electronically. Army Chief of Staff Gen. Gordon R. Sullivan is a strong aviation proponent. He recently

felt the need to warn Battle Lab chiefs to give Army Aviation a fair hearing.

Though the air is filled with potential turbulence for Army Aviation, there is plenty that looks good about the situation. As the tactical shape of US warfighting emerges, the mobile, lethal Army of the future will surely need "the air." But it will be airpower with a well-defined, ground-support-oriented purpose and technology designed for specific roles. ■

David S. Harvey is Washington bureau chief for Rotor & Wing Magazine. His most recent article for AIR FORCE Magazine was "Seeking the Heat Seekers" in the July 1990 issue.



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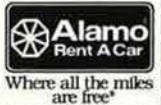


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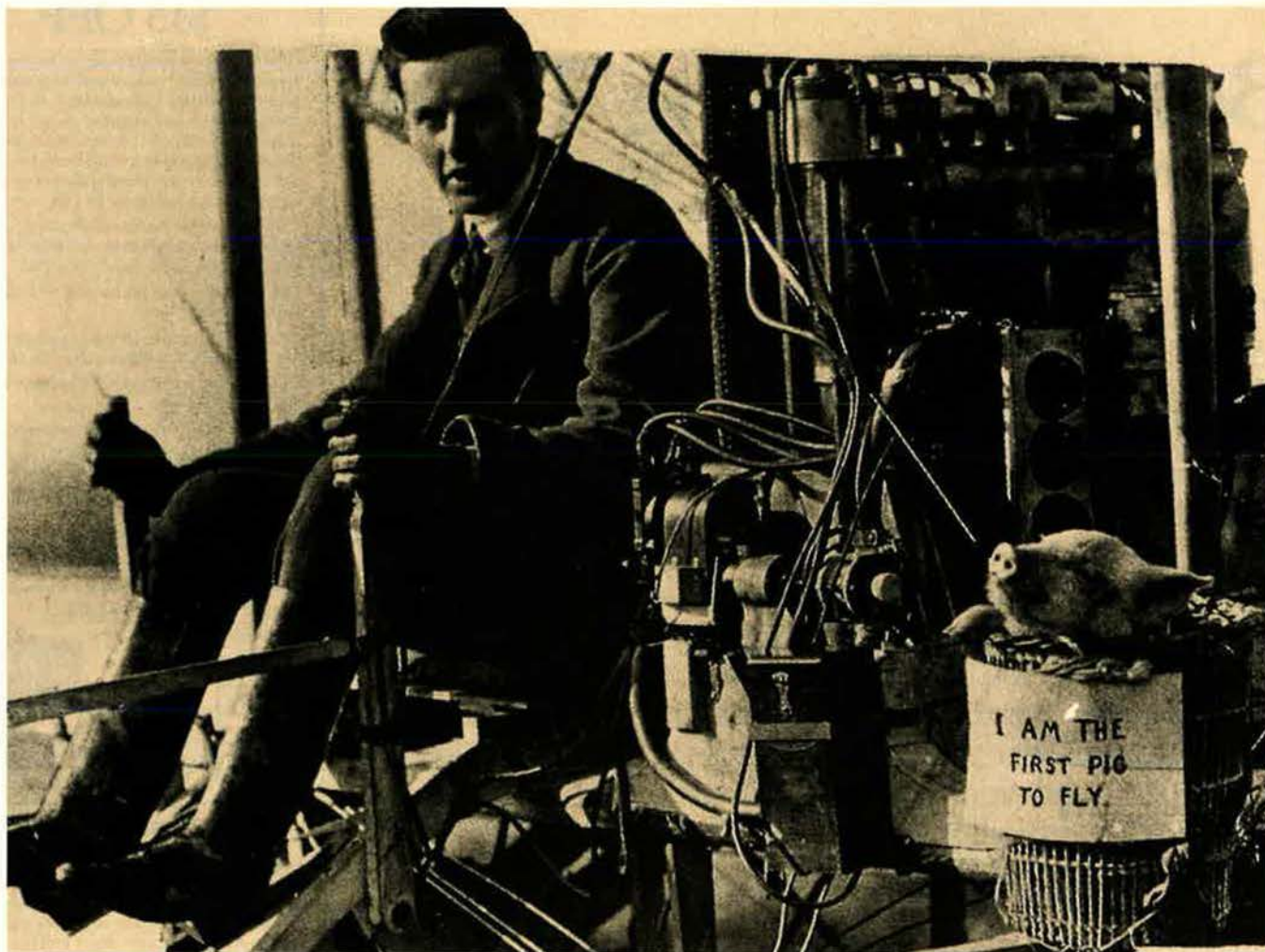
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U89B

Flashback

When Pigs Fly



John Theodore Cuthbert Moore-Brabazon (later Lord Brabazon of Tara) was England's number one aviator literally as well as in deed. He learned to fly in a French Voisin biplane in 1908 and was issued Britain's first pilot's license by the Royal Aero Club in 1910. Brabazon's worldwide aviation "first" was inspired by the adage that, when something seems impossible, it will only happen "when pigs fly." He debunked this maxim by taking a piglet on a flight in a Voisin on November 4, 1909. His porcine passenger was flown over a 3.5-mile course in a wicker basket tied to the aircraft's frame.

During World War I, Brabazon was instrumental in the development of aerial photography. Between world wars, he became president of the Royal Aeronautical Society and a member of Parliament. During World War II, he was Minister of Transport and later the first Minister of Aircraft Production. He alienated some of his colleagues by saying that bombs alone would not win the war and denouncing the RAF's strategic concepts. An outspoken proponent of air safety, Brabazon was a powerful critic of risky aviation procedures, especially the use of flammable fuels in commercial airliners. He died in 1969 at the age of eighty-five.

A Checklist of Major Aeronautical Systems

Aeronautical works in progress at the Air Force's Major Program Offices and at Aeronautical Systems Center and Wright Laboratory, Wright-Patterson AFB, Ohio

Edited by Tamar A. Mehuron, Associate Editor

Advanced Cruise Missile System Program Office

AGM-129A Advanced Cruise Missile

Program to produce a second-generation strategic air-launched cruise missile with increased range, accuracy, and stealth features. Designed for use by B-52 bombers. **Contractors:** Hughes Missile Systems Co., Williams, McDonnell Douglas (MD). **Status:** Production.

Aircraft Systems Program Office

767 Airborne Warning and Control System

Program to provide air vehicle engineering support for the modification of a Boeing 767 commercial aircraft to a 767 AWACS aircraft for sale to Japan. Project headquarters is at Electronic Systems Center, Hanscom AFB, Mass. **Contractor:** Boeing. **Status:** System proposal evaluation.

AC-130U Gunship

Program to procure 13 new C-130H aircraft and convert them to AC-130U gunship configuration. Program includes development of advanced mission computer and fire-control systems to integrate three sensors with three guns and enhancement of the electronic countermeasures (ECM) suite, battle management center, and tactical situation display. Replacement for aging AC-130As in inventory. **Contractor:** Rockwell. **Status:** Production, deployment.

Air Force Infrared Maverick (AGM-65D)

Precision guided, launch-and-leave, air-to-ground weapon to counter armored vehicles and fortified structures. **Contractors:** Hughes, Raytheon. **Status:** Production.

Air Force Infrared Maverick (AGM-65G)

Incorporates unique tracking algorithms and a pneumatic actuation system in the standard Maverick. **Contractors:** Hughes, Raytheon. **Status:** Production.

C-20H

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

C-26B

Acquisition and support of 32 Fairchild Metro III aircraft (if all options are exercised) to provide operational airlift support. **Contractor:** Fairchild Aircraft. **Status:** 30 on contract as of FY 1992, with options for 23 in FY 1993-94.

Cruise Missile Mission Control Aircraft

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

C-130H

Program to provide acquisition and support of C-130H Hercules aircraft for USAF, Air Force Reserve, Air National Guard, US Navy Reserve, US Marine Corps Reserve, and foreign military sales (FMS) customers. These aircraft provide the armed services and foreign customers with tactical airlift support, air refueling, rescue, and polar operational capability. **Contractor:** Lockheed Aeronautical Systems Co. **Status:** Production.

F-117 Avionics Modernization Program

Development and production of major modifications to F-117 avionics, including an upgrade to the forward-looking infrared (FLIR) and improvements to the navigation system, including a ring-laser gyro and a Global Positioning System receiver. **Contractor:** Lockheed. **Status:** Development.

F/EF-111 Digital Flight-Control System Program

Class IV-A safety modification to develop, test, and produce a digital flight-control computer to replace current analog flight-control computers. Also replaces angle-of-attack transmitters and normal accelerometers for improved reliability. **Contractor:** General Dynamics (GD). **Status:** Production.

F/RF-111C Digital Flight-Control System

FMS case to provide the F-111 digital flight-control system to the Royal Australian Air Force. **Contractor:** None. **Status:** Proposal evaluation.

Integrated Avionics Testers

Acquisition of automatic test equipment to support various special operations forces (SOF) aircraft (AC-130U, AC-130H, and MC-130H, initially). **Contractors:** E&S Co., DME, TAMSCO. **Status:** Ongoing.

Joint Surveillance and Target Attack Radar System (Joint STARS)

Development and production of a powerful airborne, multimode, ground surveillance radar set plus radar image processing for a real-time picture of enemy ground movements. The radar is carried in E-8C Joint STARS aircraft: used commercial 707s refurbished and militarized by Grumman Melbourne Systems, Melbourne, Fla. **Contractors:** Grumman, Norden, Boeing, Cubic. **Status:** Beginning flight tests.

Joint Vertical Lift Aircraft (CV-22A)

Development of tiltrotor vertical/short takeoff and landing (V/STOL) aircraft combining the versatility of a helicopter with the speed of a high-performance turboprop airplane. Will significantly enhance SOF long-range infiltration/exfiltration capability. **Contractor:** Bell-Boeing Tiltrotor Team. **Status:** Engineering and manufacturing development (EMD).

KC-10A On-Board Loader

Development and production of an air-transportable loader for the KC-10A capable of deployment with the aircraft. Loader will provide upload/download capability for palletized cargo in austere locations. **Contractors:** Enginetics, Digrion. **Status:** Production.

KC-10A Wing Pods

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

KC-135 Improved Aerial Refueling System

Development and test of new aerial refueling systems and subsystems. **Contractor:** None. **Status:** Development.

KC-135 Wing Pods

Modification of KC-135 aircraft with two wing-mounted air refueling hose reel pods to provide simultaneous air refueling of probe-equipped aircraft. **Contractor:** To be determined (TBD). **Status:** Request for proposal (RFP) preparation.

MC-130H Aircraft

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

MH-60G Pave Hawk

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

Navy Infrared Maverick (AGM-65F)

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

Navy Laser Maverick (AGM-65E)

Precision guided, close air support weapon with heavyweight penetration/blow warhead homes in on reflected laser radiation generated by either ground or airborne laser designators. **Contractor:** Hughes. **Status:** Limited production.

Transport Advanced Avionics and Cockpit Enhancement

Program to update Class II avionics and flight management to one C-135 aircraft to improve research and development (R&D) test capabilities. **Contractor:** Boeing. **Status:** Contractual closeout.

VC-X

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

B-1 System Program Office

B-1 Conventional Mission Upgrade Program

Program of multiphase development and production of upgrades to enable the B-1B bomber to operate in conventional conflicts. Upgrades are to increase the number of conventional weapons that the aircraft can deliver, add the capability to deliver precision guided munitions (PGMs), improve defensive avionics system capabilities, and increase the mission capable rate. **Contractor:** Rockwell. **Status:** Risk reduction, pre-EMD, EMD.

B-2 System Program Office

B-2A Bomber

Development, production, and supportable deployment of a four-engine, low-observable, flying-wing type of strategic penetrating bomber, designed specifically to elude enemy air defenses. Aircraft will be able to deliver nuclear or conventional weapons, including PGMs. Intended to hold at risk or attack enemy warmaking potential, initially striking time-critical targets, then shifting to sustained operations in concert with other theater bomber forces. Plans call for 20 two-place intercontinental-range B-2s. Delivery of first operational aircraft was to have occurred in December 1993. Initial operational capability is scheduled for mid-1990s. **Contractors:** Northrop, Boeing, LTV, General Electric (GE), Hughes, Link. **Status:** EMD, initial production.

C-17 System Program Office

C-17A Aircraft

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

Electronic Combat System Program Office

Advanced Strategic and Tactical Expendables

Program to develop near-term and longer-term infrared (IR) expendables for a variety of USAF aircraft. **Contractor:** None. **Status:** EMD.

Advanced Tactical Air Reconnaissance System

Development of electro-optical (EO) and IR sensors, digital recorders, and management system for reconnaissance aircraft, unmanned aerial vehicles, and fighter aircraft pods. **Contractor:** Martin Marietta. **Status:** EMD.

Contingency Airborne Reconnaissance System

Deployable ground station to receive and process data collected by USAF aircraft. **Contractor:** Loral. **Status:** EMD.

EF-111A System Improvement Program

Upgrades the EF-111A tactical jamming system, ALQ-99E, to maintain its capability against the growing number and sophistication of threat radars and to improve its operational availability. **Contractor:** Grumman. **Status:** EMD.

Joint Modeling and Simulation System

Program to develop standard software architecture for modeling systems used by armed services. **Contractors:** Prime, MD. **Status:** EMD.

Joint Service Electronic Combat System Tester

Program to develop common EC end-to-end ground test set for the Air Force and Navy. **Contractor:** None. **Status:** Pre-Milestone 1.

Missile Warning System

Initiative to examine the application of threat warning capabilities on USAF aircraft using integrated electronic warfare (EW) system technology in an Air Force jamming pod environment. **Contractors:** Raytheon, Westinghouse. **Status:** EMD.

Tactical Countermeasures Dispenser Upgrade (AN/ALE-47)

USAF-Navy program to provide dispenser that can operate with radar warning receivers and missile warning systems. **Contractor:** Tracor. **Status:** Production.

F-15 System Program Office

F-15 Radio Frequency Compatibility Program

An effort to improve interoperability of Tactical Electronic Warfare System (TEWS) with F-15 radar, weapons, and avionics. **Contractors:** MD, Loral, Northrop. **Status:** Development.

F-15 Very-High-Speed Integrated Circuit Central Computer

Program to develop next-generation mission computer to replace the current AP-1R. All F-15Es have completed retrofit, and Multistage Improvement Program retrofit is scheduled to start in July 1994. **Contractor:** MD. **Status:** Production.

F-15C Manned Destructive Suppression (MDS) of Enemy Air Defenses Program

The F-15C MDS program consists of two distinct programs executed simultaneously: High-Speed Antiradiation Missile integration and Precision Direction Finding (PDF). The HARM integration program will allow HARMs on F-15C aircraft to accept initial targeting functions to suppress enemy radar systems. The PDF program will develop an integrated system capable of detecting, identifying, locating, and targeting enemy radar systems. An independent HARM integration program will achieve initial limited lethal suppression capability in 1997. The PDF phase will achieve autonomous targeting capability in 2001. **Contractor:** MD. **Status:** PDF: Demonstration/validation (dem/val), HARM integration: EMD.

F-15E Dual-Role Fighter

Two-seat upgraded version of F-15 to provide long-range, day/night, fair/foul weather delivery of air-to-ground munitions as well as air-to-air capability. Includes advanced cockpit technology, Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN), ring-laser gyro guidance, conformal fuel tanks, reconfigured engine bay, Increased Performance Engines (IPEs), and upgraded TEWS. Weapons integration efforts include PGMs, HARMs, and Advanced Medium-Range Air-to-Air Missiles. **Contractors:** MD, P&W. **Status:** Development, production, deployment, modifications.

Memory/Radar Module Test Station

Recently fielded depot test systems supporting the F-15's APG-70 radar and avionics. The memory module tester is an off-the-shelf, high-speed digital test station. The radar module test station, used for depot testing and radar shop-replaceable units (SRUs), is patterned after a similar Navy test system. **Contractors:** MD/Teledyne, MD/ESCO. **Status:** Deployment.

Mobile Electronic Test Set

Initiative to enhance supportability and mobility of the F-15E Avionics Intermediate Shop. **Contractor:** MD. **Status:** Deployment.

Program Loader Verifier

Used to load and verify operational flight programs and preflight messages into line-replaceable unit (LRU) processors at the flight line. Used on all F-15 models. Original procurement for 48 units, with a follow-on contract currently being negotiated. **Contractor:** MD. **Status:** Production, deployment.

Tactical Electronic Warfare System Intermediate Support System

An advanced support equipment system designed to provide intermediate-level support for all configurations of F-15 TEWS, including the ALR-56A, ALR-56C, and ALQ-135. A total of 35 systems will be procured to support the F-15A/E fleet. **Contractor:** MD. **Status:** Production, deployment.

Tactical Electronic Warfare System P³

Program to improve ALR-56C radar warning receiver, ALQ-135 internal countermeasures set, and ALE-45 countermeasures dispenser on F-15. **Contractors:** Loral, Northrop, Tracor. **Status:** Development, production, deployment, modification.

F-16 System Program Office

F-16 Multimission Fighter

A single-engine, lightweight, high-performance, tactical fighter with an air-to-air and air-to-surface multirole capability that can be deployed from the continental US to any trouble spot in the world with minimum en route support, high reliability, and simplified maintenance procedures to ensure successful operation under austere conditions. **Contractors:** GD, P&W, GE, SABCA (Belgium), Fokker (Netherlands), Fabrique Nationale (Belgium), Philips (Netherlands), TAI (Turkey). **Status:** Development, production, deployment.

F-22 System Program Office

F-22 Advanced Tactical Fighter

Development of the Air Force's next-generation air-superiority fighter. Flight testing of the EMD aircraft will begin in 1996, and the F-22 will begin operational service in 2003. The F-22 will include advanced propulsion, flight controls, and fire controls; significant avionics integration; advanced system survivability features; designed supportability characteristics; low-observable technologies; superior subsonic and supersonic maneuverability; supersonic persistence without use of afterburners; and greatly increased combat radius. It will be powered by two F119-PW-100 advanced technology fighter engines. **Contractors:** Lockheed/Boeing, P&W. **Status:** EMD.

LANTIRN System Program Office

LANTIRN System

Production of two-pod navigation and targeting system for night, under-the-weather ground attack by F-15E and F-16C/D aircraft. Navigation pod with

FLIR provides a video display of terrain in an aircraft's flight path on the head-up display, and a TFR provides the pilot with flight cues as warnings of obstacles. Targeting pod with FLIR provides aircrews with IR target detection and tracking and laser designation/range-finding. It is used for precision munitions deliveries. LANTIRN Mobility Shelter Set provides intermediate-level maintenance capability. The Paperless LANTIRN Automated Depot provides computer-integrated repair and data collection in a paperless environment. **Contractor:** Martin Marietta (MM). **Status:** Production, deployment.

National Aerospace Plane Joint Program Office

National Aerospace Plane

DoD-NASA research program aimed at developing and demonstrating single stage to orbit (SSTO) and hypersonic flight technologies for a new generation of aerospacecraft capable of flying in the atmosphere and low-Earth orbit. The NASP program will conduct ground and flight experiments leading to the development and flight test of a technology demonstrator, the X-30, in horizontal takeoff, hypersonic flight, and SSTO flight. **Contractors:** NASP National Team, comprising GD, MD, North American Aircraft, P&W, and Rocketdyne. **Status:** Technology development.

Subsystems System Program Office

Avionics Modernization Decision Process

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

Avionics Subsystems

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

Common Support Equipment

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

Engine Component Improvement Program

Continuing engineering support for all air-breathing engines used in manned USAF aircraft. Program resolves critical flight-safety problems; corrects operational deficiencies; improves reliability, maintainability, and durability; and reduces cost of ownership. **Contractors:** GE, P&W, Allied Signal, Williams, Teledyne, Allison. **Status:** Ongoing.

F100-PW-229 Engine for F-15 and F-16

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

F110-GE-129 Engine for F-15 and F-16

IPE version of the existing F110 also being developed for the F-16 in the 1990s. Greater thrust and reliability. **Contractor:** GE. **Status:** Production.

F117-PW-100 Engine for C-17

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

Fasteners, Actuators, Connectors, Tools, Subsystems (FACTS)

Program to remove barriers to the effective distribution of quality FACTS by investigating FACTS problems, identifying quick fixes, and recommending process improvements. **Contractors:** Many. **Status:** Ongoing.

Productivity, Reliability, Availability, and Maintainability Program

Program to increase combat power and reduce support costs of the Air Force by improving equipment efficiency and exploiting lower-lifetime-cost alternatives. **Contractors:** Many. **Status:** Ongoing.

Propulsion Technology Modernization

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

Reliability and Maintainability Technology Insertion Program

Program to develop and accelerate incorporation of promising new technology into fielded and new systems. **Contractors:** Many. **Status:** Ongoing.

Technology Transfer Program

Program and process to move technologies developed in USAF laboratories and centers to academia, industry, and state and local governments. **Contractor:** In-house. **Status:** Development.

Training System Program Office

Air Mobility Command Simulator Upgrade Program

A three-phase project to analyze, gather flight test data from, and implement recommended upgrades on the fleet of AMC simulators in order to meet Federal Aviation Administration (FAA) acceptance standards. **Contractor:** TBD. **Status:** Planning.

B-1B Simulator System

Development and production of a system to train all B-1B crews and maintenance personnel. Program includes five weapon system trainers (WSTs) that simulate all four crew positions, two mission trainers that simulate only the offensive/defensive positions, cockpit procedures trainers, and several maintenance trainers. **Contractors:** Boeing, Rockwell. **Status:** Planning.

B-1B Training Systems

A family of systems designed to train all B-1B crews. Includes WSTs, mission trainers, and cockpit procedures trainers that provide complete mission rehearsal from takeoff to landing. In addition, maintenance training equipment trainers provide crew chiefs and flight-line maintenance personnel hands-on experience with aircraft systems. **Contractor:** TBD. **Status:** Source selection.

C-17 Aircrew Training System

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

C-17 Maintenance Training Devices

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

C-130 Maintenance Training Devices

A combination of modification and development of three suites of devices to certify C-130 maintenance personnel without using the aircraft. **Contractor:** TBD. **Status:** RFP development.

C-141 Aircrew Training System

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

F-15E Weapon System Trainer

Production completed of four F-15E WSTs for initial entry through advanced aircrew training. Contains high-resolution sensor displays, EO/IR weapons delivery, and LANTIRN capability for air-to-ground and low-level training. **Contractor:** Loral. **Status:** Deployment.

F-15/F-16 Unit Training Device

Program to produce for the F-15 and F-16 low-cost, unit-level training devices designed for pilot refresher and continuation training. **Contractor:** Hughes. **Status:** Production.

F-16 Weapon System Trainer

Procurement of operational flight trainers, improved digital radar landmass simulators, improved EW training devices, visual systems, and various LANTIRN simulators. **Contractors:** CAE-Link, GE, AAI, E&S. **Status:** Production.

F-22 Trainer

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

Interoperable Visuals/Sensors for Air Combat Command

Program to replace or upgrade current visuals and/or sensors on the B-1 WSTs and mission trainers, B-2 WSTs, and F-15E WSTs, and the production of visual and radar databases. **Contractor:** TBD. **Status:** Source selection.

Joint Primary Aircraft Training System (JPATS)

Program to acquire missionized, nondevelopmental aircraft and associated groundbased components to replace USAF T-37B and Navy T-34C training system components. **Contractor:** None. **Status:** Acquisition strategy planning.

JPATS Aircraft and Groundbased Training Systems

Development and production of a total aircrew training system for JPATS. **Contractor:** None. **Status:** Dem/val.

Joint Surveillance and Target Attack Radar System

Development and acquisition of pilot, copilot, and flight engineer training system for Joint STARS. **Contractor:** TBD. **Status:** Development.

KC-135 Aircrew Training System

Development and acquisition of a totally integrated aircrew training system that encompasses all training from initial entry through refresher and continuation training. **Contractor:** FlightSafety Services Corp. **Status:** Development, deployment.

New and Modified F-16 Simulated Aircraft Maintenance

Program to assist in development of trainers for the US, South Korean, Taiwanese, and Turkish Air Forces. **Contractors:** ECCI, Hughes, Lockheed Fort Worth. **Status:** Development.

Simulator for Electronic Combat Training

Development and acquisition of simulator to train electronic warfare officers. **Contractor:** AAI Corp. **Status:** Development.

Special Operations Forces Aircrew Training System

Development and production of a total aircrew training and mission-rehearsal system for MC-130H/E, AC-130H/U, MH-53J, HC-130H/P/N, and MH-60G crew members. **Contractor:** Loral. **Status:** Development, production, and test.

Standard DoD Simulator Digital Database

Triservice-sponsored and -approved program to develop database standards, production capability, and central library to support training and mission-rehearsal systems for all services. **Contractor:** Planning Research Corp. **Status:** Development.

T-1A Training System I

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

T-1A Training System II

Production and deployment of a total aircrew training system for the T-1A. **Contractors:** MD Training Systems, Quintron. **Status:** Production.

T-3A Enhanced Flight Screener

Acquisition of 113 aerobatic piston aircraft to support the Pilot Selection and Classification System. First production aircraft was accepted at Hondo, Tex., in late 1993. **Contractor:** Slingsby Aviation Ltd. **Status:** Production.

Triservice Standoff Attack Missile System Program Office

AGM-137 (MGM-137) Triservice Standoff Attack Missile

Program to produce a low-observable, conventional, standoff, cruise missile capable of air (AGM-137) and ground (MGM-137) launch employment. Designed for use by the Air Force's B-52, B-1, B-2, and F-16, the Navy's A-6 and F/A-18, and the Army's Multiple-Launch Rocket System. **Contractor:** Northrop. **Status:** Development.

Wright Laboratory/Aeropropulsion and Power Directorate

Advanced Turbine Engine Gas Generator (ATEGG)

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

Air-Breathing Missile Propulsion

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

Aviation Fuel and Lubricants

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

Combustion

Program to provide experimental data and advanced design codes for turbine engine and ramjet combustors. Extensive application of optical diagnostic techniques and computer modeling. **Contractors:** SRL, U. of Dayton Research Institute (UDRI). **Status:** In-house research, exploratory development.

High-Speed Propulsion

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

Integrated High-Performance Turbine Engine Technology Initiative

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

Joint Expendable Turbine Engine Concepts

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

Joint Technology Demonstrator Engine

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

Joint Turbine Advanced Gas Generator

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

More Electric Aircraft

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

Plasma Physics

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

Special-Purpose Power

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

Wright Laboratory/Avionics Directorate

Advanced Avionics Reconfiguration Technology

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

Advanced Defensive Avionics Response Strategies

Program to develop approaches to sensor fusion that provide the pilot situational awareness and impart both automatic and pilot-controlled countermeasure response strategies. Program to be used in fighter, bomber, SOF, and cargo/tanker aircraft. **Contractor:** Loral. **Status:** Development.

Advanced Infrared Seeker Countermeasures Experiments

Program to develop robust laser-based countermeasures techniques against advanced reticle- and imaging-infrared missile seekers. **Contractor:** SAIC. **Status:** Development.

Advanced Platform Angle-of-Arrival Antenna System

Program to develop and demonstrate a low-cost single-aperture phase interferometer employing broadband multiarm antenna technology to provide highly accurate angle-of-arrival information. **Contractor:** TRW/Mead. **Status:** Development.

Advanced Tracking Algorithm Development

Program will improve tracking accuracies of current and future fire-control sensors through the use of multiple-hypothesis tracking techniques. **Contractor:** TBD. **Status:** Ongoing.

Allied Standard Avionics Architecture Council

Joint US, UK, German, and French program to define, develop, and validate advanced avionics architecture standards for the twenty-first century. **Contractors:** Boeing, MD, Texas Instruments (TI), TRW, WEC. **Status:** Feasibility study.

Automatic Radar Air-to-Ground Target Identification Program

Program to design, build, and demonstrate all-weather identification of ground-mobile targets using synthetic aperture radar imagery and model-based vision techniques. **Contractor:** MM. **Status:** Development.

Common Ada Run-Time System

Program to develop a set of common Ada run-time interfaces, composed of Ada packages, designed to furnish a standard interface between an Ada compiler and an Ada run-time system. **Contractor:** Westinghouse. **Status:** Development.

Concealed-Target Detection Technology Program

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

Cyclostationary Signal Processing Against Spread Spectrum

Program to develop countermeasures techniques incorporating advanced signal processing and transform analysis to negate integrated air defense systems. **Contractors:** TBD and in-house. **Status:** Exploratory development.

Detection In Clutter Enhancement

Program to develop techniques for improved missile detection and identification using staring IR arrays. Program includes advanced multispectral, spatial, and temporal techniques for detection of low-signature targets in a high-clutter environment. **Contractors:** Lockheed Sanders, Nichols Research Corp., Atlantic Aerospace Electronics Corp. **Status:** Development.

Digital Electronic Warfare System

Program to reduce the cost, weight, and volume and improve the performance of EW systems by exploiting such modern solid-state technologies as digital electronics, monolithic microwave integrated circuits, and superconductivity. **Contractors:** TBD and in-house. **Status:** Exploratory development.

Digital EW Receiver

Development of a wideband EW receiver in which the baseband frequency is digitized, allowing all subsequent receiver functions to be performed digitally. **Contractor:** Honeywell. **Status:** Development.

Distributed Architecture Decoy

Program to investigate and develop the critical subsystems of next-generation off-board countermeasures concepts. **Contractors:** Tracor, Northrop. **Status:** Studies.

Domain-Specific Software Architecture/Avionics Domain Application Generation Environment

Program to design, document, and develop a set of avionics domain-specific software architectures, avionics software models, a language for their representation and composition, tools for recording avionics knowledge, and tools for composing and establishing parameters for avionics software in a megaprogramming environment. **Contractor:** IBM. **Status:** Development.

Dual-Band FLIR

Program to develop an integrated imaging sensor for a single FLIR for aircraft piloting, reconnaissance, target acquisition, and weapon delivery applications. **Contractors:** Hughes, MM. **Status:** Advanced development.

Electronic Combat Digital Simulation Technology

Development of advanced simulation technology, graphical user interface, and model components for transition to the Joint Modeling and Simulation System. **Contractor:** SAIC. **Status:** Development.

Electronic Warfare Preprocessing Elements

Program to develop and demonstrate an advanced 64-bit air-cooled avionics symmetric multiprocessing supercomputing concept for processing upgrade and integration of existing avionics. **Contractors:** Loral, Sanders/GE. **Status:** Development.

Electronic Warfare Requirements and Assessments Program

Program to analyze, evaluate, and model radio frequency (RF), EO, and IR countermeasures concepts and advanced penetration aid techniques. **Contractor:** SAIC. **Status:** Development.

Embedded Computer Resources Support Improvement Program

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

Infrared Acquisition Experiments

Program to develop and study trade-offs between alternative acquisition, pointing, and tracking systems for use in an advanced Infrared Countermeasures system. Hardware will be integrated and tested in the Laser IRCM Development Range. **Contractor:** SAIC/Loral Defense Systems-Akron/United Technologies Optical Systems. **Status:** Development.

Integrated Fire-Control Weapon Delivery

Program to develop and flight-demonstrate advanced fire-control techniques for increased weapon systems accuracy and flexibility while examining the benefits of cooperative engagement techniques and the overall impact on mission effectiveness. **Contractor:** TBD. **Status:** Development.

Joint Modeling and Simulation System Technology

Program to develop advanced simulation technologies and model components and to set standards for insertion into the EMD program. **Contractor:** SAIC. **Status:** Development.

Laser IRCM Flyout Experiment

Program to integrate an advanced IRCM system and conduct guided missile flyout tests. Program will complete all systems integration issues and conduct proof-of-concept testing prior to initiation of an advanced technology transition demonstrator. **Contractor:** TBD. **Status:** Planning.

Laser Warning

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

Machine Intelligence (MI)

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

Multifunction Communication, Navigation, and Identification (CNI)/EW Antenna System

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

Multisensor Air Target Algorithm Development Test-Bed

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

Passive Expendables Analysis Measurements

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

Passive Velocity/Altitude Sensor

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

Pave Pace

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

Radar ECCM Flight Test Validation/Vulnerability Assessment

Flight-evaluate electronic counter-countermeasures (ECCM) techniques for transition to operational systems. Techniques developed will respond directly to user-defined threats. Assessment will include a complete study of ECM vulnerability. **Contractor:** TBD. **Status:** Source selection.

Real-Time Artificial Intelligence (AI) System

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

Reusable Ada Avionics Software Packages

Program to advance the state of the art in software reuse technology in the real-time, mission-critical avionics arena. Goal is to achieve reuse at both the detailed design and source code levels. **Contractor:** Westinghouse. **Status:** Development.

Special Infrared Flare

Program to design, develop, fabricate, and test (via laboratory, sled, and flight) a flare that effectively negates current-generation and advanced IR-guided missiles. Emphasis is on a shielded-flare concept that can be spectrally tailored. **Contractor:** Lockheed Sanders, Inc. **Status:** Development.

Strapdown Stellar-Inertial System

Joint USAF-Navy-BMDO project to develop and demonstrate low-cost, strapdown star tracker systems for strategic/reconnaissance aircraft, ballistic missiles, and spacebased systems. **Contractor:** Northrop. **Status:** Advanced development.

Strategic Targeting Laser Radar (LADAR) Technology

Development and demonstration of critical technologies and components needed to produce a CO₂ LADAR sensor that will permit manned aircraft to recognize and attack critical mobile targets. **Contractors:** Hughes, Rockwell. **Status:** Advanced development.

Superconductivity Application for EW

Evaluation of superconductivity application concepts and resulting payoffs in EC and EW systems. **Contractors:** E-Systems, TRW, SRI. **Status:** Studies.

Ultrareliable Digital Avionics

Joint USAF-Army program to design and develop high-performance standard electronic module-size E data and signal modular processor for such advanced applications as infrared search and track. **Contractors:** AT&T, TI. **Status:** Development.

Ultrareliable RF Avionics

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

Wright Laboratory/Flight Dynamics Directorate

Advanced Combat Maintenance Technology

Program to provide deliverable products that will increase the capability to rapidly return battle-damaged aircraft to operational status in a combat environment. Goal is to return 80 percent of all battle-damaged aircraft to the commander within 24 hours. **Contractors:** Lockheed, Booz-Allen Hamilton, Sparta. **Status:** Ongoing.

Advanced Technology Redesign of Highly Loaded Structure

Program to apply advanced metallic structures to highly loaded structural components in operational aircraft. **Contractor:** Northrop. **Status:** Detailed design phase.

Aircraft Structural Integrity

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

Aircraft Windshield System Development

Development, validation, and integration of emerging technologies into operationally acceptable and logistically affordable transparency systems compatible with evolving military missions. **Contractors:** In-house and industry. **Status:** Ongoing.

Airframe Propulsion Integration

Technology development program for advanced fighters and high-speed flight vehicles. Advanced multifunction exhaust nozzles and highly survivable inlets. **Contractor:** MD. **Status:** Ongoing.

Airframe Weapons Integration

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

Ceramic Composite Component Demonstration

Development of structural ceramic matrix composites for turbine engine 2-D exhaust nozzle applications. **Contractor:** P&W. **Status:** Test phase.

Computational Fluid Dynamics

Program to develop, validate, and apply interdisciplinary CFD methods for design and analysis of advanced vehicles, aeromechanics technologies development, and vehicle system support. **Contractors:** In-house and many. **Status:** Research and exploratory development.

Configuration Research

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

Directly Formed Frameless Aircraft Transparencies

Technology development program for integrated computer-aided design and engineering/manufacturing capability to replace multiple labor-intensive steps with a single direct-forming (injection-molding) step. **Contractor:** In-house. **Status:** Molding and testing of full-scale confirmation articles.

Electrically Actuated Brake Technology

Development and integration of a digital antiskid/brake control/brake component design to produce an aircraft brake system using electric, instead of hydraulic, actuation. **Contractor:** MD. **Status:** Development.

Elevated-Temperature Aluminum Program

Program to develop and demonstrate elevated-temperature aluminum structure for Air Force aircraft. **Contractor:** Lockheed. **Status:** Design and fabrication complete; full-scale structure in test phase.

Exhaust-Impinged Metallic Structure

Program to develop and demonstrate innovative design techniques coupled with high-temperature metallic structures technology for future exhaust-impinged aircraft structure. **Contractor:** Northrop B-2 Division. **Status:** Detailed design phase.

Extended-Life Tire

Development and demonstration of advanced aircraft tire design technology, analytical life prediction tools, and laboratory test methods to produce extended-life, reliable aircraft tires. **Contractors:** In-house and TBD. **Status:** Development.

Fourth-Generation Escape System Technologies Demonstrator

Program to integrate a digital flight controller, a controllable propulsion system, and windblast protection to provide continuous conditional control of seat acceleration, stability, attitude, and trajectory. System will demonstrate injury-free escape at speeds up to 700 knots equivalent airspeed and reduce low-altitude adverse-attitude fatalities by 80 percent. **Contractor:** MD. **Status:** Ongoing, propulsion demonstration phase.

Halon Replacement for Aviation

Joint service and FAA-supported program to research and identify replacements for halon used in such aircraft on-board fire-extinguishing systems as engine nacelles and dry bays. **Contractors:** In-house and National Institute of Standards and Technology. **Status:** Advanced development.

Hypersonics

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

Information Positioning System

Development and flight demonstration of key situational awareness and formation flight guidance technologies to increase clandestine, all-weather, night-operated safety and survivability. **Contractor:** IBM. **Status:** Development, simulation.

Integrated Control and Avionics for Air Superiority

Development of key control and avionics technologies to enable cooperating fighter aircraft to engage and defeat multiple airborne threats. **Contractor:** MD. **Status:** Development, simulation.

Lightweight Landing Gear Technology

Joint US-Canadian Defense Development Sharing Program to design, fabricate, and test titanium matrix composite landing gear components to reduce both landing gear system weight and operations and support costs. **Contractor:** TBD. **Status:** Exploratory development.

Mission Environmental Requirements Integration Technology

Program to develop and demonstrate a knowledge-based, workstation-resident tool to predict the environmental life-cycle profile for weapon systems early in the conceptual design phase of system development. **Contractor:** McAir. **Status:** Phase 1 initiated.

Mission Integrated Transparency System

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

Smart Metallic Structures

Program to demonstrate the application of smart structures for structural integrity monitoring of existing and future aircraft. **Contractor:** Northrop. **Status:** Preliminary design phase.

Structural Assessment and Vulnerability Evaluation

Program to define the structural engagement conditions of key USAF aircraft to demonstrate the problem through component level testing and to validate analytical tools for use in future hardening programs. **Contractor:** SAIC. **Status:** Component testing complete.

Subsystems Integration Technology

Program to demonstrate the capability to produce an integrated design of an aircraft's utility subsystems during the conceptual design phase of system development and to verify the aircraft-level benefits for this capability. **Contractor:** MD Aerospace. **Status:** Phase 2, preliminary design.

Supportable Technology for Affordable Fighter Structures

Program to develop, design, fabricate, and demonstrate supportable, affordable, advanced metallic structures technologies applicable to next-generation fighter aircraft. **Contractor:** MD/McAir. **Status:** Preliminary design phase.

Technologies for Airlift Cargo Handling

Program to develop and demonstrate advanced airlift cargo-handling technologies. Robotics, expert systems, sensors, and digital processors will be used to provide a highly responsive, autonomous on- and offload capability for modified or future airlift aircraft. **Contractor:** TBD. **Status:** Source selection.

Variable Stability In-Flight Simulator Test Aircraft (VISTA/F-16)

Design and production of a high-performance in-flight simulator to replace the NT-33. **Contractors:** Lockheed Fort Worth, Calspan. **Status:** Flight test.

Vortex Flow Control

Development and flight test validation of a pneumatic system to obtain yaw control at high angles of attack by manipulation of nose vortices. **Contractor:** Grumman. **Status:** Documentation.

Wright Laboratory/Joint Cockpit Office

Advanced Information Components Manufacturing

Development of technologies to create novel displays for crew workstations and simulators/mission-rehearsal cockpits via cooperative projects with the DoE national labs. **Contractors:** FED, Photonics Imaging, Sandia National Lab, Lawrence Livermore National Lab. **Status:** Development.

Cockpit Display Generator

Program to create a Very-High-Speed Integrated Circuit Hardware Description Language model of a graphics engine for triservice procurement with

options to build application-specific integrated circuits (ASICs). **Contractors:** Honeywell, U. of Cincinnati, Ohio State U. **Status:** Development.

Defense Production Act Title III

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

High-Definition Systems

Development of technologies to create flat-panel displays for large cockpit areas. Direct-view and projection approaches used. **Contractors:** Kopin, TI, Dimension Technologies, Magnascreen, Sarnoff, Nitor, UDRI, Princeton U. **Status:** Development.

Integrated Cockpit/Avionics for Transports

Development, simulation, and flight demonstration of crew system technologies to improve night/adverse weather tactical transport operations with a minimum crew, concentrating on development of improved mission and information management. **Contractor:** MD Aerospace Transport. **Status:** Development.

Mission Reconfigurable Cockpit

Evaluation and demonstration of advanced cockpit technologies for affordable single-seat, night/adverse weather operations. **Contractors:** GD, McAir. **Status:** Development.

Wright Laboratory/Manufacturing Technology Directorate

Advanced Manufacturing of Welded Titanium Aircraft Structure

Program to establish manufacturing process for producing large, high-quality, welded titanium airframe assemblies. **Contractor:** Boeing. **Status:** Manufacturing technology.

Advanced Tooling Manufacture for Composites Tooling Structures

Program to develop and implement an expert system to design composites tooling. **Contractor:** Northrop. **Status:** Manufacturing technology.

Chemical Tank Rejuvenation

Program to establish an automated, chemical rejuvenation system for the San Antonio Air Logistics Center (ALC), Tex. **Contractor:** MM. **Status:** Manufacturing technology.

Composite Overwrapped Pressure Vessels

Program to establish and validate the influence of variability in key manufacturing parameters on graphite/epoxy composite overwrapped pressure vessel performance, reliability, and safety for space systems applications. **Contractor:** MM. **Status:** Manufacturing technology.

Continuous Electronics Enhancements Using Simulatable Specifications

Program to provide simulatable specifications for electronics system design, covering both their substance (form, content, and media) and their use. Program will address the unique requirements for the "Prototyping Plus" concept. **Contractor:** TBD. **Status:** New start.

Design/Manufacture of Low-Cost Composites

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

Enterprise Integration Program

Initiative to advance the state of the art in technology critical to enterprise integration. **Contractor:** SofTech. **Status:** Manufacturing technology.

Integrated Product Development (IPD) for Advanced Nozzles

Initiative to further IPD in a technology development program. **Contractor:** P&W. **Status:** Manufacturing technology.

Integrated Product Support Initiative

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

Integrated Tool Kit and Methods

Program to develop and implement a library of tools that can be used for integrated systems development and enterprise integration. **Contractors:** Corporation for Open Systems, Ontek, Industrial Technology Institute. **Status:** Manufacturing technology.

Knowledge-Based Integrated Design System

Program to develop an advanced workstation for designing unit fabrication processes that will be demonstrated for the casting process. **Contractor:** Universal Energy Systems (UES). **Status:** Manufacturing science.

Large Aircraft Robotic Paint-Stripping System

Program to provide environmentally safe techniques to remove paint from large aircraft, such as the C-5A. Anticipated benefits are reductions in hazardous waste and paint-removal time. **Contractor:** UTC/USBI. **Status:** Manufacturing technology.

Manufacturing Technology for Blade Tip Repair

Program to establish a flexible automated welding single-crystal and directionally solidified high-pressure turbine blade tip repair cell for Oklahoma City ALC. **Contractor:** General Atomics. **Status:** Manufacturing technology.

Manufacturing Technology for Radar Transmit/Receive Modules

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

Manufacturing Technology for Silicon on Insulator Wafer

Program to optimize the separation by implantation of oxygen process of manufacturing silicon wafers up to six inches in diameter and establish a US source for same. **Contractor:** TI. **Status:** Manufacturing technology.

Repair Technology for Printed Wiring Assemblies

Effort to establish an automated repair capability for advanced printed wire assembly boards at Air Force ALCs. **Contractor:** Westinghouse. **Status:** Manufacturing technology.

Spare Parts Reproachment and Production Support

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

Thermoplastic Radomes

Program to develop, validate, and implement a rapid thermoplastic matrix composite manufacturing technology for aircraft radomes. **Contractor:** E-Systems. **Status:** Manufacturing technology.

Ultrathin Case Nickel-Based Alloy Structures

Program to apply advanced casting technology to the manufacture of thin-wall (0.01 inch to 0.02 inch) nickel-based superalloy propulsion components. **Contractor:** P&W. **Status:** Manufacturing technology.

Virtual Test

Program to develop and demonstrate methodologies and tools for creation, capture, and simulation of tester-independent test requirements, unit under test models, and tester resource description information. Intended to promote the introduction of commercially oriented methodologies and tools. **Contractors:** IBM, Cadence, GenRad. **Status:** Manufacturing technology.

Wright Laboratory/Materials Directorate

Advanced Structural Metallic Materials

Comprehensive two-part program to research and conduct exploratory development of aluminum, titanium, and magnesium structural alloys and metal matrix composites. Program aims to produce alloys of higher strength, improved resistance to corrosion, and greater resistance to heat. **Contractors:** Lockheed, GE, U. of Virginia, Metcut, UES, P&W, Boeing, Lockheed-Calac. **Status:** Research, exploratory development.

Composite Materials R&D

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

Electronic and Optical Materials R&D

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

Hardened Materials/Airborne and Space Subsystems

Program to develop technology base to be used by systems designers for protecting tactical and space systems from effects of directed-energy and kinetic-energy weapons and laser radiation. **Contractors:** Many. **Status:** Advanced development.

High-Temperature Materials

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

Manufacturing Research

Provides the technology base for early introduction of advanced materials and processes into manufacturing; for significantly reducing new product cycle time and acquisition and life-cycle cost; and for flexible, low-volume, high-quality manufacturing. **Contractors:** Many. **Status:** Research.

Materials Processing Modeling

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

Mechanical Behavior of Advanced Materials

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

Nondestructive Evaluation/Inspection (NDE/I) R&D

Exploratory and advanced development of more accurate, more reliable, NDE/I capabilities to support weapon systems quality assurance and reliability and maintainability programs within USAF. **Contractors:** Many. **Status:** Exploratory and advanced development.

Nonstructural Materials

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

Ultralightweight Structural Materials

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

Weapon Systems Material Support

Development of advanced composite repair techniques, new NDE/I procedures, and corrosion control coatings and methods. Provides structural and electronic failure analysis and materials-engineering support to acquisition, operational, and logistics commands. **Contractors:** UDRI, Universal Technology Corp., Rockwell, Boeing, McAir, others. **Status:** Ongoing.

Wright Laboratory/Plans and Programs Directorate

Enhanced Surface-to-Air Missile Simulation

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

Fighter Airframe/Propulsion Integration Pre-design Studies

Assessment of the benefits and penalties of individual technologies and integration concepts for future multimission fighter aircraft as well as upgrades to and derivatives of current aircraft. Areas of interest: advanced aerodynamic controls; thrust-vectoring nozzles; signature control; acquisition and operations cost; reliability, maintainability, and supportability; and weapons integration. **Contractors:** Boeing, GD, GE, MD, P&W, Rockwell. **Status:** Ongoing.

Flight Vehicles Technology Plan

Development of a broad range of technologies that enable improved aeronautical systems (*i.e.*, aircraft and conventional armament and supporting infrastructure). **Contractor:** In-house. **Status:** Ongoing.

Future Fighter Technology Transition

Assessment of high-value technologies needing development for future fighters, identification of technology application windows and needed technology maturity, and development of technology transition strategy. **Contractor:** None. **Status:** Ongoing.

Special Operations Aircraft Study

Long-term planning project to support development of system requirements and technology for future SOF airlift aircraft. Areas of investigation include power operation, navigation, aircrew-vehicle interface, sensors, fire control, air vehicle, and armament. **Contractor:** None. **Status:** Ongoing.

Special Operations Forces Technology Transition

Assessment of high-value technologies having application to SOF mission needs. Identification of technology application windows and needed technology developments. Development of technology planning and transition strategy for Chapter 7 of Air Force Special Operations Command Weapon System Roadmap, AFSOC Technology Base. **Contractor:** None. **Status:** Ongoing.

Within-Visual-Range Air-Superiority Technology Evaluation

Part of a broad-based initiative to assure the lethality and survivability of USAF systems in the within-visual-range combat arena. Technologies under

evaluation include aircraft and weapon airframe, propulsion, flight control, sensors, situational awareness, fire control, and countermeasures. **Contractors:** Many. **Status:** Ongoing.

Wright Laboratory/Solid-State Electronics Directorate

Device Research

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

High-Density Microwave Packaging

Advanced Research Projects Agency (ARPA)-triservice program to develop three-dimensional microwave packaging technology for airborne phased-array applications. **Contractors:** TI/MM, Hughes Aircraft, Westinghouse/IBM. **Status:** Ongoing.

Microelectronics Manufacturing Science and Technology

Program to demonstrate a new, flexible, low-cost manufacturing concept for semiconductor devices based on modular cluster tools, real-time process controls, and advanced object-oriented, factory control software. **Contractors:** TI, Applied Materials, Stanford U., IPEC. **Status:** Ongoing.

Microwave/Millimeter-Wave Monolithic Integrated Circuits

ARPA-triservice program to develop affordable gallium arsenide MIMICs for advanced DoD systems. Emphasizes such MIMIC development areas as computer-aided design (CAD), chip fabrication, testing procedures, packaging, and manufacturing. **Contractors:** Phase 2: Hughes/GE. Phase 3: AT&T, Avantek, Gateway Modeling, TriQuint, Compact Software Inc., Scientific Atlantic, U. of Illinois. **Status:** Ongoing.

Rapid Prototyping System for ASICs, MCMs, and DSPs

Program to establish and demonstrate electronic design automation technology for the quick-turnaround design of custom ASICs, multichip module (MCM) packages, and digital signal processors (DSPs). **Contractors:** Many. **Status:** Ongoing.

RF Vacuum Electronics

ARPA-triservice program to develop advanced microwave and millimeter-wave power amplifiers for airborne EW, radar, and communication transmitter applications. Emphasis is on traveling-wave tube design, fabrication, and assembly techniques that yield affordable high-performance thermionic sources. **Contractors:** Hughes Aircraft, Northrop, Raytheon, Teledyne, Varian. **Status:** Ongoing.

ASC Development Planning Directorate

25K Standard and Tactical Loader Replacement

Study of replacement options for an improved reliability, availability, and maintainability 25K loader for palletized cargo. **Contractors:** Nichols Research Corp. **Status:** Ongoing.

AC-130 SOF Gunship Standoff Weapons

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

Advanced Aerial Refueling Capability

Program to assess current aerial refueling capabilities and future requirements. The goal is to develop a comprehensive plan to meet future needs through current force modifications, such as multipoint and boom receptacle upgrades and new acquisitions options. **Contractors:** Frontier, Logicon. **Status:** Ongoing.

Advanced Countermeasures for Large Aircraft Study

Study to investigate specific technologies for use in active/passive warning soft-kill/hard-kill countermeasures for C-141, C-5, AWACS, Joint STARS, and C/AC/MC-130 aircraft. **Contractors:** In-house and SAIC. **Status:** Ongoing.

Advanced Direct Strike Munitions

Project to study the advantages of enhancing aircraft capabilities and munitions performance through the application of advanced technologies. **Contractor:** In-house. **Status:** Ongoing.

Air Force-Industry Life-Cycle Cost (LCC) Working Group

Program to enable organizations to pool vehicle LCC-estimating expertise and resources to more effectively develop common standardized conceptual level cost-estimating tools. **Contractor:** In-house. **Status:** Ongoing.

Air Force Mission Area Development Plans

Annual publication of Technical Planning Integrated Product Team Mission Area development plans for air-to-surface, counterair, SOF, mobility, aircrew training, EC, air base operability, and combat search-and-rescue mission areas. **Contractor:** In-house. **Status:** Ongoing.

Avionics Interface for Common Data Transfer System

Project to determine the requirements and system capability for a common data loading system to interface with avionics subsystems. Investigating the two-way data transfer through a single interface system. **Contractor:** In-house. **Status:** Concept definition.

Bomb-Damage Assessment (BDA)

Study to identify options to improve BDA—a critical need highlighted during Operation Desert Storm. **Contractor:** TBD. **Status:** Initial planning.

Development Planning Decision Support Tool

Program to develop and demonstrate the application of a computer-based decision support tool in support of ASC Technical Planning Integrated Product Teams. **Contractors:** Decision Science Associates, Lynne Gilfillan Associates. **Status:** Ongoing.

Enhancements to the Advanced Air-to-Air System Performance Model (AASPEM)

Program to update the Pilot Decision Logic with enhanced aerodynamic/flight mechanics model that improves the ability of AASPEM to model close-in combat between highly agile, high-thrust-to-weight fighter aircraft armed with all-aspect IR and radar missiles and guns. **Contractor:** Eidetics International. **Status:** Ongoing.

Extended Coverage Antimateriel Submunition

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

Fighter Force Planning Parametrics

Program to develop an analysis tool for tactical fighter force planners and decision-makers that provides robust analytical products using the strategies-to-task framework. **Contractor:** SR Corp. **Status:** Ongoing.

Foreign Comparative Testing

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

Functional Avionics Life-Cycle Cost Model for Hardware

Program to develop an avionics LCC model for hardware that provides estimates of acquisition, operations, and support costs at the subsystem level with breakout to LRU, SRU, or module level. **Contractor:** Research and Management Technology, Inc. **Status:** Ongoing.

Future Systems Cost Analysis

Development of cost-estimating relationships and estimates for future theater airlift system concepts. **Contractor:** Axion Corp. **Status:** Ongoing.

Future Theater Airlift Studies

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

Hard-Target Munitions

Program to develop an advanced penetrator weapon and intelligent fuze for the next generation of hardened target munitions. **Contractors:** Motorola, ARA. **Status:** Pre-concept definition.

High-Temperature Superconductivity Delay Lines and Filter Banks

Program consists of two development demonstrations: a delay line assembly and a switchable, band reject filter bank. **Contractor:** Superconductor Technologies, Inc. **Status:** Concept definition.

Integration of Nondefense Missions Into Aeronautical Systems/Subsystems

Program to study the feasibility of long-term planning to incorporate non-defense-related mission equipment into future Air Force weapon systems. **Contractor:** Summation, Ltd. **Status:** Ongoing.

IR/EO Sensor Trends and Requirements

Investigation to provide an assessment of performance capability and availability of specific IR and EO technology. **Contractor:** MacAulay-Brown, Inc. **Status:** Ongoing.

Lighter-Than-Air Technology

Effort defines USAF and non-USAF, including commercial, missions that may be performed effectively and with reduced resources by a small, remotely piloted Cyclocraft. **Contractor:** Mission Research Corp. **Status:** Expected completion January 1994.

Low Probability of Intercept/Detection Data Link Technology Evaluation

Study will evaluate needs and potential concepts for jam-resistant LPI/low probability of detection data links to enhance intraformation communication and data-sharing. **Contractors:** In-house and SAIC. **Status:** Ongoing.

Precision Guided Munitions

Study to identify the cost-effective solutions for an all-environment PGMs effective against a wide variety of targets. **Contractor:** TBD. **Status:** Concept evaluation.

Silent Hard Kill for Defense Suppression

Study to determine the most effective way to augment the AGM-88 HARM and provide preemptive destruction of radar-guided threats. **Contractors:** In-house and various. **Status:** Milestone 0.

T-38X

Application of technologies to enhance the T-38 to meet bomber/fighter training system mission needs. **Contractor:** Eidetics International. **Status:** Ongoing.

Target Acquisition and Location Concepts Study

Program to determine best ways for on-board attack aircraft systems to acquire surface targets (mobile and transportable) and geolocate them with accuracy compatible with accurate and precision guided weapons. This will examine both above/through-the-weather and under-the-weather concepts. **Contractor:** In-house. **Status:** Initial planning.

Warfighting Effectiveness for Theater Airlift

Program to develop a warfighting effectiveness evaluation system for assessing how theater airlift system alternatives and mixes contribute to the outcome of a ground battle. Tied to Future Theater Airlift Studies project. **Contractor:** Vector Research, Inc. **Status:** Ongoing.

ASC Integrated Engineering and Technical Management Directorate

Aircraft Structural Integrity Program

Program to link all aspects of structural design, analysis, test, and operational use of aircraft to establish service life and track it continually. **Contractor:** None. **Status:** Ongoing.

Avionics Integrity Program

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

Engine Structural Integrity Program

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

Integrated Product Development

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

Manufacturing Development Initiative

Program to carry out the best practices from three-year aircraft "lean production" study in an integrated product development environment. Emphasizes advanced manufacturing and quality systems process development. **Contractors:** MIT and Industry Consortium. **Status:** Ongoing.

Mechanical Subsystems and Equipment Structural Integrity Program

Program to adapt integrity-assurance process to air and ground mechanical systems and such equipment as hydraulic, pneumatic, and secondary power systems. **Contractor:** None. **Status:** Ongoing.

MIL-PRIME Program

Initiative to streamline acquisition by improving quality of specifications and standards placed on contracts and to eliminate overspecification of program requirements. **Contractor:** None. **Status:** Ongoing.

Senior Engineering Technology Assessment Review

Program for review and assessment of objectives, approach, and possible payoffs of advanced technology development programs. **Contractor:** None. **Status:** Ongoing.

Software Development Integrity Program

Initiative to improve operational capability and supportability of aeronautical weapon systems software. **Contractor:** None. **Status:** Ongoing.

Systems Engineering Process Development

Program developing MIL-STD-499 and supporting handbooks; defines systems engineering requirements and implements event-based management. **Contractor:** None. **Status:** Ongoing.

Value Engineering

Incentive program to reduce acquisition and support costs while maintaining or improving performance by implementing high-payoff changes to system design and production processes. **Contractors:** Many. **Status:** Ongoing. ■

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By John L. Frisbee, Contributing Editor

Missions Accomplished

On the bomb run, the lead B-29 was hit by flak and burst into flame.

ON THE morning of June 5, 1945, B-29s of the 52d Bomb Squadron, 29th Bomb Group, lifted off the runway at North Field, Guam, for the long flight to Japan, their target the industrial city of Kobe. Leading the squadron was Maj. George A. "Tony" Simeral, one of the most experienced aircraft commanders in the 314th Wing. In 1942 and 1943, he had flown thirty combat missions in the Mediterranean as a B-24 commander. Then came a year as a B-24 instructor—duty he considered dull and almost as dangerous as combat. He volunteered for B-29s and was assigned to the 29th, which arrived at Guam in February 1945 with Major Simeral as commander of a lead crew.

Prior to June 5, Simeral had flown twelve B-29 missions. He was the pilot of *City of Los Angeles* on April 12, when his radio operator, Medal of Honor recipient SSgt. Henry "Red" Erwin, saved the crew by carrying a burning phosphorus bomb to the flight deck and throwing it out the copilot's window. [See "Red Erwin's Personal Purgatory," October 1989, p. 91.]

When the B-29s arrived at the assembly point for their Kobe strike, enemy fighters attacked. As *City of Los Angeles* began the twelve-minute bomb run, heavy guns defending the target opened fire. The deputy leader was shot down, and Major Simeral's aircraft took flak hits on the number four engine, ripping a three-foot hole in the outer wing panel through which 800 gallons of fuel began siphoning away.

With the Superfortress's wing and engine sheathed in flames and only two minutes from release point, Major Simeral had two alternatives. He could drop out of formation and concentrate the crew's attention on controlling or putting out the fire. The formation would then be without a lead bombardier, on whose release all other bombardiers dropped their bombs. It would be too late for the

other bombardiers to bomb accurately. The mission would fail.

Major Simeral instead chose to keep power on the burning engine, increasing the danger of explosion, and lead the squadron to the release point. His bombardier, Lt. Bill Loesch, made the necessary final adjustments and put the squadron's bombs on target. Mission accomplished. Now Tony Simeral's mission was to save his crew.

He shut down the burning engine and was forced to drop out of formation. Twelve enemy fighters immediately attacked the lone and damaged bomber. Lieutenant Loesch and the waist and tailgunners, Cpls. Herb Schnipper, Vern Widmayer, and Ken Young, shot down three fighters and damaged several others, driving them off. Near land's end, the fire was extinguished. Then a second wave of fighters closed in. The situation rapidly deteriorated from perilous to critical. Sgt. Howard Stubstad's upper and aft turrets were out of ammunition, but from the now-distant formation a B-29, piloted by Lt. Leo Nathans, dropped back in time to drive off the fighters.

Without enough fuel to return to Guam and with undetermined damage to the right wing, a dead engine, and two turrets out of ammunition, Major Simeral told navigator Capt. P. I. Youngkin to set course for Iwo Jima. Flight engineer Sgt. Vern Schiller calculated that with precise cruise control, fuel for the 700-mile flight was marginally adequate. Simeral was informed that there were enemy fighters in the vicinity of Iwo. If they made it, they would have to rely on friendly antiaircraft artillery and fighters to protect the nearly defenseless bomber.

Three hours later, Iwo came into view as their fuel gauges hovered near zero. However, the crew's relief was short-lived. A damaged B-29 ahead of *City of Los Angeles* crashed on the runway, closing it down. With what little fuel remained, Major Simeral had to attempt a landing on a short fighter strip, which they would have to share with a fuel-starved P-51.

To add to the tension, the strip could not be seen from the flight deck of a B-29 until the last moment because of terrain.

Once the strip came in sight, there was another unhappy surprise. The left wing flaps extended fully, but those on the right wing went down only part way. The B-29 started to roll. Unable to raise the flaps, Major Simeral and his copilot, Lt. Roy Stables, used their combined strength to level the bomber and spike it on the runway.

For courageous leadership that saved a threatened mission, followed by superb airmanship, Major Simeral was awarded the Distinguished Service Cross (predecessor of the Air Force Cross), the highest award for valor next to the Medal of Honor.

After V-J Day, Tony Simeral served as deputy commander of the Great Falls Air Defense Sector, Mont., and as F-4 systems support manager at Ogden Air Materiel Area, Utah. In those positions, he flew both the F-101 Voodoo and F-4 Phantom II, which he found "a lot more fun than bombers." A much-decorated Colonel Simeral retired from the Air Force in 1968 and now lives in San Antonio, Tex. ■



Major Simeral got his crew home safely despite fire and enemy fighters.

Tens of thousands of them plied their specialties on the big bombers of World War II.

The RO-Gunners

By Bruce D. Callander



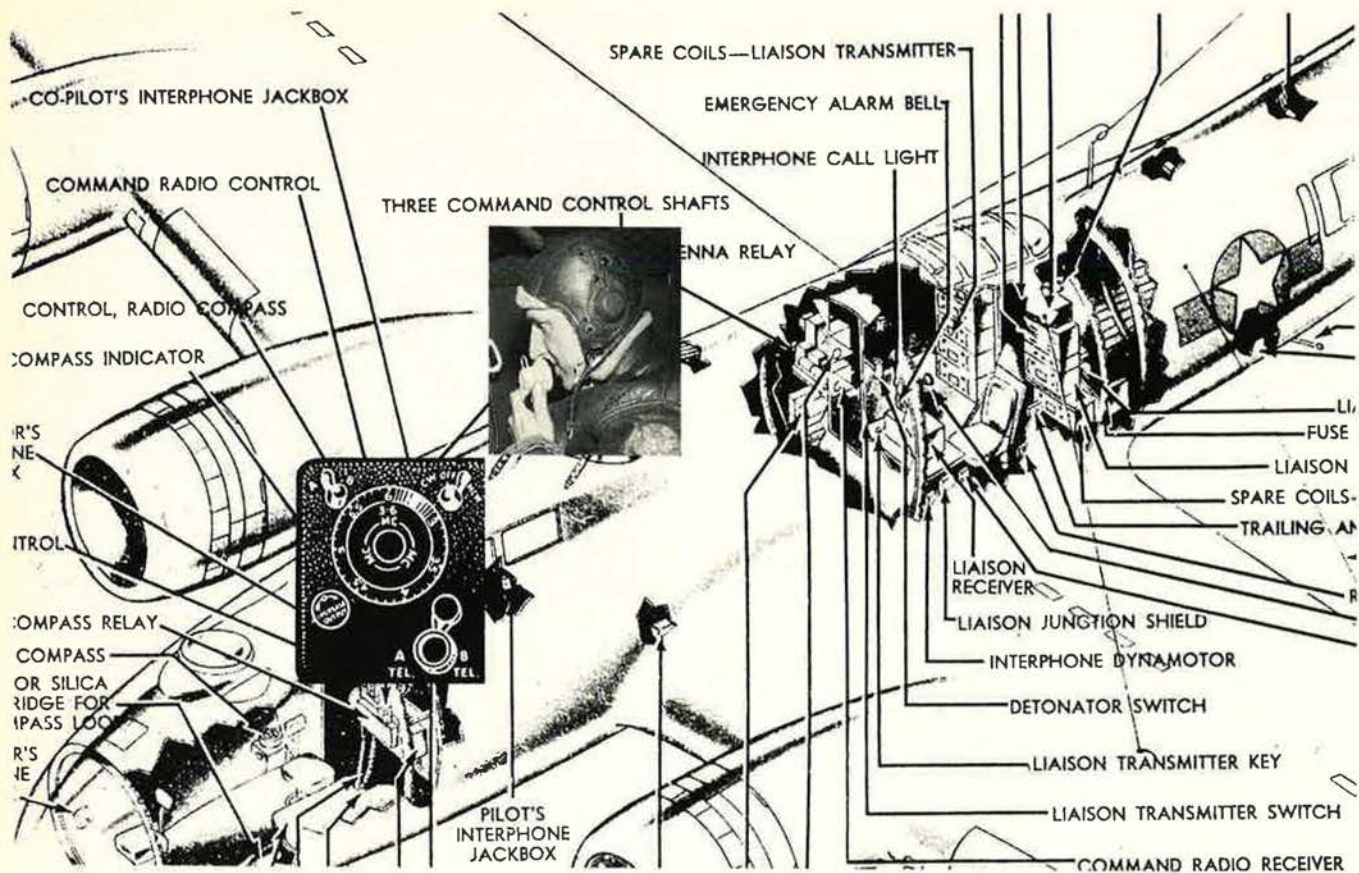
THE AMERICAN B-17 *Skywolf*, hit by flak over Bremen, Germany, dropped out of formation. Nazi fighters then swarmed in for the kill. A 20-mm shell burst into the radio compartment, wounding the radio operator-gunner, TSgt. Forrest "Woody" Vosler, in the legs and thighs and damaging his wireless equipment.

Then another shell struck the tailgunner and knocked out his guns. Though severely wounded, Sergeant Vosler continued to fire to protect the plane from rear attack.

A third shell wounded Sergeant Vosler in the face. He could barely see, but he kept firing until the pilot announced he would have to ditch in the North Sea. Sergeant Vosler felt his way through the plane to the radio, repaired it largely by touch, and sent out urgent distress signals. As the bomber settled into the water, the Sergeant crawled out onto a wing and held the wounded tailgunner securely until other crew members could get them both into a dinghy.

Sergeant Vosler, then twenty years old, survived the ordeal and went on to receive the Medal of Honor. He was one of only four Army Air Forces enlisted men in World War II to do so. He was one of a long-vanished breed—the tens of thousands of radio operator-gunners who plied their specialties in the era of the big-crew bombers and then gradually faded from the scene. [See "Valor: *Unsung Heroes of World War II*," July 1993, p. 89.]

In the 1920s and 1930s, as radio came of age, so did the combat planes that would fight the next war. Range increased. Crews grew and became more specialized. In the mid-1930s, the Air Corps took delivery of the B-10, an all-metal bomber with a movable gun turret and a separate station for the radio operator. Soon the even bigger B-17 joined the inventory, followed by the longer-range B-24.



“Spark sets” and telegraph keys still were needed to communicate over long distances, but planes now carried radio phones to talk to each other in formation, intercoms to keep crewmen in contact within the planes, and radio compasses for direction finding.

Weak Link

The RO's job also had grown. The B-17 flight manual urged the pilot to be sure his operator knew such duties as rendering position reports, helping the navigator take fixes, keeping the liaison and command sets tuned, maintaining a log, knowing direction-finding procedures, and understanding codes and authentication measures.

“The radio operator who cannot perform his job properly may be the weakest member of your crew,” the manual warned.

The specialty had another dimension. Like the flight engineer, the radio operator also had to qualify as a gunner. After a twenty-week course in radio operation and repair, he had to take six weeks of gunnery training and three months of unit training with an assigned crew.

Much of the radio course was learning Morse code. It was a long, dull process. For hours each day, the student sat in a cubicle with a headset clamped over his ears. He listened to recorded dits and dahs and transcribed characters. To make things harder, the messages weren't in recognizable words but in random five-letter groupings. Once trained, a good operator could copy German, Japanese, or any other language without understanding a word of it.

When a student had mastered the basic characters, the instructor speeded up the recorded transmission. To graduate, a student had to be able to send and receive sixteen

words per minute, or more than one letter per second. Most could do better than the minimum, and some could operate at speeds that made the sounds little more than a blur to untrained ears.

Some war-trained ROs were a match for the old-time telegraphers, but there was one important difference in their training. A civilian telegrapher developed a personal “fist,” a distinctive style of sending that was as recognizable to other operators as a friend's voice. Army training discouraged this personalized touch. What added color to the civilian occupation could be a security problem in aerial operations, where an enemy might recognize the sender's touch and thereby identify his plane and unit.

Otherwise, modern ROs took on many of the characteristics of the earlier sender-receivers. In effect, they acquired a second language. Many said they heard code in their sleep. Some even claimed they could detect it in the background of commercial broadcasts and were convinced they heard spies at work.

The RO's specialty gave him a certain mystique. To other crew members, he seemed withdrawn, as though listening to voices no one else could hear. He earned various nicknames. The British called him “Sparks,” a carry-over from the name given to naval wireless operators. To Americans, he was a “key jockey,” “static bender,” or “code chaser.” He was diagnosed as being “dit-dah happy.” In an otherwise regimented world, he stood out as something of a character.

Wrestling With Tubes

His was not a soft desk job. Radio was still a cumbersome technology. Transmitters and receivers were built

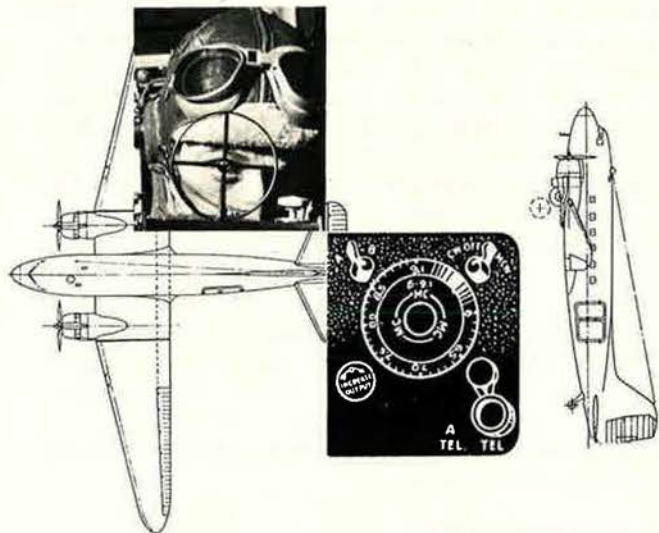
around vacuum tubes planted in forests of bulbs that generated enough heat to sear fingers and had a tendency to go dead at critical moments. Frequency bands were narrow; to reach some, the operator had to extract one set of heavy tubes and wrestle another into its place. Army Air Forces job descriptions listed him as a "radio operator-mechanic," and repair work was a large part of his duty.

Both equipment and operator were vulnerable to the natural hazards of flight and the added dangers of war. Flak was a particular problem. Often ROs worked apparent miracles to restore radio sets that seemed damaged beyond repair. When the operator himself was disabled, it was a far more serious problem for the aircrew. Other crew members were given some training in code and, in theory, one of the gunners was supposed to be groomed as assistant radio operator. However, few other crewmen had more than a rudimentary knowledge of radio, and a plane without an RO was badly handicapped.

If the radio was a worry, it also provided welcome relief on a long mission, particularly during the more relaxed homeward leg. The ROs then had time to search the dial for commercial broadcasts and patch them into the intercom for the entertainment of the crew. Outside England, most stations featured non-English-speaking announcers and regional music, but there was one popular English-speaking broadcaster in most combat zones: "Axis Sally," "Tokyo Rose," or other propagandists using powerful transmitters. Their messages extolling the superiority of the enemy were more amusing than demoralizing, and the crews liked the music.

At other times, the radio performed more vital functions. The operator kept tabs on weather reports and monitored command centers at home base for special orders. Most of the time, he received but did not send. An enemy could track down sources of broadcasts and alert interceptors and ground gunners. The only true safety was in radio silence.

Transports also carried radio operators, and, although they rarely got to use their skills as gunners, some saw considerable action. Cpl. Arthur Baca flew on the C-47 *Passionate Patches* with the 3d Combat Cargo Group in China, supporting the British 14th Army, the OSS, and



Adapting Marconi's Gadget

In 1907, when the Army's Signal Corps was dicking for its first flying machine, it also was experimenting with the wireless radio, a new gadget developed by Guglielmo Marconi. About that time, Lt. Benjamin Foulois, a student in the Signal Corps school at Fort Leavenworth, Kan., wrote a thesis predicting that aircraft one day would report sightings instantaneously over radio waves. Young Foulois had not even seen a flying machine and had only read about the wireless experiments.

Two years later, the Army bought its first plane and sent him to show it off at the annual Electrical Trade Exposition in Chicago. Lieutenant Foulois hung the machine from the roof of the Coliseum, rigged an electric motor to turn its propellers, and installed a battery-operated wireless set to pass messages between the "flying" scout and a ground receiver. It was the hit of the show.

During August 1912 Army maneuvers, Lieutenant Foulois tried sending a message from a plane in actual flight and found himself too busy controlling the machine to operate the key. A few months later, Lt. H. H. "Hap" Arnold took up a Navy wireless operator to send messages directing artillery fire. Their main problem was keeping the trailing antenna wire from snagging their pusher propellers.

Airborne radio was still a one-way street. Electrical interference, noise, vibration, and the sheer size of receiving sets made reception next to impossible. Then, in 1914, two American officers in the Philippines built a compact radio set, shielded it against interference, and took it up in a Burgess seaplane. With Lt. Herbert A. Dargue as pilot and Lt. Joseph O. Mauborgne as radio operator, they sent and received messages over a distance of ten miles.

When the US entered World War I in 1917, the Aviation Section bought a million dollars' worth of French radio sets. On most planes, the observer acted as radio operator. The noise problem was reduced by building headsets into flying helmets. It was still hard to pick up the faint signals. In frustration, some flyers went back to dropping written notes or taking along carrier pigeons for communication.

Despite the problems, new technologies were emerging. Voice transmission had been used on Navy ships as early as 1907, but few planes were big enough to carry the equipment and provide room for an operator. Flying boats were the exception. Their hulls were roomy and solid enough to screen out at least some of the engine noise. The crew of the German Dornier Do. WAL included not only a pilot, observer, and engineer, but also a radio operator-gunner.

When Brig. Gen. William Mitchell conducted demonstration bombing of captured German warships off the Virginia capes, some of his bombers carried radio telephones. The General went along in a de Havilland, using his own radio to direct the attack.

For many flyers, however, radio was still not worth the space. When Charles Lindbergh crossed the Atlantic in 1927, he left his bulky set behind so he could carry an additional 425 gallons of fuel. "What I lose in navigational accuracy," he said before the trip, "I hope to gain twice over in total range."

various Chinese units. Unarmed and theoretically a non-combatant, *Patches* made numerous airdrops and forward landings with troops and supplies.

ROs on Heavies

It was aboard the heavy bombers that RO-gunners exercised their specialties in the greatest numbers. Sgt. Dick Horton was code chaser on the British-based B-17 *Fuddyhuckle* when he flew his thirteenth and roughest mission. The bomber hit the marshaling yards at Vienna, Austria, and the Germans hit back. German gunners shot away both

flaps, punctured the left wing tank, knocked out the number three engine, and destroyed the rudder tabs. The bomb bay doors were blown open, and fire broke out in the bomb bay. Sergeant Horton and other crewmen fought the fire for an hour before putting it out, but he made it home and completed another fourteen missions.

TSgt. Ronald H. Harknett, a RO-gunner aboard the Fortress *Heaven Can Wait*, flew thirty missions, including three to Berlin. He participated in the D-Day invasion and dropped supplies to the Free French resistance. On one run to Germany, flak hit the nose and blew off the top turret, but the plane returned.

Sgt. James Sedlack also made it home eventually, but not aboard his plane. He was on the B-24 *Boomerang* when it was hit over Ploesti, Romania, on the low-level raid of 1943. The bomber crash-landed, and Sergeant Sedlack was pinned in the wreckage. He was rescued after four hours and spent the rest of the war as a POW. Sgt. Jesse Hinely, on the same mission in *Li'l Abner*, also went down and was captured. Several other RO-gunners were killed on the mission.

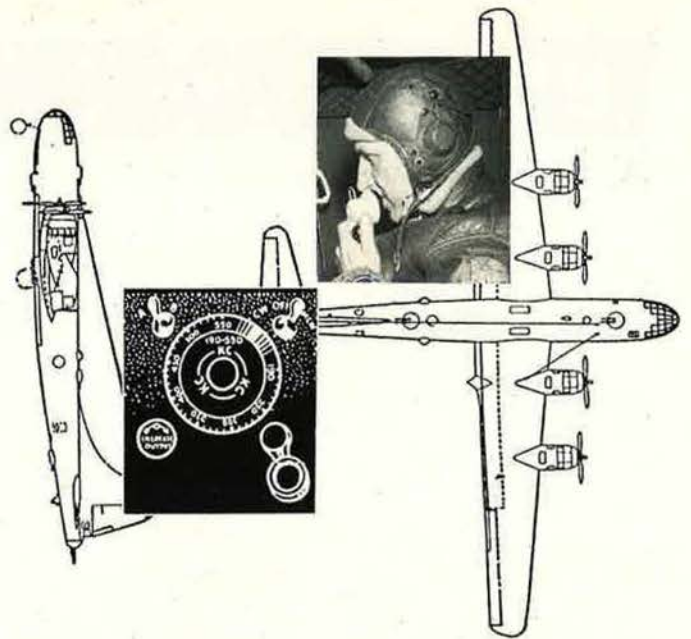
A year later, bombers of Fifteenth Air Force were returning to Ploesti on a regular basis. They flew at high altitude, but the target still was considered one of the roughest in Europe. Sgt. James H. Hearon, Jr., RO-gunner of the B-24 *Home for Christmas*, paid it three visits and survived. His gun position was in the nose, some distance from his radio station on the flight deck. (The top turret would have been more convenient for him, but it was taken over by the engineer on the theory that he should remain close to the pilots in case of emergency.) Sergeant Hearon had to drop through a small hatch on the flight deck, crawl through the narrow tunnel around the nose wheel, squeeze past the bombardier and navigator, and wedge himself into the nose turret. Wearing a fleece-lined flight suit, a flak vest, and a steel helmet and carrying a walkaround oxygen bottle, he did not have an easy passage, but manning the nose guns was vital, particularly if *Christmas* was flying near the front of the formation where it was vulnerable to a head-on attack.

When the plane was beyond the reach of enemy fighters, Sergeant Hearon would work his way back to the flight deck, sometimes to find that flak or fighters had damaged his radio equipment. Unless it was totally destroyed, however, he usually managed to get it operating again. He made his fifty missions.

Toward the end of the war, some ROs graduated to the "very heavy" B-29, an oversized relative of the Fortress with a pressurized hull. It carried not only a radio section on the flight deck but also a radar operator's position in the rear. SSgt. Robert Monroe manned the radio on *Thumper*, which flew the first mission to hit Tokyo since the Doolittle raid of 1942.

"Bingo"

In August 1945, another B-29 headed for Japan. An hour from the islands, the RO, Pvt. Richard N. Nelson, received a message from the scouting planes that had gone ahead. There was light cloud cover over the alternate target, they reported, but all was clear over the primary target, the Japanese city of Hiroshima.



At 9:15 a.m., they began the bomb run. Soon afterward, Private Nelson sent out one loud radio tone, a signal to the escorting planes that they were two minutes from "bombs away." His next signal, a clear, continuous tone, lasted fifteen seconds. When it ended, the plane dropped its one and only bomb.

The B-29 turned away. Eleven miles from the target, it lurched, and the crewmen thought they had been hit by flak. It was the shock wave from the bomb. Private Nelson radioed a one-word message to home base on Tinian Island: "Bingo." *Enola Gay* headed back toward the Marianas.

After the war, the big-crew tradition continued, and it looked as though the radio operator would have lifetime tenure. The Air Rescue Service began flying the SA-16 Albatross flying boat, which carried an RO and two medical technicians. C-119 troop carriers also had a radio section, and the mammoth B-36 stayed aloft so long that it had to carry two operators so one could spell the other on long missions.

Before long, however, advancing technology began to threaten the specialty. Sturdy transistors replaced fragile vacuum tubes. The unwieldy black boxes gave way to miniaturized components that could be tucked away in various locations. The new sets could be worked by any crew member and didn't require full-time repairmen to keep them going. Radio, once bulky, unreliable, and possibly unjustifiable, had become indispensable, but that could not be said of the radio operator.

Echoes of the specialty live on in the job descriptions of electronic warfare officers, navigators, defensive systems operators, and the array of communications specialists who handle the flying broadcasting stations aboard the E-3 Airborne Warning and Control System aircraft, but the RO-gunners of World War II would hardly recognize their similarities, much less the equipment on which today's specialists do their work. ■

Bruce D. Callander, a regular contributor to AIR FORCE Magazine, served tours of active duty during World War II and the Korean War. In 1952, he joined Air Force Times, becoming editor in 1972. His most recent article for AIR FORCE Magazine, "Some Breaks in the Cloud Cover," appeared in the December 1993 issue.

Books

Compiled by Frank Oliveri, Associate Editor

Alexander, Bevin. *How Great Generals Win.* W. W. Norton & Co., Inc., 500 Fifth Ave., New York, NY 10110. 1993. Including photos and index, 320 pages. \$25.00.

Barrett, David M. *Uncertain Warriors: Lyndon Johnson and His Vietnam Advisers.* University Press of Kansas, 2501 W. 15th, Lawrence, KS 66049-3904. 1993. Including notes, bibliography, and index, 279 pages. \$35.00.

Bell, Brig. Gen. Ken, USAF (Ret.). *100 Missions North: A Fighter Pilot's Story of the Vietnam War.* Brassey's (US) Inc., 8000 Westpark Dr., First Floor, McLean, VA 22102. 1993. Including photos, glossary, and index, 314 pages. \$24.00.

Bright, Charles D., ed. *Historical Dictionary of the US Air Force.* Greenwood Press, Inc., 88 Post Rd. W., Box 5007, Westport, CT 06881. 1992. Including index, 713 pages. \$85.00.

Burns, Richard Dean, ed. *Encyclopedia of Arms Control and Disarmament, Vols. 1, 2, and 3.* Charles Scribner's Sons, 866 Third Ave., New York, NY 10022. 1993. Including index, 1,692 pages. \$280.00.

Chilstrom, Ken, and Leary, Penn, eds. *Test Flying at Old Wright Field: From the Piston Engine to Jet Power.* Ken Chilstrom, 20 Selby Ln., Palm Beach Gardens, FL 33418. 1993. Including photos, 276 pages. \$24.00.

Clemente, Steven E. *For King and Kaiser! The Making of the Prussian Army Officer, 1860-1914.* Greenwood Press, Inc., 88 Post Rd. W., Box 5007, Westport, CT 06881. 1992. Including appendix, bibliography, and index, 280 pages. \$45.00.

Craine, Eric R. *Burma Roadsters.* Western Research Co., Inc., 2127 E. Speedway, Suite 209, Tucson, AZ 85719. 1992. Including graphics, glossary, appendix, and index, 263 pages. \$24.95.

Dauber, Cori Elizabeth. *Cold War Analytical Structures and the Post-Post-War World: A Critique of Deterrence Theory.* Greenwood Press, Inc., 88 Post Rd. W., Box 5007, Westport, CT 06881. 1993. Including bibliography and index, 207 pages. \$47.95.

Downs, Frederick. *No Longer Enemies, Not Yet Friends.* Pocket Books/Simon & Schuster Inc., 1230 Avenue of the Americas, New York, NY 10020. 1991. Including photos and index, 405 pages. \$5.99.

Everett-Heath, John. *Helicopters in Combat: The First Fifty Years.* Sterling Publishing Co., Inc., 387 Park Ave. S., New York, NY 10016-8810. 1993. Including photos, glossary, and index, 219 pages. \$29.95.

Finnegan, John P., and Gilbert, James L., eds. *US Army Signals Intelligence in World War II: A Documentary History.* Center of Military History, United States Army, Washington, DC 20005-3402. 1993. Including photos and appendix, 237 pages. \$24.00.

Godson, Roy; Greenwood, Ted; and Shultz, Richard, eds. *Security Studies for the 1990s.* Brassey's (US), Inc., 8000 Westpark Dr., First Floor, McLean, VA 22102. 1993. Including notes and index, 423 pages. \$50.00.

Grayson, William C. *Chicksands: A Millennium of History.* Shefford Press, P. O. Box 4053, Crofton, MD 21114. 1992. Including photos and index, 330 pages. \$19.95.

Higham, Robin, and Mrozek, Donald J., eds. *A Guide to the Sources of United States Military History, Supplement III.* The Shoe String Press, 925 Sherman Ave., Hamden, CT 06514. 1993. Including notes, 531 pages. \$55.00.

Hitchcock, Lt. Col. Walter T. (USAF), ed. *The Intelligence Revolution: A Historical Perspective.* US Government Printing Office, Washington, DC 20402. 1993. Including index, 366 pages. \$30.00.

Horowitz, Barry M. *Strategic Buying for the Future: Opportunities for Innovation in Government Electronics System Acquisition.* Libey Publishing Inc., 1130 17th St., N. W., Suite 600, Washington, DC 20036. 1993. Including glossary and index, 182 pages. \$19.95.

Hoyt, Edwin P. *War in the Pacific: Iwo Jima.* Avon Books, 1350 Avenue of the Americas, New York, NY 10019. 1992. Including notes, bibliography, and index, 214 pages. \$4.99.

Imrie, Alex. *The Fokker Triplane.* Sterling Publishing Co., Inc., 387 Park Ave. S., New York, NY 10016-8810. 1993. Including photos and index, 128 pages. \$24.95.

Lake, Jon, ed. *McDonnell F-4 Phantom: Spirit in the Skies.* Abbeville Press, Inc., 488 Madison Ave., New York, NY 10022. 1992. Including photos and index, 232 pages. \$29.95.

Lombardo, David. *Advanced Aircraft Systems.* TAB Books, Blue Ridge Summit, PA 17294-0850. 1993. Including illustrations, photos, and index, 359 pages. \$18.95.

Lynn, John A., ed. *Feeding Mars: Logistics in Western Warfare From the Middle Ages to the Present.* Westview Press, 5500 Central Ave., Boulder, CO 80301-2877. 1993. Including notes and index, 326 pages. \$44.50.

MacDermott, Brian. *Ships Without Names: The Story of the Royal Navy's Tank Landing Ships of World War II.* Sterling Publishing Co., Inc., 387 Park Ave. S., New York, NY 10016-8810. 1993. Including photos and bibliography, 128 pages. \$35.00.

Odom, Lt. Gen. William E. *America's Military Revolution: Strategy and Structure After the Cold War.* The American University Press, 4400 Massachusetts Ave., McDowell, Room 117, Washington, DC 20016. 1993. Including index, 186 pages. \$22.95.

Phillips, Sky. *Secret Mission to Melbourne: November 1941.* Sunflower University Press, 1531 Yuma, Box 1009, Manhattan, KS 66502-4228. 1992. 296 pages. \$18.95.

Robie, Bill. *For the Greatest Achievement: A History of the Aero Club of America and the National Aeronautic Association.* Smithsonian Institution Press, 470 L'Enfant Plaza, Suite 7100, Washington, DC 20560. 1993. Including photos, notes, bibliography, and index, 378 pages. \$35.00.

Romm, Joseph J. *Defining National Security: The Nonmilitary Aspects.* Council on Foreign Relations Press, 58 E. 68th St., New York, NY 10021. 1993. Including notes and bibliography, 122 pages. \$10.95.

Selhaus, Edi. *Evasion and Repatriation: Slovene Partisans and Rescued American Airmen in World War II.* Sunflower University Press, 1531 Yuma, Box 1009, Manhattan, KS 66502-4228. 1993. Including photos, notes, and index, 233 pages. \$24.00.

Sheymov, Victor. *Tower of Secrets: A Real Life Spy Thriller.* Naval Institute Press, 118 Maryland Ave., Annapolis, MD 21402-5035. 1993. Including appendix, 422 pages. \$24.95.

Thompson, Warren. *Korea: The Air War (2).* Octopus Illustrated Books, 1st Floor, Michelin House, 81 Fulham Rd., London SW3 6RB, England. 1992. Including photos, 128 pages. \$15.95.

Tomedi, Rudy. *No Bugles, No Drums: An Oral History of the Korean War.* John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158-0012. 1993. Including photos and index, 259 pages. \$24.95.

Tripodi, Tom, with Joseph P. DeSario. *Crusade: Undercover Against the Mafia & KGB.* Brassey's (US), Inc., 8000 Westpark Dr., First Floor, McLean, VA 22102. 1993. Including index, 280 pages. \$22.00.

Tsouras, Peter G. *"The Great Patriotic War," An Illustrated History of Total War: The Soviet Union and Germany, 1941-1945.* Presidio Press, P. O. Box 1764, Novato, CA 94948. 1992. Including photos, appendix, and bibliography, 255 pages. \$45.00.

Vaughan, Bradley. *Counterspy Mission in World War II.* Professional Press, P. O. Box 4371, Chapel Hill, NC 27515-4371. 1993. Including photos and glossary, 110 pages. \$12.95.

Winter, Frank H. *Rockets Into Space: Frontiers of Space.* Harvard University Press, Cambridge, MA 02138. 1990. Including photos, notes, and index, 165 pages. \$12.95.

Yoshino, Ronald W. *Lightning Strikes: The 475th Fighter Group in the Pacific War, 1943-1945.* Sunflower University Press, 1531 Yuma, Box 1009, Manhattan, KS 66502-4228. 1992. Including photos and index, 163 pages. \$23.00. ■



By Daniel M. Sheehan, Assistant Managing Editor



Rep. Mac Collins (R-Ga.) delivers his speech to the Southeast Region Conference at Robins AFB, Ga. He stands before a picture of the C-130 Hercules, a USAF workhorse for which Warner Robins Air Logistics Center provides worldwide logistics management. Many awards were presented at the conference (see text), including an Exceptional Service Award to Edward Farrell.

Congressional Action

As the defense budget came under close scrutiny in Congress, AFA members strongly communicated their positions to their representatives in Washington, D. C. AFA's Southeast Region and the **Carl Vinson Memorial** and **South Georgia Chapters** presented their views to Rep. Mac Collins (R-Ga.) during the region's annual AFA conference, held at Robins AFB, Ga.

Representative Collins, a member of the House Public Works and Transportation Committee's Aviation Subcommittee, received an extended tour of the base and the Robins AFB Museum of Aviation before delivering his remarks about aviation issues. Before his speech, the Vinson Chapter screened a video promoting construction of a National Air Force Memorial in Washington, D. C.

Conference attendees had earlier heard presentations on the C-17 airlifter, the Joint Surveillance and Target Attack Radar System aircraft, the Base Realignment and Closure Commission, and the Air Force Junior ROTC. Museum Director Peggy

Young gave an overview of the history of aviation and updated listeners on the museum's plans and acquisitions.

Mrs. Ira C. Eaker traveled to Colorado Springs, Colo., to take part in the fall Falcon Foundation meeting at the US Air Force Academy last year. Mrs. Eaker was the first recipient of the Aerospace Education Foundation's Ira C. Eaker Fellowship, which was named for her late husband.



Vinson Chapter President Jane Channell hosted the conference and welcomed state and chapter officials from North Carolina, South Carolina, Georgia, and Florida. Chapter President Channell and National Vice President (Southeast Region) Dr. Dan Callahan accepted Exceptional Service Awards for their work on behalf of AFA. South Georgia Chapter President Raymond Trusz picked up his chapter's Community Partner Gold Award for 1993.

Dr. Callahan expressed his gratitude to the members of the Vinson Chapter for their hard work in hosting the conference, saying, "such a successful event could not have happened otherwise."

Another Doolittle Tribute

When **Indian River (Fla.) Chapter** President Robert B. Stiasny witnessed the local media's unsatisfactory recognition of the accomplishments of late airpower pioneer Gen. James H. Doolittle, he could have grumbled about the area's apathy and let it go at that. Instead, he took action. He wrote a letter to the editor of the Vero Beach *Press-Journal* praising General Doolittle's career, and the news-

paper's 30,000 readers received an education about one of America's genuine heroes.

Mr. Stiasny took pains to detail Doolittle's historic accomplishments, the large boost his wartime exploits gave to US morale, and his importance to the founding of the Air Force and the Air Force Association. He also used the opportunity to praise the late Arthur Raymond Brooks, a World War I flyer and less remembered aviation pioneer. Thanks in part to Mr. Stiasny, the significance of the careers of these two men received the recognition it deserved.

Mississippi Banquet

Mississippi State AFA held its annual banquet in Jackson to recognize the contributions of the Civil Air Patrol. State President Gene Smith, who has been succeeded by Leonard R. Vernamonti, presented the plaque for Outstanding CAP Cadet of the Year to Cadet Lt. Col. Michael Mc-Millan of the Mississippi Wing.

Chapter News

At a quarterly membership meeting of the **Lt. Erwin R. Bleckley (Kan.) Chapter**, National Vice President (Midwest Region) Samuel M. Gardner honored the 384th Bomb Wing, McConnell AFB, Kan., with a Special Citation for the fine work of the Base Visual Information Support Center—part of the wing's 384th Communications Squadron. The center has offered unstinting support of the chapter's World War II



Cadet Col. Lori A. Vilgats accepts her \$1,000 Angel Flight/Silver Wings Society Scholarship from Central Florida Chapter President Richard A. Ortega. The scholarship was one of ten presented by the Aerospace Education Foundation.

Commemorative Community Programs. Brig. Gen. Charles R. Henderson, 384th Bomb Wing commander, accepted the award. Maj. Gary Ford, 384th Communications Squadron commander, was unable to attend but was ably represented by Capt. Alishia C. Holder, who is also chapter vice president (aerospace education). Chapter President Antonio Pimentel thanked Captain Holder, the center's NCO in Charge MSgt. Robert Rodriguez, and seven

other members of the center who attended the ceremony.

The inhospitable climate of Alaska presents no obstacle to the **Anchor-age Chapter** in its pursuit of Community Partners and new chapter members. The chapter won a Community Partner Gold Award at the 1993 AFA Convention, and Chapter Vice President (Membership) Victor R. Davis reports that Thomas R. Minnich of the Matanuska Telephone Association, a Community Partner, has signed up seven other MTA employees for membership in AFA, earning the MTA a Community Partner plaque.

The Northeast Fly-In at the Wilmington, Del., Municipal Airport gave the **Brandywine (Pa.) Chapter** an opportunity to show the flag last autumn. Chapter President Joe Dougherty, Vice President (Communications) Steve Rudloff, and Vice President (Aerospace Education) Nick Agneta brought AFA caps and other paraphernalia to the well-attended air show, which featured a replica of the *Spirit of St. Louis* among its dozens of vintage and modern aircraft.

One of AFA's most active organizations, the **Panhandle (Tex.) Chapter**, is under new management. Outgoing Chapter President Robert P. Balliett turned over the reins to Joseph T. Rinella, a Vietnam veteran and retired AFRES lieutenant colonel. The new president will be assisted by Executive Vice President Wanda Jones, Vice President (Veterans Affairs) Elwood Stein, Vice President (Communi-



Virginia State Vice President John Craig (right) discusses legislative issues with Brent Franzel, legislative council for Sen. Christopher "Kit" Bond (R-Mo.), at a Defense Appropriations Subcommittee staff reception, held by AFA in conjunction with the Air Force Senate Liaison Office.



House Armed Services Committee Senior Counsel Robert B. Brauer (left) discusses the AFA Statement of Policy and AFA issue papers with National President James M. McCoy at a December 1 meeting.

nications) Tate Williams, Treasurer Chet Smith, and Secretary Laquita Gardner.

Also in Texas, the **Alamo Chapter** held its annual Berkant Civilian Awards banquet at Mitchell Hall, Lackland AFB. Forty civilians were honored for

their contributions to the Air Force. National Director E. F. "Sandy" Faust, a former state and chapter president, received the prestigious W. W. McAllister Patriotism Award for his outstanding work on behalf of USAF, AFA, and the city of San Antonio. Chap-

ter President Buster Horlen and Chapter Executive Vice President Ed Garland presented the McAllister Award and praised Mr. Faust for his long and distinguished service to AFA.

The **Frank Luke (Ariz.) Chapter** chose the occasion of its sixth annual Octoberfest for the installation of its new officers. The event, which saw active participation by the 58th Fighter Wing from nearby Luke AFB, including 58th FW Commander Brig. Gen. Stephen B. Plummer, drew a crowd of more than 300. The chapter has been busy, coping with the closing of Williams AFB, Ariz., and the transfer of the 58th FW from Air Combat Command to Air Education and Training Command. President SMSgt. Jerry Palmer, First Vice President Rulon Booth, Second Vice President Kurt Hannum, Third Vice President Giles Leonard, Treasurer Howard Bump, and Secretary SSgt. Elizabeth Chase will lead the chapter into the new era. Former President Harry Bailey has been appointed to the chapter's board of directors.

Have AFA/AEF News?

Contributions to "AFA/AEF Report" should be sent to Dave Noerr, AFA National Headquarters, 1501 Lee Highway, Arlington, VA 22209-1198. ■

Unit Reunions

Air Weather Ass'n

Veterans who served in Air Weather Service or major command, ANG/Reserve, or reconnaissance weather units will hold a reunion October 26-30, 1994, in Tucson, Ariz. **Contact:** Air Weather Association, 5301 Reservation Rd., Placerville, CA 95667-9745.

Bataan and Corregidor

The American Defenders of Bataan and Corregidor will hold a reunion May 5-11, 1994, at the Hilton Hotel at the Circle, Indianapolis, Ind. **Contact:** Charles L. Pruitt, 1231 Sweetwater-Vonore Rd., Sweetwater, TN 37874.

CBI Veterans Ass'n

Veterans who served in the CBI theater (World War II) will hold a reunion September 3-8, 1994, in Baltimore, Md. **Contact:** Homer C. Cooper, 145 Pendleton Dr., Athens, GA 30606.

Pecos AAF

Veterans who served at Pecos Army Airfield, Tex., will hold a reunion October 10-12, 1994, in Pecos, Tex., in conjunction with the Confederate Air Force air show at Midland. **Contact:** L. M. McDonald, Rte. 4, Box 978, Old Town, ID 83822.

Strategic Air Command Squadrons

Strategic Air Command squadrons assigned in Airborne Command and Control System operations and Post-Attack Command Control System operations are planning to hold a reunion Sep-

tember 29-October 2, 1994, in Omaha, Neb. **Contacts:** Col. Jack W. Suggs, USAF (Ret.), 855 Crenshaw Loop N., Keizer, OR 97303. Phone: (503) 390-2435. CMSgt. Don Wilson, USAF (Ret.), Rte. 1, Box 574A, Tupelo, MS 38801. Phone: (601) 680-4972. Col. Jack E. Gatewood, USAF (Ret.), 358 Sharon Dr., Niceville, FL 32578. Phone: (904) 678-6464.

USAF Test Pilot School Alumni Ass'n

The USAF Test Pilot School Alumni Association will hold a fiftieth-anniversary reunion September 7-10, 1994, at Edwards AFB, Calif. Former students, staff, and friends of Wright-Patterson AFB, Ohio, and Edwards AFB schools are invited. **Contact:** USAF Test Pilot School Alumni Association, P. O. Box 404, Edwards, CA 93523-0404.

Vietnam Pilots/Mechanics

Veteran pilots and mechanics of 7th Air Force "Scatbacks" who served in Vietnam will hold a reunion September 30-October 1, 1994, in Colorado Springs, Colo. **Contact:** TSgt. William V. Roberts, USAF (Ret.), 518 Potter Dr., Colorado Springs, CO 80909. Phone: (719) 591-1557.

9th Bomb Wing

Veterans of the 9th Bomb Wing (Travis AFB, Calif./Mountain Home AFB, Idaho) will hold a reunion September 7-10, 1994, in Seattle, Wash. **Contact:** Conrad Williams, 2512 62d Ave. E., Apt. A, Fife, WA 98424. Phone: (206) 922-3832.

29th Air Service Group Ass'n

Veterans of the 29th Air Service Group will hold a reunion July 17-23, 1994, at the Holiday Inn Gateway in Huntington, W. Va. **Contact:** Frank Pace, 315 W. 15th St., Dover, OH 44622. Phone: (216) 343-7855.

Class 38-A

Members of Class 38-A will hold a reunion March 10-12, 1994, at the Menger Hotel in San Antonio, Tex. **Contact:** Col. Marvin S. Zipp, USAF (Ret.), 4917 Ravenswood Dr., #853, San Antonio, TX 78227.

Class 42-D

Members of Class 42-D (Stockton, Calif.) will hold a reunion April 26-28, 1994, in Mesa, Ariz. **Contact:** Lt. Col. George Gunn, USAF (Ret.), 7430 E. Mallory, Mesa, AZ 85207. Phone: (602) 985-0125.

Class 45-A

Members of Class 45-A who attended basic or advanced pilot training at Enid AAF, Okla., will hold a reunion May 17-19, 1994, in Dayton, Ohio. **Contact:** Bud Merritt, Rte. 1, Box 180, Beverly, OH 45715. Phone: (614) 984-2462.

Class 52-F

Members of Class 52-F (Bartow AB, Fla.) will hold a reunion in April 1994 in Tucson, Ariz. **Contact:** R. E. Rocque, 220 Lee Ave., Satellite Beach, FL 32937. Phone: (407) 777-0716.

Unit Reunions

73d Bomb Wing Ass'n

Veterans of the 73d Bomb Wing and assigned units, including the 497th, 498th, 499th, and 500th Bomb Groups and the 65th, 91st, 303d, and 330th Service Groups, who served on Saipan during World War II will hold a reunion May 12-15, 1994, at the Sheraton Hotel in Colorado Springs, Colo. **Contact:** 73d Bomb Wing Association, 105 Circle Dr., Universal City, TX 78148.

309th Troop Carrier Group

Veterans of the 16th Troop Carrier Squadron and the 309th Troop Carrier Group, which included the 376th, 377th, and 378th TC Squadrons (Ardmore AFB, Okla., and Dreux AB, France), who served during 1955-58 will hold a reunion October 13-16, 1994, at the Holiday Inn Northwest Loop, San Antonio, Tex. **Contacts:** Bill Donovan, 126 Forest Valley Dr., San Antonio, TX 78227. Phone: (210) 673-4571. Col. Joe C. Williams, USAF (Ret.), 2610 Deerfoot Trail, Austin, TX 78704. Phone: (512) 443-5115.

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to "Unit Reunions," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Please designate the unit holding the reunion, time, location, and a contact for more information.

364th Fighter Group Ass'n

The 364th Fighter Group, 8th Air Force (World War II), and support units will hold a reunion September 7-11, 1994, at the Hilton Valley Forge in King of Prussia, Pa. **Contact:** Dan Leftwich, 6630 Caldero Ct., Dayton, OH 45415. Phone: (513) 890-3641.

376th Service Squadron

Veterans of the 376th Service Squadron will hold

a reunion March 30-April 2, 1994, in Natchez, Miss. **Contact:** Maj. Frank S. Swalm, USAF (Ret.), 403 Lindberg Ave., Natchez, MS 39120. Phone: (601) 442-5974.

394th Bomb/4th Recon Squadrons

Veterans of the 394th Bomb Squadron and the 4th Reconnaissance Squadron, 5th Bomb Group, 13th Air Force (World War II), will hold a reunion April 28-May 1, 1994, at the Sheraton Plaza Hotel in Orlando, Fla. **Contact:** Dag Larsen, 1600 N. Oak St., Apt. 1627, Arlington, VA 22209. Phone: (703) 524-2666.

401st Bomb Group

Veterans of the 401st Bomb Group will hold a reunion September 14-17, 1994, in Omaha, Neb. **Contact:** Ralph Trout, P. O. Box 22044, Tampa, FL 33622.

410th Bomb Group

Veterans of the 410th Bomb Group, 9th Air Force, will hold a reunion May 4-7, 1994, at the Sheraton Hotel in Charleston, S. C. **Contact:** John P. McDonagh, 6013 Rembert Dr., Hanahan, SC 29410. Phone: (803) 747-2404.

446th Bomb Group Ass'n

Veterans of the 446th Bomb Group who served in World War II with 8th Air Force (Bungay, England) will hold a reunion May 12-15, 1994, in Tucson, Ariz. **Contact:** W. F. Davenport, 13382 Wheeler Pl., Santa Ana, CA 92705. Phone: (714) 832-2829.

483d Bomb Group Ass'n

The 483d Bomb Group will hold a reunion September 20-25, 1994, in Harrisburg, Pa. **Contact:** Don Neiser, 1832 Church Rd., York, PA 17404. Phone: (717) 764-3363.

802d Aviation Engineers

Members of the 802d Aviation Engineers will hold a reunion in September 1994 in Springfield, Mo. **Contact:** Raymond Griffith, 5 Cooper Ln., Chester, NJ 07930. Phone: (908) 879-5687.

820th Bomb Squadron

Veterans of the 820th Bomb Squadron, 41st Bomb Group, 7th Air Force (World War II), will hold a reunion May 26-29, 1994, at the Fairmont Hotel in Chicago, Ill. **Contact:** William W. Childs, 3637

Patsy Ann Dr., Richmond, VA 23234-2951. Phone: (804) 275-6012.

6594th Test Group

Members of the 6594th Test Group "Catch A Falling Star," Hickam AFB, Hawaii, will hold a reunion October 27-29, 1994, in Waikiki, Hawaii. **Contacts:** Jim Johnston, 1320 Kirby Rd., McLean, VA 22101. Phone: (703) 276-8548. CMSgt. John A. Ashe, USAF (Ret.), P. O. Box 1484, Tehachapi, CA 93561. Phone: (805) 822-1705. Ray Romero, 98-1992 Hopaki St., Aiea, Hawaii 96701. Phone: (808) 488-7082.

Air Force Academy Construction Agency

Seeking personnel who were assigned to the Air Force Academy Construction Agency interested in planning a fortieth-anniversary reunion for September 1994. **Contact:** Col. William C. Giltner, USAF (Ret.), 1634 Shrider Rd., Colorado Springs, CO 80920. Phone: (719) 598-5693.

Class 45-A

For the purpose of planning a reunion, I am seeking members of Class 45-A who attended pilot training at the following locations: primary at Lancaster, Calif., basic at Gardner Field, Calif., or advanced at Marfa, Tex. **Contact:** Herald E. Beaty, 1908 Culver, Midland, TX 79705. Phone: (915) 697-2465.

337th Fighter-Interceptor Squadron

Seeking contact with former officers of the 337th Fighter-Interceptor Squadron for the purpose of organizing a reunion in 1994 or 1995. **Contacts:** Norman R. Lockard, 4907 W. Royal Palm Rd., Glendale, AZ 85302. Phone: (602) 931-2133. Bill Bradley, 33 Norway Hill, Hancock, NH 03449-5610. Phone: (603) 525-3541.

441st Troop Carrier Group

Seeking information and addresses for a reunion of the 441st Troop Carrier Group, which included the 99th, 100th, 301st, and 302d Troop Carrier Squadrons, stationed between 1944 and 1945 at Merryfield, England, and Dreux, France. **Contact:** Scott Brantley, 15361 Grantley Dr., Chesterfield, MO 63017. Phone: (314) 532-5804. ■

Bulletin Board

Seeking film, photos, or personal recollections of a visit by **USAAC Generals Strong and Emmons** and Navy **Rear Admiral Gormley** to Hendon, England, on September 15, 1940. Shortly after their arrival, No. 504 Squadron, Royal Auxiliary Air Force, intercepted a German raid on London; Sgt. Ray Holmes shot down a Dornier 17Z near Victoria Station. **Contact:** T. T. J. Handley, 24 Tower Rd., Darlington, County Durham DL3 6RU, UK.

Seeking information about **B-26 Marauder** aircraft and crews that passed through Baer Field, Ind., during World War II. **Contact:** William L. Wilhelm, 729 S. 32d St., South Bend, IN 46615.

To help establish an aviation museum at **Bankstown Airport**, Australia, seeking photos, reminiscences, or memorabilia from personnel who served at Bankstown with the **35th or 49th Pursuit Groups**, 5th Air Force, during World War II. **Con-**

tact: Gail Naylor, Kingsford Smith Hangar Restoration and Aviation Museum Trust, Hangar 1995, Bankstown Airport, N. S. W. 2200, Australia.

Seeking the whereabouts of **Col. Si Richards**, who served with 9th Air Force in Britain during World War II. He was stationed at RAF Cottesmore and also lived at Windsor Great Park, Newbury, and West Drayton in Berkshire. Before joining USAAF, he was a pilot for United Air Lines. **Contact:** Ernest R. McDowell, 1922 W. Berenice Ave., Chicago, IL 60613-2722.

Seeking photos of **F-86D #52-3864** and information on the units it was assigned to: 62d Fighter-Interceptor Squadron (1954), 85th FIS (1955-56), 4750th Air Defense Wing (1956), 173d FIS (1957), and 1001st Air Base Wing (1959). Also seeking information about its 1959 donation. **Contact:** Kurt C. Gibson, 6494 Duquesne Pl., Virginia Beach, VA 23464-4433.

Seeking contact with **Jerry Ayers, Robert B. Kelly, Jerald Lienweber, Joseph Tracey**, or anyone who knew **James H. Hancock**. Mr. Hancock was a P-38 pilot with the 38th Fighter Squadron, Paine Field, Wash., who crashed off Vashon Island near Seattle on June 7, 1942. **Contact:** Dave Mahre, 2762 Cook Rd., Yakima, WA 98908.

Seeking the whereabouts of **John Boggs, Harold Choate, Penny Hill, Burns Lundgreen, B. W. Ryan**, and **Harvey Schwartz** of the 465th Troop Carrier Wing, as well as the names of others not on the 465th TCW Association's current roster. **Contact:** Jim Strickland, 3218 Greenwood Ct., Fort Collins, CO 80525.

Seeking contact with **Cpts. James P. Lundy, George A. (Tony) Jordan, and William Frewin** and **SSgt. Chester Slezzer**, crew members on a C-47 out of Wheelus AB, Libya, that was forced down by Soviet fighters over East Germany on

May 20, 1960. **Contact:** Leon Porter, 4716 Spiva Dr., Del City, OK 73115.

Seeking information on **John F. Curry**, from Dallas, Tex., who joined the Royal Canadian Air Force early in World War II and may have flown Spitfires. Before the war he was a barnstormer. Also seeking information about a **May 1944 near-crash** between a Spitfire and a Silver Fortress at Ford, Sussex, England. **Contact:** G. Greenough, 14 Maple Pl., Kentville, N. S. B4N 2K4, Canada.

Seeking information and photos from personnel who served with the **10th Photo Tech Unit** at Kadena AB, Japan, during 1946-49, or the **12th PTU** at Greenville, S. C., during 1948-49. **Contact:** Maj. Jerry D. Byers, USAF (Ret.), 10885 S. Santa Fe Ln., Goodyear, AZ 85338.

Historian seeks contact with pilots and support personnel associated with the **A-10 "Warthog,"** especially #79-112 flown by the 355th Tactical Fighter Squadron, 354th Tactical Fighter Wing, Myrtle Beach AFB, S. C. Photos, slides, patches, and documents would be appreciated. **Contact:** John Odum, P. O. Box 426, Lake City, SC 29560.

Seeking information about radar operator **Gordon Ault** and bombardier **Joseph E. Flaherty**, who served in the China-Burma-India theater during World War II. **Contact:** Maj. William R. McGuire, USAAF (Ret.), 659 Ensenada Ave., Berkeley, CA 94707.

Researcher seeks information on families with **three or more brothers who were military pilots.** Results will be furnished to the families and the Historical Society. **Contact:** Maj. Jefferson K. Warren, USAF (Ret.), 13618 E. 2d Ave., Aurora, CO 80011.

Seeking the whereabouts of **SSgt. Richard Pack**, who served with the 7th Bomb Wing at Carswell AFB, Tex., during 1957-58. He was a friend of Donald F. Bondick. **Contact:** Ginny Darnell, 3100 E. Park Row, #U201, Arlington, TX 76010.

World War II enthusiast wishes to donate copies of **Philippine newspapers** from 1945 to a collector or historian. Also seeking contact with anyone who served with the **307th Airdrome Squadron** or **486th Service Squadron**, 64th Service Group, 5th Air Force. **Contact:** George Vines, 333 Sunset Dr., Wilmette, IL 60091-3028.

Author seeks contact with crew members of the **94th, 96th, 385th, 388th, 447th, or 452d Bomb Groups** who participated in a raid on the Clermont-Ferrand/Aulnat airfield on April 30, 1944. **Contact:** Claude Grimaud, 2 rue du Château, 48200 St. Chély d'Apcher, France.

Seeking contact with anyone who flew or worked on **F-105D #61-138** at Takhli RTAFB, Thailand, in 1965. Photos showing the aircraft's markings would be welcome. **Contact:** CMSgt. Brian Wasko, 202 Liberty Way, Dover AFB, DE 19902-7202.

Seeking the names of anyone who flew or worked on the **B-26 Flak Bait** of the 449th Bomb Squadron, 322d Bomb Group, for a commemorative plaque to be given to the Smithsonian Institution. **Contact:** Robert F. Wittling, 240 N. Edison Ave., South Bend, IN 46619.

Seeking historical items concerning the **39th Airlift Squadron**, recently reactivated at Dyess AFB, Tex. **Contact:** Capt. Nick Coleman, USAF, 965 Herk Dr., Dyess AFB, TX 79607-1876.

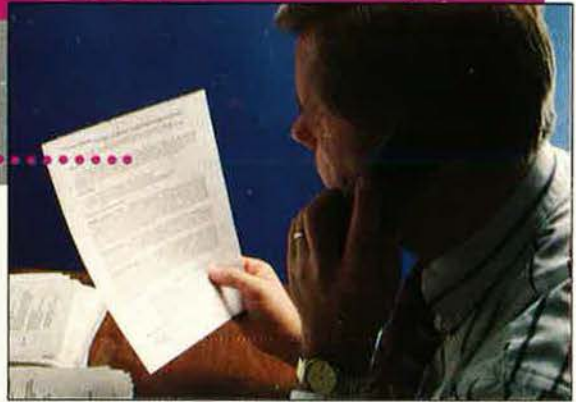
Seeking information about **Maj. Larry D. Dennis** of the 374th Service Squadron, Biak, New Guinea, who rescued **P. A. Guillermo Garcia Ramos** of the Mexican Expeditionary Force on July 20, 1945. **Contact:** Santiago A. Flores, P. O. Box 430910, San Ysidro, CA 92143-0910.

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Historian seeks photos for an updated **Air Force History of the Air National Guard.** Photos will be returned. **Contact:** Charles J. Gross, Skyline VI, Suite 401C, 5109 Leesburg Pike, Falls Church, VA 22041-3201.

Seeking contact with relatives and friends of **Joseph Belas**, a waist gunner with the 93d Bomb Group, 20th Bomb Wing, 8th Air Force, at RAF Hardwick, UK, in 1943-45. He lived in Aliquippa, Pa., and died in Pennsylvania in 1976. **Contact:** Joseph Belas, 94 Pilling Park Rd., Norwich City NR1 4NZ, UK.

Seeking contact with personnel who served with the **52d Fighter Group** in Northern Ireland during 1942-45, especially the 2d Fighter Squadron. **Contact:** Robert J. Almy, 525 Ambridge Ave., Fair Oaks, PA 15003.

Seeking contact with personnel who served with the **332d Bomb Squadron**, 94th Bomb Group, 4th Combat Wing, 8th Air Force, in England in 1943. **Contact:** Ernest Ricci, 8824 Fort Hunt Rd., Alexandria, VA 22308.

Seeking contact with veterans of the **2d Bomb Group** or **2d Bomb Wing** who are not members of the 2d Bombardment Association. **Contact:** Kemp F. Martin, 8433 Katy Fwy., Suite 102, Houston, TX 77024.

Seeking information on **Lieutenant Walters-housen** or members of his B-29 crew that left for Korea in 1951. **Contact:** Raymond L. Willard, 260 Santa Maria, #212, Venice, FL 34285.

Seeking contact with **radiological safety and decontamination personnel** who served at

Bulletin Board

Walker AFB, N. M., in 1952. **Contact:** Bernard Tschoerner, Rte. 1, Box 236A, Bartlett, TX 76511.

Seeking information about **Emilio A. Ragucci**, from Boston, Mass., who was stationed with the 112th Tactical Fighter Squadron, Ohio ANG, at Toledo Express Airport in 1961-62. Also seeking patches, pictures, or other information on the 112th TFS during this period. **Contact:** J. R. Detrick, 6916 Winchester Pl., Fort Worth, TX 76133.

Seeking information on combat operations of **F-105G #62-4444** during the Vietnam War. The aircraft operated from Takhli RTAFB, Thailand, in 1968-69 and Korat RTAFB, Thailand, in 1972-74. **Contact:** John J. Panoski, Empire State Aerosciences Museum, 130 Saratoga Rd., Scotia, NY 12302.

Seeking information on **Fred G. Straut**, of Ramsey, N. J., **Vincent Tranquillo**, of Philadelphia, Pa., and **Howard W. Willoughby**, of Syracuse, N. Y. All were P-51 pilots with the 4th and 5th Fighter Squadrons in Italy in 1944. Also seeking contact with the crew of a **World War II B-24** that saw **four P-51 Mustangs down a Bf-110** with Soviet markings south of Budapest, Hungary, on March 1, 1945. **Contact:** Charles E. Wilson, 2425 Lauderdale Ct., Orlando, FL 32805.

Historian seeks contact with members of the **91st Bomb Group**, 8th Air Force, and anyone else who participated in the May 29, 1944, attack on Poznan, Poland. Also seeking photos of P-40s, P-47s, and P-51s of the **325th Fighter Group "Checkertail Clan."** **Contact:** Michal Mucha, Al Wielkopolska 43, 60-603 Poznan, Poland.

Seeking the whereabouts of **Sgt. James Michael Demko**, who was stationed at RAF Upper Heyford, UK. His last known address (1982) was Beale AFB, Calif. **Contact:** Cathleen Taylor, 85 Durban Rd. W., Watford, Hertfordshire WD1 7DS, England.

Seeking contact with **Peter Cannon**, who was born in Monroeville, Ala., in 1927. He was stationed at Pensacola, Fla., and Brookley Field, Ala., in 1946 and at Fürstenfeldbruck, West Germany, with the 36th Fighter Wing, in 1948-50. He may have moved to England after 1950. **Contact:** Renate Papenberg, 2821 78th St., Des Moines, IA 50322-4407.

Free-lance writer seeks reminiscences of **fighter pilots, forward air controllers, or line crews** from the Vietnam War or Persian Gulf War. **Contact:** Lt. Col. Philip H. Johnson, USAF (Ret.), 55 Grand Ave., Rockville Centre, NY 11570.

Author seeks high-quality Kodachrome slides and color photos of the **F-16 Fighting Falcon**. All material will be returned, and a copy of the book will be given for any material used. **Contact:** Mike Reyno, 896 Shelborne St., London, ON N5Z 5A7, Canada.

Author seeks contact with **test pilots** from the **Air Force Flight Test Center** at Edwards AFB, Calif., to obtain colorful stories about test flights at Edwards from the 1940s to the present. **Contact:** Steve Pace, 6501 E. I St., Tacoma, WA 98404.

Collector seeks patches, name tags, T-shirts, and other items from USAF, ANG, and AFRES **fighter, reconnaissance, and bomber squadrons**. Also interested in items from squadrons stationed in Europe and the Pacific. **Contact:** Bill Jennaro, 10040 Gothic Ave., North Hills, CA 91343.

Seeking information about **MSgt. Edward Hanley**, a B-17 waist gunner with 8th Air Force, who may have been stationed in Scotland in 1943-45.

Contact: Robert E. Waters, 2821 Mockingbird Ct., Annapolis, MD 21401-7288.

Researcher seeks information on **Allied airmen** who bailed out over Axis-occupied Greece during World War II. **Contact:** Nikos Kouklelis, 48 Karapanos St., 166 75 Glyfada, Greece.

Seeking information on a **World War II B-26 mission** in the South Pacific on which **Lyndon B. Johnson** was a passenger. **Contact:** Lt. Col. Robert W. Fox, USAF (Ret.), 89 Liberty St., Middleton, MA 01949.

Author seeks information about and photos of **aircraft mission and kill markings**. Especially interested in data from the Korean, Vietnam, and Persian Gulf Wars. **Contact:** Ernest R. McDowell, 1922 W. Berenice Ave., Chicago, IL 60613-2722.

Seeking contact with members of the **49th Fighter Group** from 1941 to the present. **Contact:** Bill Shultz, 49th Fighter Group Association, P. O. Box 1270, Phoenix, AZ 85001.

Seeking contact with **Lt. Col. Mike (Miles) Doyle**, **Majs. Keith Cook** and **Bob Mechlin**, and **Lts. Charley Brown, Ron Phillips, and Jack Wallace**, or anyone with information on the downing of **Capt. Robert L. Simpson's** T-28 near Phu Vinh, South Vietnam, on August 28, 1962. Captain Simpson was with Det. 2, 4400th CCTS, escorting C-123s, when he crashed into the Mekong River. **Contact:** Lt. Col. Eugene D. Rossel, USAF (Ret.), 6083 Rosa Ct., Chino, CA 91710.

If you need information on an individual, unit, or aircraft, or if you want to collect, donate, or trade USAF-related items, write to "Bulletin Board," Air Force Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be brief and typewritten; we reserve the right to condense them as necessary. We cannot acknowledge receipt of letters. Unsigned letters, items or services for sale or otherwise intended to bring in money, and photographs will not be used or returned.—THE EDITORS

Historian seeks contact with members of USAF and Navy **aircrews shot down by the North Vietnamese Air Force** during 1965-72. Interested in accounts of their engagements, rescue or imprisonment, and repatriation. Also seeking contact with aircrew members who returned safely and USAF rescue helicopter pilots. **Contact:** Frank G. Rozendaal, Akker 113, 3732 XC de Bilt, the Netherlands.

Author seeks information on and photos of **USAFE operations** at RAF Upper Heyford, UK. Also seeking contact with members of the **66th Tactical Reconnaissance Wing** and **20th Tactical Fighter Wing**. **Contact:** Dylan Eklund, 49 Spruce Dr., Bicester, Oxon. OX6 9YF, UK.

Seeking information about anyone who was in the **Dulag-Luft Transit Camp** in Frankfurt, Germany, when the camp was destroyed by an RAF bomb in March 1944. **Contact:** Charles Brennan, 92 Overlook Rd., Morristown, NJ 07960.

Seeking copies of a set of **aerial photographs of Paris** that I took while assigned to the 92d Troop Carrier Squadron, 439th Troop Carrier Group, at Alençon, France, in 1944. The photos are enlarged prints in sepia. **Contact:** Lt. Col. William Bailey, USAF (Ret.), 5948 Niblick Cir., North Port, FL 34287.

Seeking information on **AT-6 instructors** of students who became aces. **Contact:** Lt. Col. Phillip Coady, AFRES (Ret.), 12935 Rio Oso Rd., Auburn, CA 95602-7502.

Seeking contact with **Ellis L. Boone** and **Edward M. Rogers**, from California, who served with the 85th Bomb Squadron at RAF Sculthorpe, UK, in the mid-1950s. **Contact:** Richard L. McCormick, 307 S. Meridian St., Greenwood, IN 46143.

Seeking contact with members of the **6053d Radio Flight Mobile**, Osan AB, South Korea, in 1958-59. **Contact:** MSgt. Glyn Laird, USAF (Ret.), 2467 N. Ridgewood Dr., Wichita, KS 67220-4006.

Seeking information about **Cols. Floyd D. Harris** and **Frederick H. Marsh**. **Contact:** Lt. Col. George Gunn, USAF (Ret.), 7430 E. Mallory, Mesa, AZ 85207.

Seeking contact with **Charles W. Hunigan** (last known address: Bristol, Tenn.), **Jim Randall** (Syracuse, N. Y.), and **A. E. Weisleder, Jr.** (Brielle, N. J.). **Contact:** Walter H. Pierson, 717 Running Creek, Seguin, TX 78155.

Seeking contact with members of the **3973d Combat Defense Squadron**, Morón AB, Spain, during 1958-65. Also interested in squadron patch or related memorabilia. **Contact:** Nicholas M. Snow, 200 Space Blvd., #6A, Del Rio, TX 78840. ■

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50-54	\$89.06	\$134.54	\$49.04
55-59	\$115.31	\$171.28	\$49.04
60-64	\$143.77	\$194.22	\$49.04

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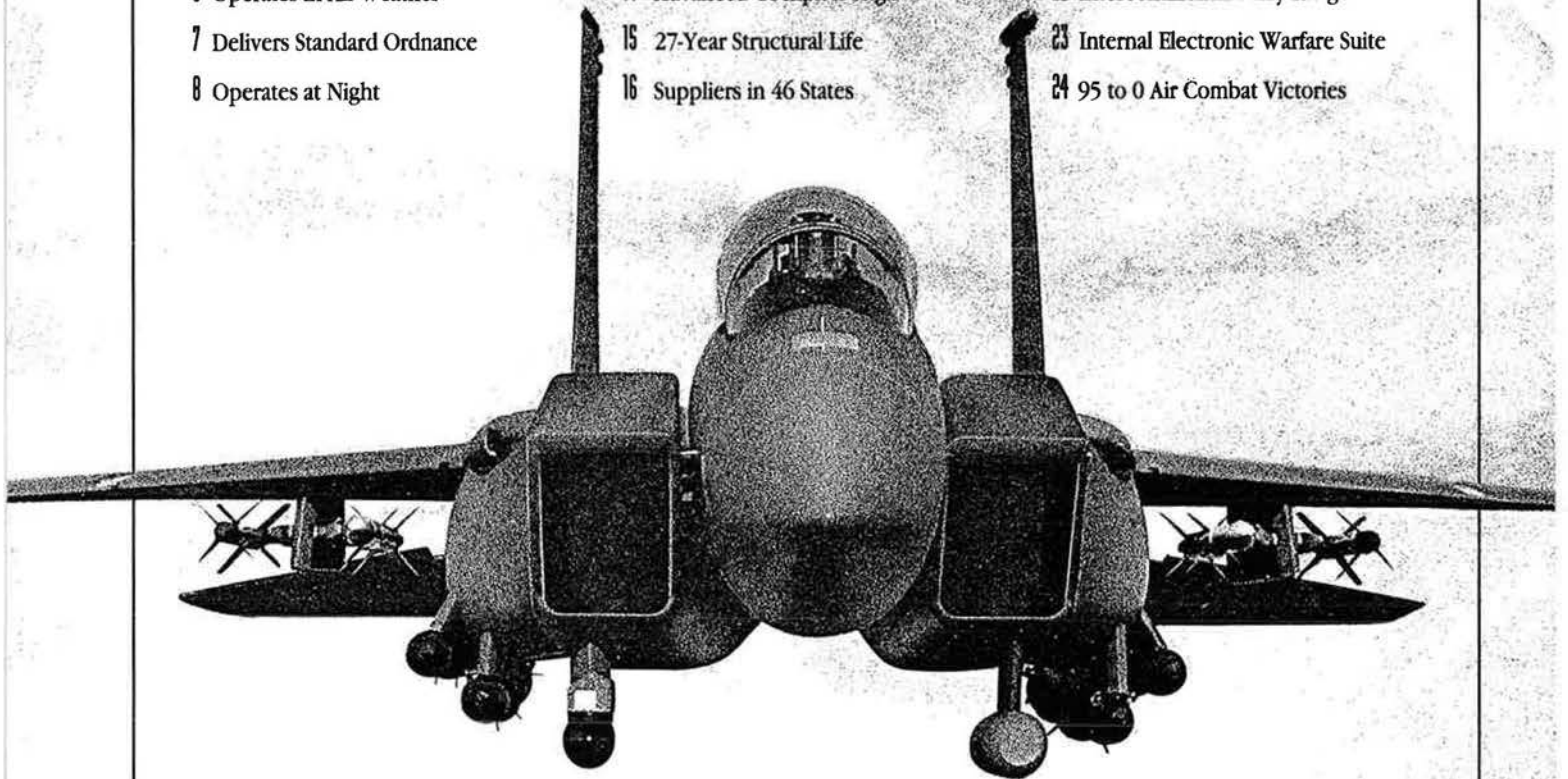
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