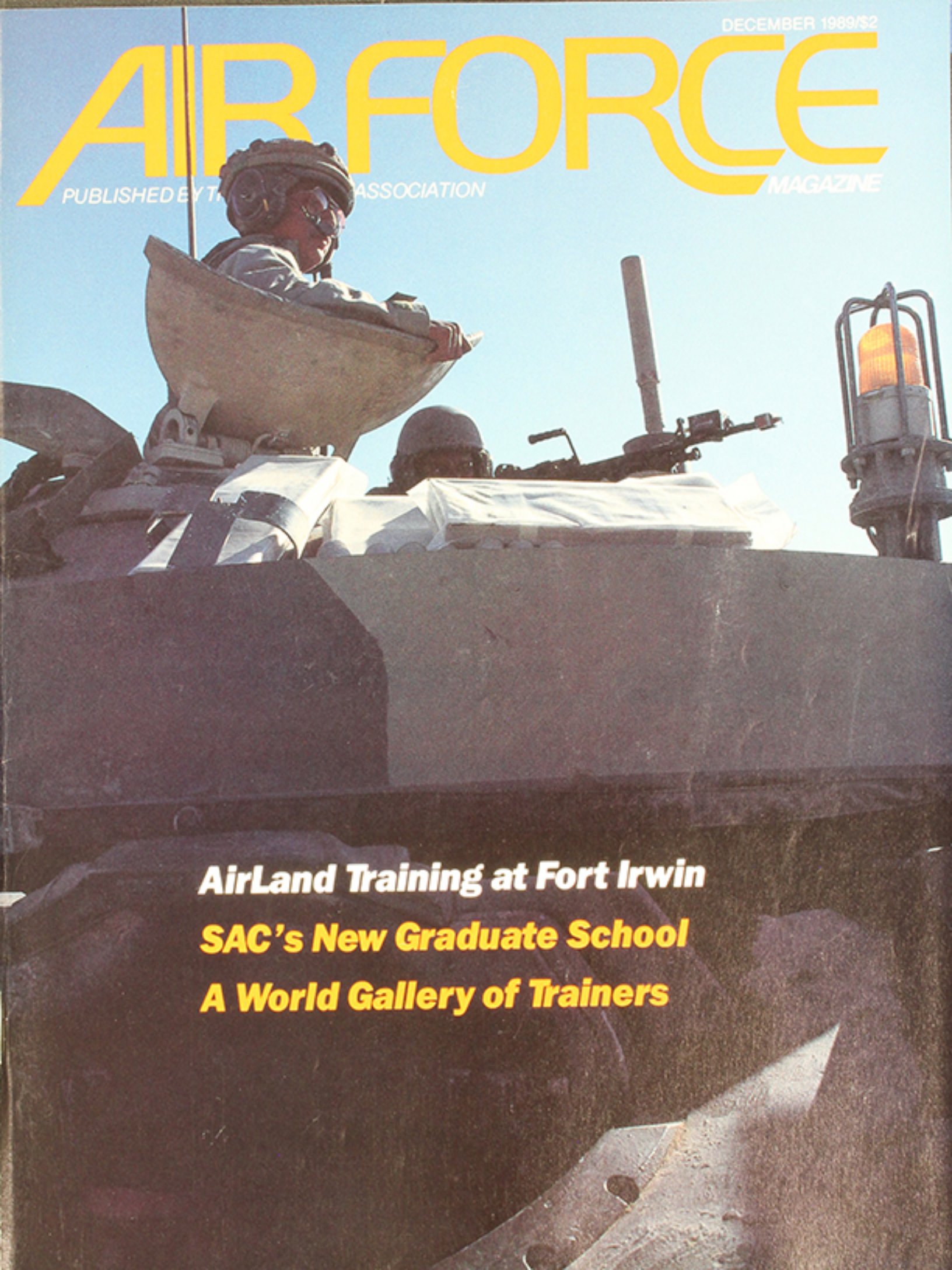
DECEMBER 1989/$2

AIR FORCE MAGAZINE

PUBLISHED BY T[illegible] ASSOCIATION



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–Air Force Official

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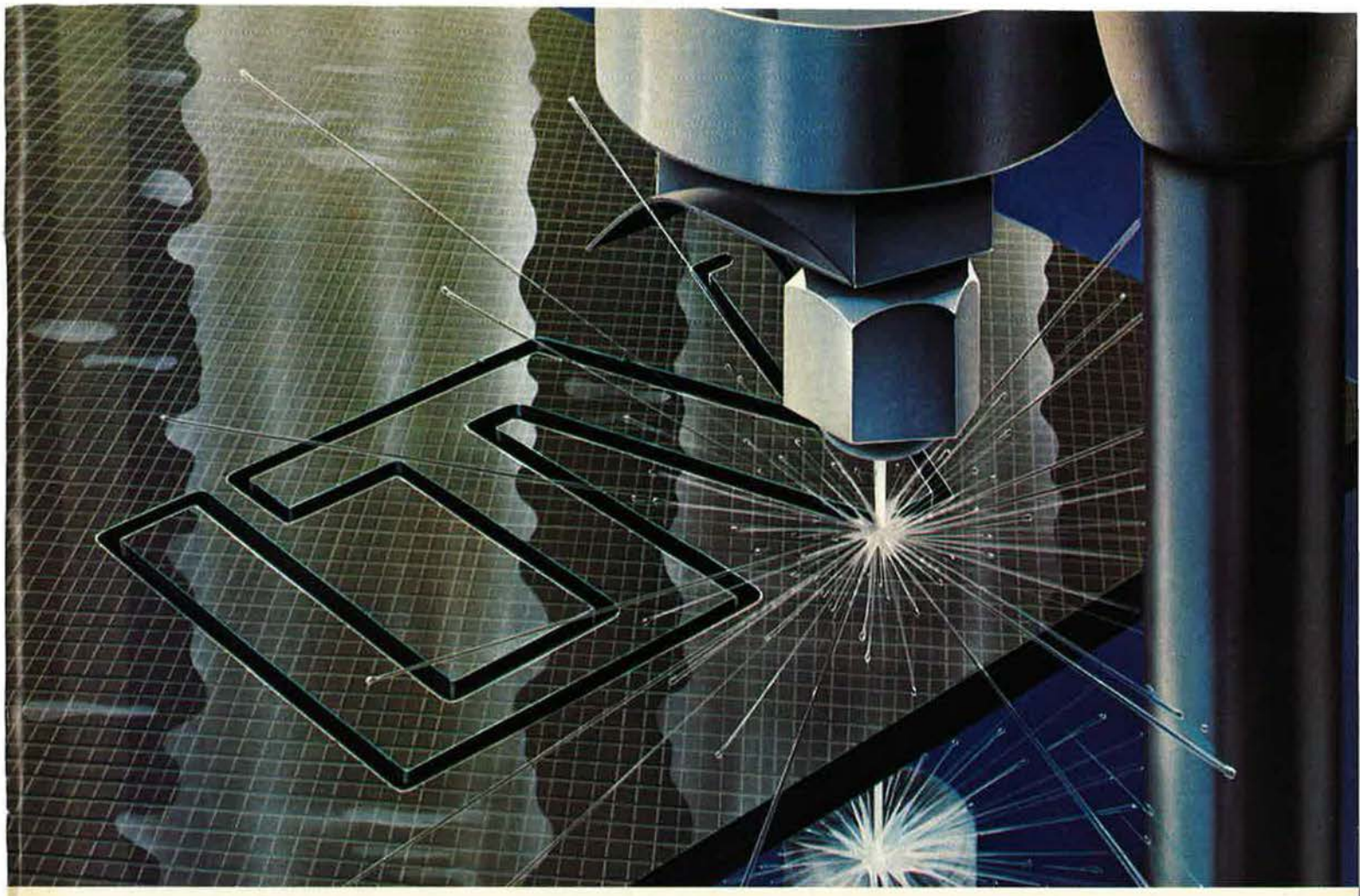

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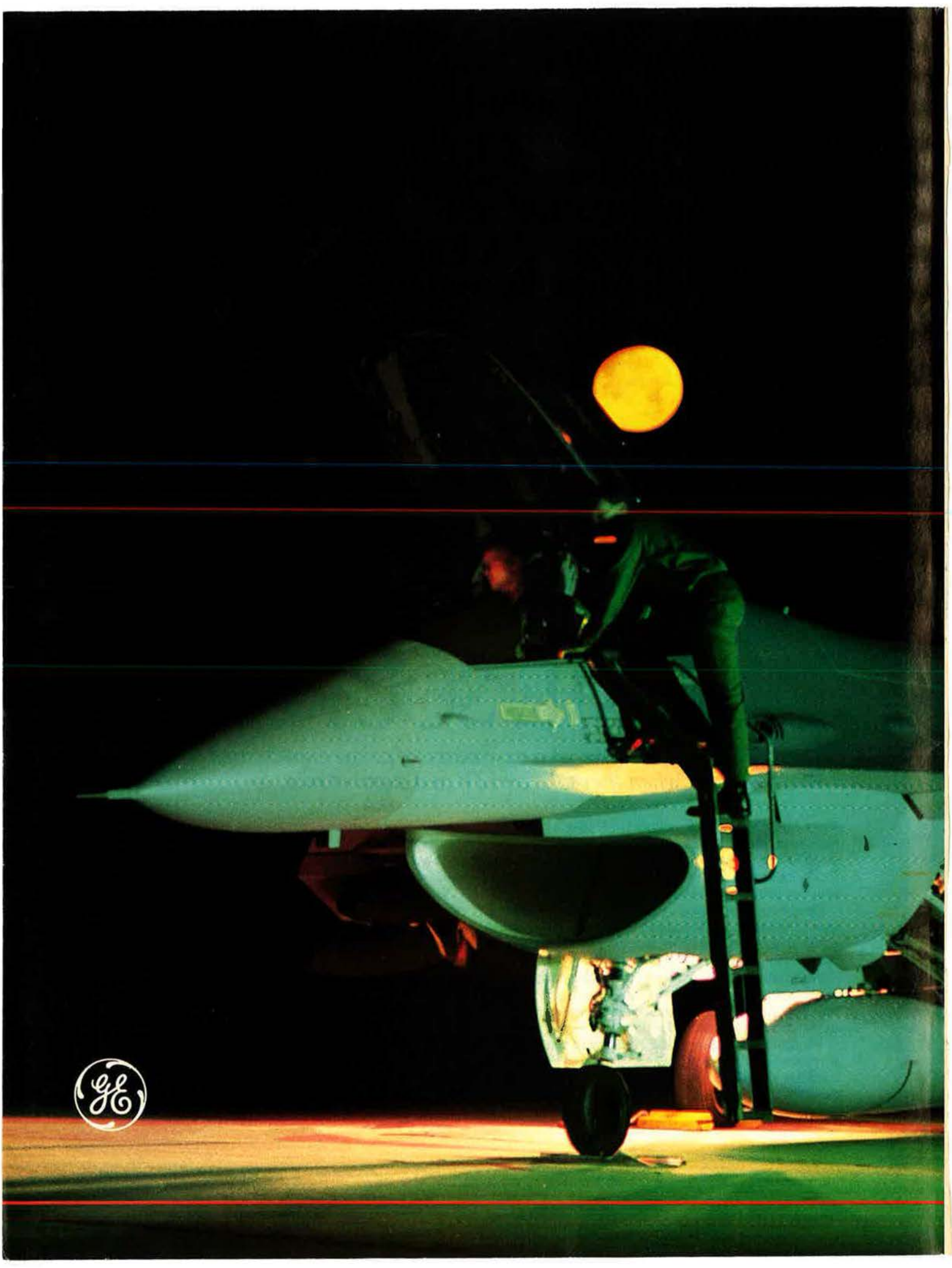

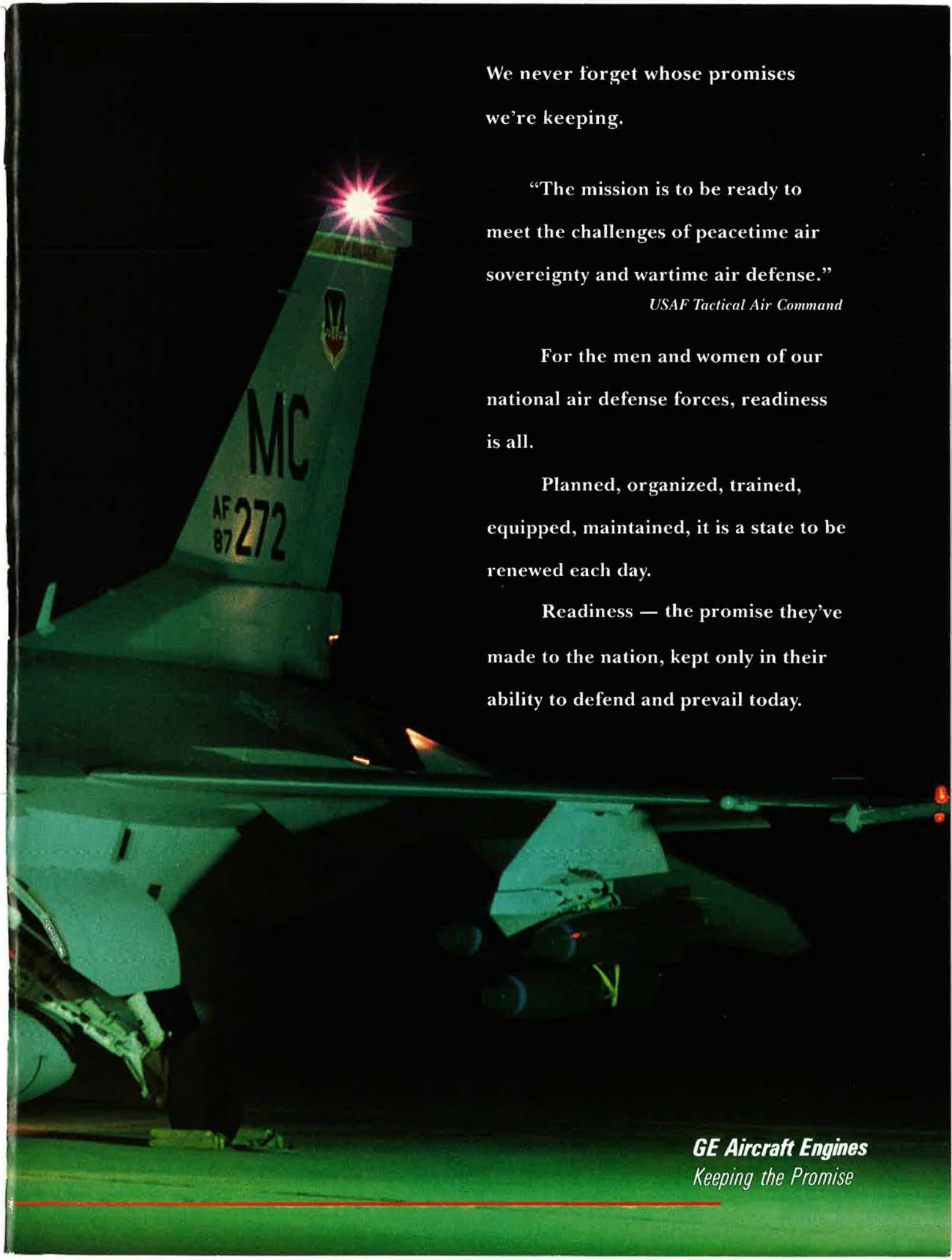

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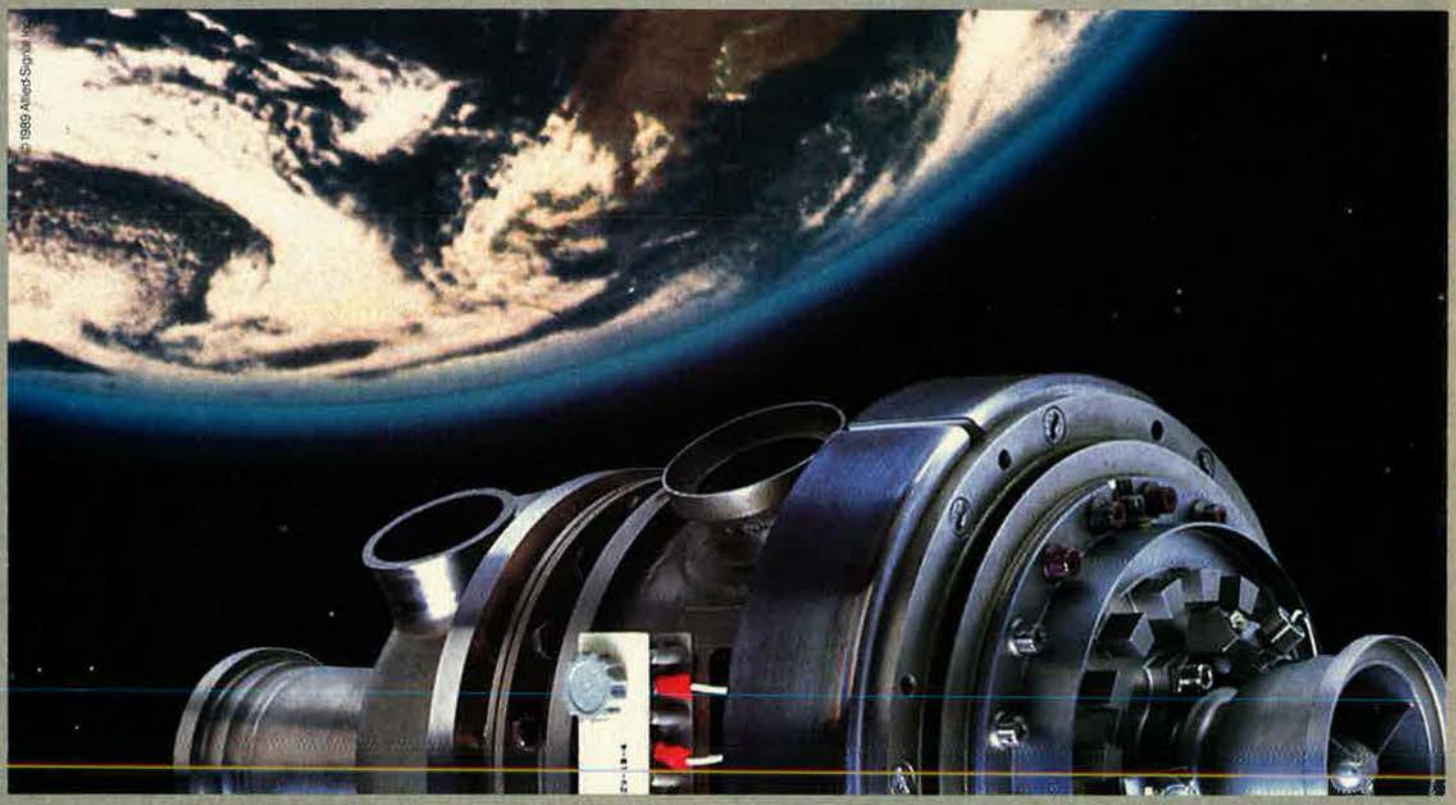

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DECEMBER 1989
VOLUME 72, NUMBER 12

AIR FORCE MAGAZINE

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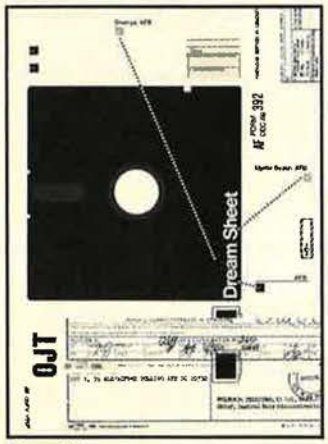

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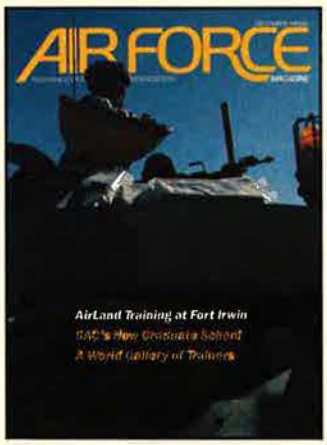

About the cover: Members of the Fort Irwin OPFOR peer from the turret of their Soviet BMP (really a US Sheridan modified to resemble the Soviet tank). The training that troops receive at the National Training Center is designed to simulate what they could face in a European war. Staff photo by Guy Aceto.

Training Comes First

Departments

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An Editorial

Aunt Wilma In Washington

By John T. Correll, EDITOR IN CHIEF

WASHINGTON, D. C., needs a statue of Aunt Wilma Hudson. It could stand in the middle of Pennsylvania Avenue, halfway between the Capitol and the White House. On such a perch, Aunt Wilma would be a symbol of the federal city, which conducts its affairs much as she did hers, unintimidated by common logic.

In James Thurber's short story "The Figgerin' of Aunt Wilma," Mrs. Hudson is baffled by numbers. She compensates for her confusion with a contempt for the computational arts and a distrust of those who dabble in them. She also triumphs in the end, proving that reality isn't always that important.

She drags a hapless grocer through eight other-worldly recalculations of her bill. In desperation, he settles for less than she actually owes him. Aunt Wilma quits the field eventually, but she remains dissatisfied, convinced that she had more money coming.

Aunt Wilma would have fit well among the nation's leaders this year as they staggered through the federal budget process, leading up to October 16 when accounts were sequestered for automatic reduction. But that gets ahead of our story.

In theory, the government set out last January to develop a budget that held the federal deficit within a ten percent margin of $100 billion. That is the ceiling prescribed for 1990 by the Gramm-Rudman-Hollings deficit reduction act. If the process fails, the President must "sequester" (set aside) departmental budget authority and make up the difference with across-the-board reductions. By law, half the reduction comes from defense, although it expends less than thirty percent of the outlays.

Instead of work on the budget or the deficit, though, the ensuing ten months saw a struggle over numbers that everyone *pretends* are the budget and the deficit. The October 16 sequester order illustrates. Exempt from sequestration was $765.8 billion, or sixty-four percent of the outlays proposed for 1990.

The annual "budget" debate ignores entitlements and other mandatory spending. A huge share of federal spending is untouched by human control. Funds will be dispensed by preset procedures, no matter what the deficit is. There is—no joke—an *on-budget* budget and an *off-budget* budget.

The "deficit" isn't really the deficit, either. We have two estimates, $116.1 billion (from the Office of Management and Budget) and $141.3 (from the Congressional Budget Office). OMB was overly optimistic by $15 billion last year. CBO's number is regarded as the better of the two, but it does not count. The Supreme Court says that CBO, as an arm of the legislative branch, cannot steer the executive function of sequestration.

Both estimates are fudged. Alas, there is an *on-budget* deficit and an *off-budget* deficit. CBO, like OMB, credits the balance with a $65 billion "surplus" (in fact, the reserve against obligations coming due in the next century) from the Social Security trust fund. CBO pegs the on-budget deficit at $206 billion.

Naturally enough, it's the contrived estimate, not the actual deficit, that matters. If the projection is later found to be wrong, that's written off as history. All manner of accounting games can be played in this loophole. For example, the government "reduced" the 1990 "deficit" by shifting the October 1 military payday to September 29, thus allocating outlays of $2.1 billion to FY 1989.

The Administration and Congress also agreed to treat a large portion of the savings and loan bailout as off-budget. Otherwise, the argument went, it would swell the deficit and undermine the crusade for a balanced budget.

Gramm-Rudman was invoked when the "budget" process came a cropper. The law is mindless by design, distributing cuts evenly over the "discretionary" thirty-six percent of the spending. It does not notice that some reductions are particularly stupid. IRS tax collectors, for example, must absorb their fair share of the personnel layoffs, even if the revenue consequently not collected causes the deficit to rise.

OMB's $116.1 billion "deficit" projection that triggered sequestration is expressed in outlays. The reduction process, however, cancels budget authority. That makes a big difference in accounts that pay out slowly. To get its assigned share—$8.1 billion—of the $16.1 billion cut mandated in outlays, the Department of Defense will have to scrub $13.1 billion in budget authority.

October 16 came and went in relative calm. Congress passed a continuing resolution to keep the government operating. The unfortunate agencies caught in the sequester did not know what their budget authority would be for the fiscal year already begun, but they have been through this before.

Hardly anyone took the threat of automatic reductions seriously. Sooner or later, it was assumed, we would hit upon a different solution. But what is certain when all is unreal? It might be better, some said, to let the automatic "budget" reductions proceed and take the savings where you can get them. Under Gramm-Rudman, the 1991 "deficit" ceiling is $64 billion, and that's going to be tough.

Aunt Wilma may have been addled, but her transaction wound up within ten percent of the correct number. Who can say whether the government will do as well? ■

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McDonnell Douglas aircrew training is designed to polish the skills of U.S. aviators as bright as the wings they wear. The T45TS for the U.S. Navy will provide all elements of training—academics to aircraft. Our U.S. Air Force C-17 Aircrew Training System along with the Tanker Transport Training System we propose will lead to new levels of proficiency. McDonnell Douglas leadership in training will help maintain the tradition of excellence in U.S. military aviation into the next century while significantly reducing cost.

MCDONNELL DOUGLAS

Airmail

America's Next Crisis

With regard to your Editorial, "Unskilled and Unprepared," in the October 1989 issue *[p. 6]*:

As a former Air Force officer, a front-line educator, and a historian who shares your concern about our schools, I offer the following observations from an insider's perspective.

The new AFA study detailing the failure of America's schools is another in a long line of school-reform reports issued over the past eight years by business interests, private and public foundations, government agencies, and professional associations of scholar-educators in nearly every academic discipline. Each report has noted the mediocre performance of American students and warned of the consequences, and most have made recommendations of remarkable similarity: higher standards for promotion and graduation, a more rigorous curriculum, teachers better trained in their fields, increased class time, better books, and more.

Some of these reforms are taking place—mostly the cheapest ones. Graduation requirements have increased in most schools, and we seldom hear any longer the silly claim, once an accepted tenet of the school business, that no subject is more important than any other. On the other hand, there are strong local pressures to move kids along regardless of how much they know, and those who reach age seventeen or eighteen without prospect of graduation are likely to opt out in any case. There are no meaningful societal pressures to do otherwise for the shortsighted.

Some reforms are mired in the politics of price. Our normal 180-day school year is forty days shorter than that of most of the advanced nations, but there is no public outcry to pay for extending it. Textbooks are not a high-profit item for publishers, and their content is held hostage by regional bias in potentially controversial fields like history, biology, and literature; a book whose contents might inhibit sales in one large state will be edited until it can offend no one, resulting in vapid, innocuous, lifeless material of value to no one. Books are also "dumbed down" to be understandable by the least able readers in the age-group, again to make the books more marketable.

The central figure in any discussion of schooling has to be the teacher, and the sad fact is that the average teaching career in the US is about five years. In effect, our classes are led by apprentices. Many are very capable but inexperienced, and many of these are destined to move up or out to more lucrative positions at an early date. Good teaching is an art and is a function of insight and reflection on one's experiences. We need to attract a much larger proportion of our "best and brightest" to our classrooms and make it worth it to stay there. . . .

Sometimes we are our own worst enemy. One of the great successes of our schools since World War II has been in the education of women—raising their aspirations, providing solid training in technical fields previously almost exclusively male, encouraging their competitive drive in team sports, and the like. As a result, bright and high-achieving women—once the mainstay of intellectual leadership in our schools—are no longer drawn to the business in large numbers. Their gain has indisputably been the schools' loss.

I quite agree with the Pentagon that our educational deficiencies are the most serious problem facing the defense industrial base. This may be the worst problem facing our culture, period. I also agree that the solution is at the school and community levels, although some clear and measurable national goals and incentives for local schools to achieve them would help a lot.

In the largest sense, it is a question of the national will. Will Americans make the commitment to have schools on a par with the best? Will rebuilding our schools be a national priority like the interstate highway system of the 1950s or the manned-lunar missions of the 1960s? We spend money on our schools, but the proportion of our GNP so invested is not high compared to other countries. . . .

Just as important is the need for parents and children to see learning as the top priority of young people—more important than Little League, more important than having a job and a car, and more important than the short-term pleasures of youth most of the time.

Businesses and other employers—such as the Air Force—can help by allying closely with local schools and by encouraging employees to pay close attention to their children's progress. The media can help by making education front-page and prime-time stuff every day. Political leaders can help by publicly paying the same attention to education as to defense and the economy. The many school-reform reports make clear that the latter two are troubled because of inattention to the former.

We in the schools want to offer the best education in the world to our students, and I am confident we can. But our students have to be hungry for it, and that requires the enthusiastic support of American society. Lip service is not enough.

Dr. Jim Haas
Principal,
Pierson Jr. High School
Kansas City, Kan.

I am neither an educator, education-related specialist, nor one of a seemingly unlimited number of "experts" who continuously offer their opinions on the subject of edu-

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

cation in America. I am, however, a recent product of this educational system that has "failed the nation." I am a twenty-seven-year-old college graduate in a technical discipline, a former Air Force officer, and a current employee of a major defense firm. From firsthand experience, I do not believe the system has failed us. Rather, I believe our priorities have failed us. . . .

Pursuit of a technical career is akin to self-imposed oblivion. How many parents passionately push their kids to be number one in physics as well as sports? How many chemistry majors are voted most popular in school? When was the last time the mass media portrayed a bright, attractive young person signing a multimillion, multiyear contract to work in an engineering discipline? When was the last time a technical/engineering career field was ranked at or near the top of the highest-paying jobs in America?

Our young people may be technically "undereducated" in the eyes of some people, but they are certainly not stupid. They've been sold the message as to what is valued in our society, and they've bought it. Blaming the educational system is the easy way out. Faulting our own social value system and realigning it with the needs of tomorrow's increasingly technical economy is not so easy. But then, real change to fix real problems is never as easy to come by as scapegoats are.

Bryan L. Cordell
Bel Air, Md.

I certainly cannot disagree with [your October Editorial's] content. However, I have taught part-time at night for several years. My full-time job pays two to three times what I receive for teaching. For us to attract young, gifted people to teaching, they have got to be compensated better. The education system expects teachers to continue updating their education, but we, the taxpayers, vote reluctantly to increase our taxes to support education.

I have met many dedicated, underpaid teachers whom I admire greatly because they have forgone large salaries in private industry to teach.

I feel that the education system alone cannot solve this problem. It must be solved by you and me—the American people.

Stephen A. Wineteer
Bellevue, Neb.

In the Gallery

Jeffrey Rhodes did a marvelous piece on the warbirds from the Air Force past *[see "A Gallery of Classics," September 1989 issue, p. 102]*. It brought back many nostalgic memories, from the first moment I held a control stick in my hand to the last time my hand left the yoke.

However, he missed two very important aircraft that were used to train thousands of multiengine pilots: the AT-9 and AT-17. These twin-engine trainers were an essential transition from single engine to multiengine aircraft. We didn't all hop from the AT-6 into the B-17.

Lt. Col. Merritt E. Derr,
USAF (Ret.)
Barto, Pa.

On p. 128 [in "A Gallery of Classics"], you show a picture of a Genie being launched by an F-101B/F. Your accompanying write-up states, in part: "Primarily used on F-106s."

The Genie was primarily used on both the F-101B/F and F-106A/B. It was the *primary* armament for the F-101B/F, which carried two AIR-2As internally, whereas the F-106A/B carried one AIR-2A internally.

The Genie was ballistic. All guidance signals (produced by the Hughes Radar/Fire Control System) were generated to steer (pilot or autopilot) the interceptor to the desired launch position. At launch, the AIR-2A was ejected from the intercep-

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Airmail

tor, and the rocket motor ignited to propel the weapon on a ballistic trajectory.

Only the F-89 launched the Genie from a rail, which gave it greater accuracy over the F-101B/F and the F-106A/B.

Russ Johnson
Colorado Springs, Colo.

Global Airpower

Regarding "Global Power from American Shores" *[see October 1989 issue, p. 38]*, I was saddened to learn that the new doctrine for airpower is only a sales pitch for the B-2.

Airpower, you may be surprised to learn, also applies to operations based at sea. You seem to have missed the point made by the Commission on Integrated Long-Term Strategy that highlights the present sea-based alternatives to overseas bases. Unlike ships, shore bases overseas are costly, vulnerable, and often politically hamstrung.

Your claim that the Air Force needs all 132 B-2s or it won't be "able to cover all nuclear and nonnuclear contingencies in the threatening world" is the height of overstatement. Such inflated claims undermine serious arguments for continued development of a potentially vital technological capability—Stealth. Your discussion of the 1986 operations against Libya is an eloquent argument for the production of Stealth attack aircraft, such as the A-12, and for Stealth cruise missiles.

Such airpower aboard mobile bases near to potential targets has a real day-to-day deterrent effect, without the need to violate a nation's airspace to dump bags of flour from B-2s (your example) simply to prove our capability.

Cmdr. Jim Moseman,
USN
Springfield, Va.

I read James W. Canan's article "Global Power from American Shores" with great interest and found one key word missing—airlift. The ability to project airpower is not limited strictly to fighters and bombers. It must go hand-in-hand with the deployment of forces or support forces to ensure that offensive air operations are possible. As noted in the article, changes in the Soviet Union and the Eastern bloc will not diminish the threat but will increase the need to project national policy quickly and effectively. Offensive airpower is but one tool available to support national policy and may or may not be a viable option. Unless we consider and support airlift as an integral part of Air Force strategy, we may find we have limited our ability to support national policy.

Maj. David K. Barrett,
USAF
Scott AFB, Ill.

The recent article by Mr. Canan, "Global Power from American Shores," is riddled with poor judgment and continues the trend of us-vs.-them thinking that is only harmful to both the Air Force and the Navy.

The article is headlined, "A new doctrine is taking shape. . . ." Projecting power from the homefront is nothing new. Intercontinental bombers have been capable of that for years. So have carriers. Both have varying degrees of success and constraints. We probably need both, and discussion of one that totally eliminates the other is, on or off the merits of the argument, not going to happen in the next forty years. There are too many vested interests and good arguments for both. In the days of declining budgets, it is unreasonable for leaders of either the Air Force or the Navy to attempt to keep their share of the defense budget expanding, or at the same level, by trying to monopolize a particular job.

I recognize General Boyd's concern for the Soviet threat. Both in quantitative and qualitative terms, the Soviet threat is changing. If these changes are not "substantive," then neither is a change from the B-52 to the B-1. . . .

Mr. Canan states, "Air Force leaders past and present insist that the US needs all, or nearly all, of the 132 B-2s originally planned and that a lesser force will not be able to cover all nuclear and nonnuclear contingencies in the threatening world ahead." Once again, we are seeing not a new thing, but the old attempt to provide the ultimate solution to all problems. US leaders were told after World War II that all wars would be nuclear and that the B-36 would answer all problems. At least something has been learned—that not all responses will be quite so drastic. But why is the intercontinental bomber still the only answer? Once again, the price of being wrong could be seen in lives lost on the battlefield or in the sky.

Sending bombers over target with sacks of flour? Late-night dreamers have thought of wonder weapons that could be used with impunity, but the reality of war, brought home in battle [in] Vietnam, Grenada, Lebanon,

The Best Deserve The Best

Stable TTTS Flight Starts On The Ground

Before they ever climb into an aircraft cockpit, undergraduate student pilots in the Tanker Transport Training System (TTTS) will spend hours in the classroom, at computer-based training terminals, and in flight simulators. To be successful in the air, their ground-based curriculum and training equipment must be comprehensive and of the highest quality.

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Clearly, there is no TTTS candidate team or aircraft with more experience or greater capabilities. And the new General Dynamics Flight Training Systems Division is totally dedicated to focusing those capabilities on a low-cost, low-risk, fully integrated TTTS program.

GENERAL DYNAMICS
Flight Training Systems Division

Libya, Iran, and Colombia, shows that men die, no matter how good the plan.

It fascinates me that articles that start out talking about sending bombers from Peoria to Timbuktu and coming home always end up mentioning foreign bases as support structures and dirt strips. Diego Garcia and "austere fields" are not part of the fifty states, and we have no way of ensuring we'll have them when we need them.

The old argument about carriers said they couldn't withstand nuclear attacks. The new one seems to be about missiles and torpedos. Are bombers suddenly invulnerable? What happened to the idea that for every offensive weapon there is a counter? You may applaud Navy operators and their "recent success under fire," [but] Colonel Turner, who speaks of "a new reliance on the Air Force as the most important contributor to national defense," sounds like a cheerleader. . . . This is not responsible, reasoned military analysis. . . .

A 10,000-mile bombing mission is simply not realistic in cockpits that are not supersonic and have no bunk space. Safety and success demand shorter missions. Perhaps the FB-111 that was lost in the Eldorado Canyon mission would have returned safely if its flight had not been so long. That mission was approximately one half of the length you speak of. God bless the Air Force. I am glad you handle so much of the SIOP. Please, don't pretend you can do it all—nonnuclear, nuclear, and with impunity. Not even the Navy can.

Lt. Stephen E. Rollins,
USN
NAS Lemoore, Calif.

A Sad Mindset

The banter between Lt. Barrett Craig, USN, and several USAF flyers *[see "Airmail," July 1989 and September 1989 issues]* has been interesting.

But one phrase in one response betrays a sad mindset: Maj. Buzz Bannister's referring to the wayward Lieutenant Craig, an A-6E bombardier/navigator, as "a passenger." Since when is a crew member a passenger? Most USAF planes carry a WSO, an EWO, a navigator, or a flight engineer. I'm fairly certain none of these flyers considers himself a passenger. F-111 pilots speak proudly of the job their WSOs do, enabling the pilots to concentrate on flying the jet. RC-135 pilots don't want to do their mission without the navigator's skills. A B-52 can't perform its mission without several nonpilots on board. Passengers can sleep or watch the in-flight movie; crew members can't.

The bottom line is that it takes more than pilots to put airplanes or astronauts in the sky. But then I suppose the pilot-vs.-nonpilot war will rage as long as the pilot bonus-vs.-patriotism battle goes on, if not as long as we continue to play the Air Force-vs.-Navy game.

Capt. James M. Pfaff,
USAF
North Pole, Alaska

Enlisted in Limbo

Lieutenant Colonel Lyle's letter regarding "Enlisted Pilots" *[by Bruce Callander, June 1989 issue, p. 98]* in the September 1989 issue *[see "Airmail," p. 9]* is interesting. However, he seems a bit pejorative in his references to the cadets. It is hard to agree with him that the volunteers were draft dodgers, especially those who volunteered for such essentially dangerous training as learning to fly. Further, regarding his reference to enlisted men, I am sure the colonel knows that an imposing number of cadet appointments were made from among prior-service people in enlisted status. It is just unfortunate that some of a highly qualified group of men were caught in the wringer.

It is interesting to note that nowhere in this correspondence generated by Mr. Callander's article is there any mention of the first cadets to graduate from navigator training, who, after receiving their wings, found themselves in limbo. Since there was not yet any official recognition of their status, they were neither commissioned nor enlisted, but served in a simulated rank of cadet on active duty. They ranked somewhere between a master sergeant and a second lieutenant, and no one knew whether to salute them or run them off the flight line! Not even flight pay could be drawn until Congress resolved the snarl—a process that took some time. And the sergeant pilots thought they had it bad!

Maj. Arthur Ross,
USAF (Ret.)
Boynton Beach, Fla.

Have Gun, Will Travel

I would like to comment on Herb Cook's letter on "Navy Designations," in which he offers some corrections to the July article "Back into Harm's Way" *[see "Airmail," September 1989 issue, p. 9]* but also makes some further errors. VA-105, based in Cecil, Fla., is indeed named the "Gunslingers." This is reflected in their insignia showing the knight chesspiece (remember the TV hero "Paladin"?) in a chevron. The name "Gladiators" applies to VFA-106—also at Cecil—serving as the Atlantic Fleet F/A-18 replacement squadron. Interestingly, there is a VFA-131 ("Wildcats"); while it's not technically a fighter outfit, it comes pretty close with F/A-18 Hornets.

Frank Mirande
Smyrna, Ga.

SAC's Eldership

The September issue of your magazine was a treat for me. It featured crew S-01, 441st Bombardment Squadron, 320th Bombardment Wing, as Crew of the Year (I've flown with them), and your "Aerospace World" column mentions the retirement of SAC's oldest active bomber, the B-52G "Eldership."

However, you list the serial number of said aircraft as 58-0232. The correct serial number is 57-6468. I have firsthand knowledge of this, since I've flown in both aircraft.

I was one of the last gunners to depart from the recently inactivated 320th Bombardment Wing, Mather AFB, Calif. Just wanted to set the record straight.

SSgt. Carlos D. Cisneros,
USAF
Fairchild AFB, Wash.

Don't Try This at Home

The cover of your October issue is stunning—as attention-getting as any you've published in a long time. One has to look several times to determine that it is an illustration and not a photograph, and therein lies what we perceive to be a problem. While it is very attractive and visually dramatic, the picture does not accurately depict how we operate. We don't fly aircraft that low except during takeoff and landing. It's not smart, it's not a good tactic, it implies terrain-following capability that is probably well beyond the structural and aerodynamic capability of the aircraft, and we prefer that your [readers] not be misled into thinking it is a tactic we employ. We . . . want to get and keep people's interest, but we also want to ensure that incorrect signals aren't sent that could serve to undermine the . . . mission risk-awareness that we are trying so hard to instill.

Brig. Gen. James M. Johnston,
USAF
Director, Aerospace Safety
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Norton AFB, Calif.

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Point Man for Space

By James W. Canan, SENIOR EDITOR

The Air Force, having made its strongest-ever commitment to space, has now appointed its first-ever Assistant Secretary for Space. Tall tasks lie ahead for him.

Washington, D. C. One year ago this month, the Air Force made its strongest-ever commitment to space. On December 2, 1988, its leaders issued a new policy that put spacepower on a par with airpower. Starring roles were envisioned for the Air Force in space and for space in the Air Force.

Now the Air Force has a point man for putting that policy into practice. He is Martin C. Faga, the first Assistant Secretary of the Air Force for Space.

Mr. Faga has a tall order: "to ensure that the Air Force integrates space throughout its structure and to prepare for the evolution of spacepower from combat support to the full spectrum of military capabilities."

Thus did Secretary of the Air Force Donald B. Rice define the purpose of USAF's new space-leadership post in announcing its creation last October. Dr. Rice called his move "consistent with Air Force policy that space is intrinsic to the future of the Air Force, and that spacepower will assume as decisive a role in future combat operations as airpower has today."

Mr. Faga says "Amen" to that. He believes that USAF should lay claim to space as a warfighting arena and develop combat capabilities to back up that claim.

He asserts, "We need to advance our role in space, recognizing that there will always be individual space systems that the other services will be building for themselves. All the services need satellite systems to conduct unique operations.

"But that's different from having combat capability in space and being responsible for military activity in space, which is a role that I expect the Air Force to seek, organize for, and attain.

"We need to be *the* aerospace service. We need to move now to accomplish that—not in the sense of grabbing off the role, but by forming the infrastructure and planning the strategy to build the role."

Air Force space advocates in blue suits and in mufti hailed the establishment of the space-oriented post in the upper echelons of USAF's civilian hierarchy. They saw it as evidence that Secretary Rice is picking up on space where his predecessor, Edward C. "Pete" Aldridge, Jr., left off.

As Air Force Secretary, Mr. Aldridge consistently championed space operations. He and Gen. Larry D. Welch, Air Force Chief of Staff, wrote the new Air Force space policy that went into effect a year ago.

Mr. Faga will call the shots on space within the Air Force and for the Air Force in such arenas as Capitol Hill, the Defense Department, and the intelligence community. An electrical engineer, he has long experience in the technical and techno-policy circles of all those arenas. His feel for them should serve him well in the battles over space strategies, priorities, programs, and politics that surely lie ahead.

Mr. Faga seems in good shape to answer the bell. His brief, as articulated by Secretary Rice, is nothing less than "the overall supervision of Air Force space and space-related matters, with primary emphasis on policy, strategy, and planning."

There's more. The Air Force Secretary made it clear that Mr. Faga is now his "principal advisor on space matters" and his special agent. He has instructed Mr. Faga to see to it that Air Force space systems "are responsive to the needs of all operational services," and to form "close, cooperative relationships with the Army, the Navy, and other Department of Defense and non-DoD organizations [such as the National Aeronautics and Space Administration] with space-related responsibilities."

Mr. Faga does not have carte blanche. There are things he cannot do, such as horn in on programs that are properly the purview of the Assistant Secretary of the Air Force for Acquisition, Jack Welch, and of Maj. Gen. Thomas S. Moorman, Jr., the acquisition shop's Director of Space and Strategic Defense Initiative (SDI) programs.

Nonetheless, Mr. Faga has leverage in programming and budgeting by virtue of his mandate to collaborate with Air Force acquisition and financial executives. He is responsible for forging space budgets acceptable to all and for ensuring "an internally consistent and balanced space program."

Mr. Faga also serves on the Air Force Council, a heavyweight organization of top uniformed and civilian leaders that holds sway on all manner of high-priority matters. He enjoys direct access to USAF's uniformed leadership, too, thanks to what may be the most sweeping line in his charter.

It empowers him to "advise the Secretary and the Chief of Staff on space policies, plans, programs, budgets, and operations," which pretty much says it all.

"One of the things I like about having a title that specifies 'space' is that I can be completely up front about what I'm doing," Mr. Faga says. "Everybody understands where I'm coming from. I'm the space guy; I'm here for one thing—to represent space. I'm free to be its all-out advocate."

He has no illusions that space priorities and programs will always win or hold their own in competition with others more obviously oriented to airpower. "It will be interesting, taking part in [Air Force] Council meetings and other forums where C-17s, B-2s, ATFs, and the like are being discussed. I'll have to learn, but I'll need to play heavily in those discussions representing space.

"There is a lot of education about space that needs to go on inside the Air Force, and this is perfectly natural. People who have been flying bombers and fighters sometimes don't know all that much about space.

"But I find that many of them get very interested, even excited, when they learn what it's all about and what it can do for the Air Force and for military operations in general. Many senior officers with no current duties involving space are more and more attentive to space and recognize that it is now a big part of the Air Force.

"It is important for me to build on that recognition. I'm not talking about long-term planning for space as just a support service, with communications and weather and navigation data, for example, coming from satellites.

"I'm talking about planning for space control and for applying military force in space."

Mindful of moves to "demilitarize" space, such as the opposition to deploying space-based weapons planned in the SDI program and the congressional ban on further US testing of antisatellite weapons, Mr. Faga says he expects little or no slackening of the "great resistance to military capability in space of whatever sort" now evident in political and popular circles.

"But I believe that military force moves into any arena where technology permits it to go—in the form of airplanes, submarines, and now spacecraft," he declares. "That's not to say that I don't also believe in the arms-limitation process and in the attempts to build strategic stability through negotiation."

Mr. Faga emphasizes that the US should be capable of doing battle in space and that the Air Force, as the designated "aerospace service," should carry out that mission.

He describes the issue of military activity in space as "politically charged" and predicts that it will engender "a very difficult national debate, in Congress and in the public, over the next five years.

"It's the right debate to have," Mr. Faga continues, "and I expect that the going will be difficult for me on the Hill. Secretary Rice recognizes that putting 'space' behind my title is sure to draw fire."

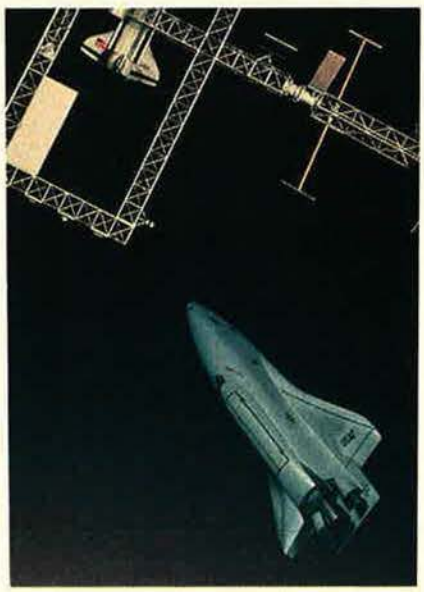
Mr. Faga is no Johnny-come-lately to political debate or to space issues. A Capitol Hill veteran, he joined the staff of the House Permanent Select Committee on Intelligence more than twelve years ago and has headed its Program and Budget Authorization Subcommittee staff since 1984. Among other things, he was responsible for the oversight of "technical collection" programs by means of classified systems based in space.

He has the advantage of hands-on experience with such programs. From 1972 to 1977, he was an engineer in the CIA's Office of Development and Engineering, working on "advanced systems for intelligence collection by technical means."

Mr. Faga is in no position to comment on those experiences or on spaceborne intelligence systems that were in play, or being developed, during his years in the intelligence community. Nor can he comment on reports that he now represents the Air Force in overseeing the deployments and operations of such systems, along with counterparts from the intelligence world.

Sensors and such have been the stuff of Mr. Faga's career. A native of Bethlehem, Pa., he earned bachelor's and master's degrees in electrical engineering at Lehigh University. He served in the Air Force in the 1960s as a research and development officer, specializing in infrared and laser technologies for reconnaissance systems. He worked on seismic and magnetic sensors at MITRE Corp. before joining the CIA in 1972.

Mr. Faga's congressional experience should prove valuable at the Pentagon quite apart from the technical, legislative, and political insights that he gained from it. He earned a reputation on Capitol Hill for good work and good sense, and he rubbed elbows with more than a few members of Congress who make a difference.



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"We need to be *the* aerospace service. We need to move now to accomplish that . . . by forming the infrastructure and planning the strategy to build the role."

One was Rep. Richard Cheney of Wyoming, a member of the House Intelligence Committee, who showed a keen interest in space.

Mr. Cheney became Secretary of Defense last March and was joined at the Pentagon in May by Dr. Rice, who had headed the RAND Corp. Almost at once, the two leaders began conferring on space plans and policy. Dr. Rice made it clear that he intended to strengthen the Air Force's commitment to space.

His first move in this regard was to reorganize his shop to sharpen its focus on space. He had inherited a secretariat in which space elements were scattered. They were being handled, in isolation or duplication, by several offices, such as those of the Assistant to the Secretary for Space Policy and the Military Assistant to the Secretary.

With Mr. Cheney's approval, Secretary Rice created the position of Assistant Secretary for Space and consolidated all space responsibilities in it. Mr. Cheney then recommended Mr. Faga's appointment to it, and President Bush followed through.

General Welch was in the picture throughout. He is said to have encouraged Secretary Rice to create Mr. Faga's post.

"The Chief of Staff has been most supportive," Mr. Faga declares. "He stands solidly behind the space policy that he and Mr. Aldridge signed late last year. He approves of this as the way to bring focus to organizing, training, and equipping the Air Force for space."

Technically, the military departments are restricted to doing just that—organizing, training, and equipping forces. They are not empowered to run the combat operations of those forces. That responsibility falls to the commanders in chief of the unified or specified warfighting commands, such as US Space Command and US European Command.

Mr. Faga acknowledges this distinction, but sees "no conflict between the proper role of the Air Force and the purposes of the Air Force in space." Referring to the CINC of US Space Command, Air Force Gen. John L. Piotrowski, Mr. Faga says, "most of the capabilities that he needs as an operational commander have got to be developed here, in the Air Force, and my job is to build support for that.

"But there will be more and more military activity in space, and I believe

that the Air Force should assert combat capability in space as an Air Force mission. We need to prepare to be the service that operates in space."

There is increasing evidence that the uniformed Air Force leadership is bent on doing so. For example, USAF's basic doctrine is being revised to put more emphasis on projecting airpower around the world from bases in the United States and to take advantage of space and space systems in the process.

The officer in charge of the doctrine's updating, Maj. Gen. Charles G. "Chuck" Boyd, USAF's Director of Plans, declares, "We can't think of the future without thinking about space, about the kinds of aerospace power that will be required. Most, if not all, of the missions that we perform in the atmosphere today we will be able to perform from space.

"We should not turn to performing them from space just to be able to say we can. However, as technologies evolve, and if they make it possible for us to do our missions more effectively and at less cost from space, then we must do so, whether those missions be close air support, interdiction, offensive counterair, defensive counterair, or whatever."

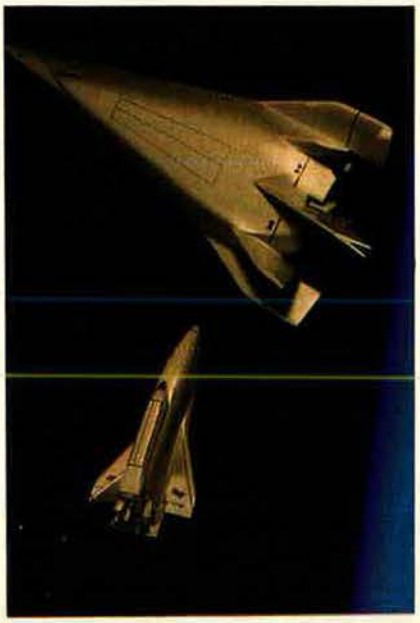
The Air Force/NASA National Aerospace Plane (NASP) program is seen as the seedbed of those technologies. It is aimed at developing a family of hypersonic aircraft/spacecraft that could vault into space from ordinary runways and perform a wide variety of combat missions.

The NASP program has been stretched to cut its costs in the short term and reduce its technical risks over the long term. Mr. Faga thinks this makes good sense.

"I talked to Dr. Rice a good bit about NASP before I came aboard," he says. "We agreed that the Air Force needs to be working on things that will affect it fifteen or twenty years into the future. But we also agreed that we don't know now—and don't need to know now—what some of these technologies will lead to.

"We know we have to be in scramjets, hypervelocity vehicles, advanced aerospace materials and structures, and advanced avionics control systems—all part of NASP. We've pushed those technologies, and we welcome and need the focus that the NASP program provides for them. But we shouldn't set specific goals for the program just yet. For example, we don't know at the moment whether a single-stage-to-orbit machine is going to make any sense.

"Almost anything we can imagine in space, we'll eventually see there . . . we must begin discussing and planning the time frame in which we'll see it."



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"We do know that all sorts of new things become possible as technology evolves, and this will be the case in space. Technology will offer new capabilities and lead to new requirements there."

Mr. Faga sees tough force-structure decisions awaiting USAF in future years as space systems and operations continue to increase in importance. To make the best use of its resources, the Air Force may someday have to choose between combat space wings and combat air wings, for example, in deciding how best to deploy both, or either, in applying "aerospace power."

"I see it coming," Mr. Faga says. "It will happen long after my time, but it's something we have to start planning for now. There's a lot of work to be done on the question of the Air Force's role in space, and on fitting that into the larger question, which is being asked at the OSD [Office of the Secretary of Defense] level, about the role of the military in space.

"We need to begin organizing for that. Among other things, we need to build a more responsive, less expensive infrastructure for operational space launches, which is one of the major needs that General Piotrowski emphasizes."

This need is the reason that the Air Force has tied a big blue ribbon on the Advanced Launch System (ALS) program, in which NASA is its partner. The overarching purpose of the program is to develop next-generation technologies for a new family of booster rockets. Mr. Faga calls ALS "an umbrella program for the kind of improvements that we need for quicker response on launchpads and for much lower costs per launch."

The space-launch demands projected for SDI systems in the 1990s figured heavily in the decision to embark on ALS. Some SDI systems would need to ride into space atop heavy-lift boosters such as those expected to emerge from ALS. But the Air Force needs ALS quite apart from its connection with SDI and would continue to pursue it with might and main should SDI falter.

"Heavy lift may be one reason for ALS, but there are dozens of others that have nothing to do with heavy lift," Mr. Faga declares.

The SDI program is developing several technologies and systems that the Air Force covets for future space operations, including satellites to detect and target enemy ICBMs in air and space. USAF needs less-complicated variants of such satellites for early-warning and space-surveillance purposes and is prepared to take over their development if SDI goes away.

The Air Force would also like to have an antisatellite weapon for intercepting hostile spacecraft, notably the Soviet radar satellites that would be used in wartime to target US naval forces. All the services are developing ASATs of different kinds. Congress is leery of them, and their future is uncertain.

To the Air Force, though, one thing is sure about ASATs. USAF will insist on being in charge of their battle management and command control and communications, no matter which service develops and deploys them.

This bullish approach to ASATs is in accord with USAF's newfound assertiveness on space and on its role in space, as personified by Mr. Faga.

Says he: "I believe that we must begin organizing for operations of military man in space and start looking ahead to when we'll reach that point. I also believe that almost anything we can imagine in space, we'll eventually see there, and that we must begin discussing and planning the time frame in which we'll see it." ■

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The Chart Page

Edited by **Colleen A. Nash,** ASSOCIATE EDITOR

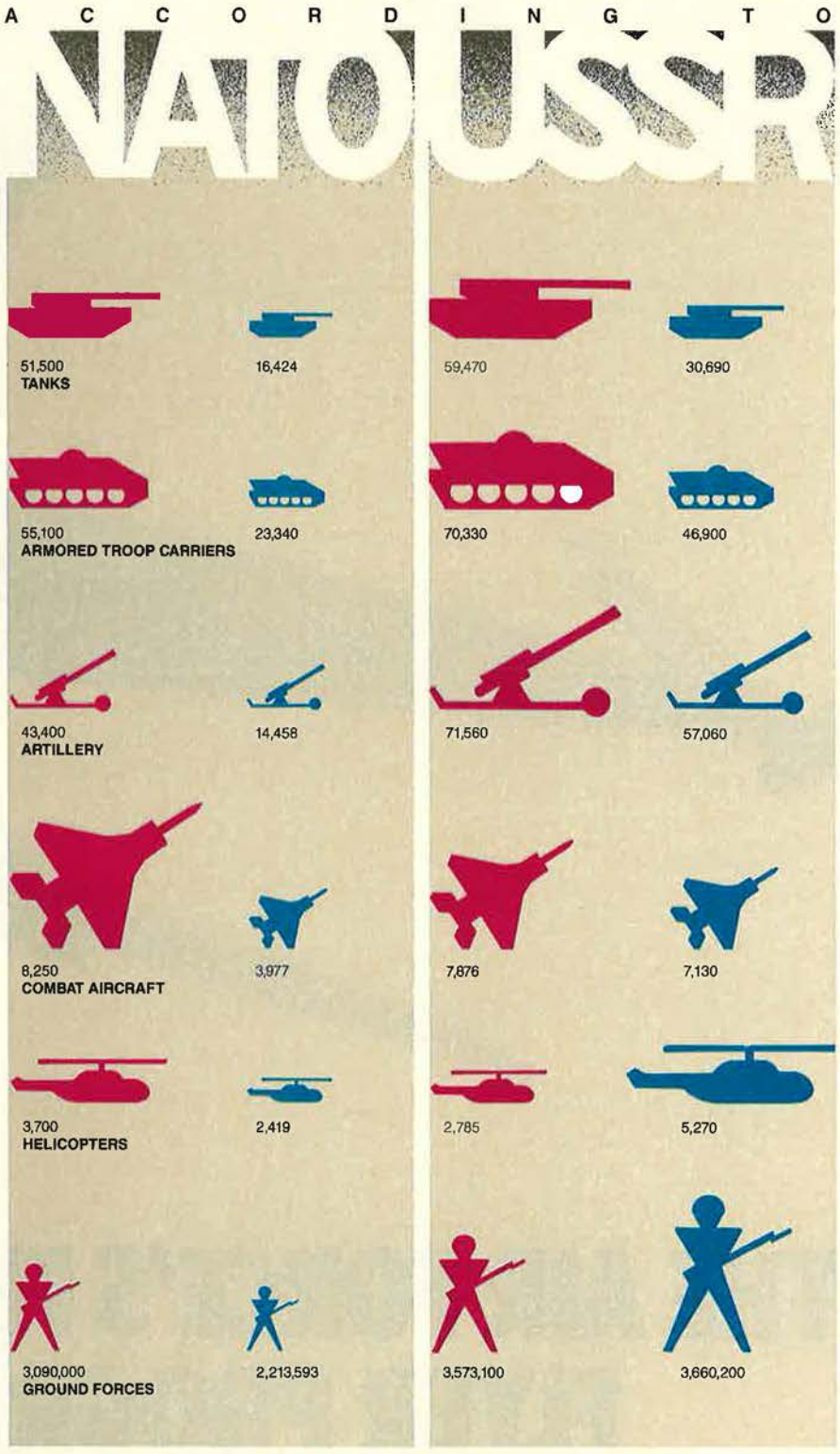
We Say/They Say

(Military Force Levels in Europe)

NATO **Warsaw Pact**

You could arrive at radically different conclusions about the conventional force balance in Europe, depending on whose numbers you consulted. NATO's version of the count, published in November 1988 and May 1989, is far different from the Soviet Union's count, published in January 1989. Even allowing for differences in counting procedures—such as how to account for equipment in storage—everybody agrees that the Warsaw Pact outnumbers NATO considerably in most combat force categories. The discrepancy in force counts, however, is a major obstacle that must be dealt with before the Conventional Armed Forces in Europe (CAFE) talks can get down to discussions about cuts.

Source: US Department of Defense, *Soviet Military Power 1989.*



THE AIR FORCE'S FREQUENT FLYER PROGRAM.

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GENERAL DYNAMICS

Capitol Hill

By Brian Green, CONGRESSIONAL EDITOR

Washington, D. C.

Conference Breakthrough

House and Senate negotiators concluded work on a $305.5 billion Fiscal Year 1990 defense authorization bill that includes:

- Procurement of two B-2 Stealth bombers and $4.3 billion for the B-2 program. The Administration requested three bombers and $4.7 billion; the Senate had cut $300 million, the House $1 billion.
- An across-the-board cut of $150 million from ICBM modernization. A statutory cap of fifty deployed Peacekeepers was adopted. The conferees left to the Administration the task of assigning priority to the rail-garrison Peacekeeper and the Small ICBM. The House had cut Peacekeeper by $500 million and terminated the Small ICBM; the Senate approved both.
- SDI funding of $3.8 billion. The Administration requested $4.9 billion, the House approved $3.1 billion, and the Senate approved $4.6 billion. SDI was cut seven percent compared to FY 1989, its first reduction ever.
- A $200 million reduction to the Advanced Tactical Fighter program. USAF believes that full funding is needed to keep the program on track.
- Procurement of four aircraft and $2.4 billion for the C-17 program. Six aircraft and $2.9 billion were sought.
- Additional funding for V-22 tilt-rotor transport R&D ($255 million) and new Navy F-14D fighters (eighteen planes). The Administration sought to terminate both programs.
- Unrequested drug interdiction funding of $450 million.

The FY 1990 defense appropriations conference had not begun by early November. Differences between the House and Senate appropriations bills were even greater than those between the authorization bills *[see "Capitol Hill," November 1989, p. 20].*

Catastrophic Cap Surtax Repealed

The Senate voted 99–0 to support the proposal of Sen. John McCain (R-Ariz.) to repeal the surtax that funded the benefits of the Catastrophic Coverage Act of 1988 (known as CatCap). This came two days after the House voted 360–66 to repeal the entire act. The votes reflected bitter opposition to the surtax by many military and civilian retirees.

The House amendment to repeal the 1988 Act is part of the House budget reconciliation bill. The Senate's repeal of the surtax was passed as a freestanding bill. The two chambers will now have to reconcile the differences between the two measures.

The Senate bill repealed only the surtax and its associated benefits. These benefits include payment for most prescription drugs, skilled-nursing facility care added by CatCap to earlier Medicare coverage, and other out-of-pocket expenses not covered by Medicare Part-B. The existing Part-B premium—$4.00 a month, rising to $10.20 a month in 1993—would pay for all of the retained benefits. The benefits retained in the Senate bill include long-term hospitalization protection, protection against impoverishment of spouse, home health care, respite care, and hospice care. Coverage to take effect in 1991 for mammography screening and outpatient intravenous and immunosuppressive drugs would also be retained. The Part-B premium could be reduced if, as expected, premium income exceeds benefit costs.

Sequestration—Maybe

The House and Senate reconciliation bills—bills that adjust expected government revenue and expenditures to meet the deficit limit—remained deadlocked in conference as well. Key issues in the conference included CatCap repeal (see above) and capital gains tax reductions, both in the House bill but not the Senate version. Sequestration—automatic budget cuts that reduce virtually all defense and discretionary domestic programs across-the-board by a uniform percentage—was triggered because the October 16 deadline was missed.

If left unchallenged for the course of the year, the sequestration would have a major impact on DoD and the Air Force. The federal deficit projected by the President's Office of Management and Budget (OMB) is $116 billion, and the legal deficit limit is $100 billion. The sequestration order would reduce the deficit by $16.1 billion and the defense budget by $8.1 billion in outlays. That would mean a cut of $13.3 billion in budget authority (BA) and a defense budget considerably lower than last year's, probably around $290 billion (although the experts aren't clear on just what the final figure would be). The White House and Congress agreed earlier this year on $305.5 billion in BA for defense. In inflation-adjusted terms, the defense budget could decrease by seven to ten percent compared to last year.

The sequestration order can be reversed through final passage of a budget reconcilation bill that contains a provision rescinding the sequestration. Director of OMB Richard Darman, however, opposed rescinding the sequestration order. That may indicate that the White House is less willing to compromise with Congress.

Bleak Outlook?

The long-term outlook for strategic modernization is uncertain, no matter how Congress resolves outstanding program issues this year. Some Capitol Hill observers argue that a "strange bedfellows" coalition that started to form earlier this year may become a force again. Conservative Republicans, whose support for the B-2 and Small ICBM was conditional on Administration support for SDI, have been upset by what they see as the Administration's failure to uphold its end of the bargain. Following this line of thought, they would join with liberal Democrats to cut funding for or to kill the B-2 and Small ICBM. Rail-garrison Peacekeeper would then fall because the liberal-to-moderate Democratic vote, whose support for rail-garrison basing was conditional on the continued development of the SICBM, would refuse to support the program. Finally, the argument goes, SDI would falter due to lack of support from the Administration and in the House. ■

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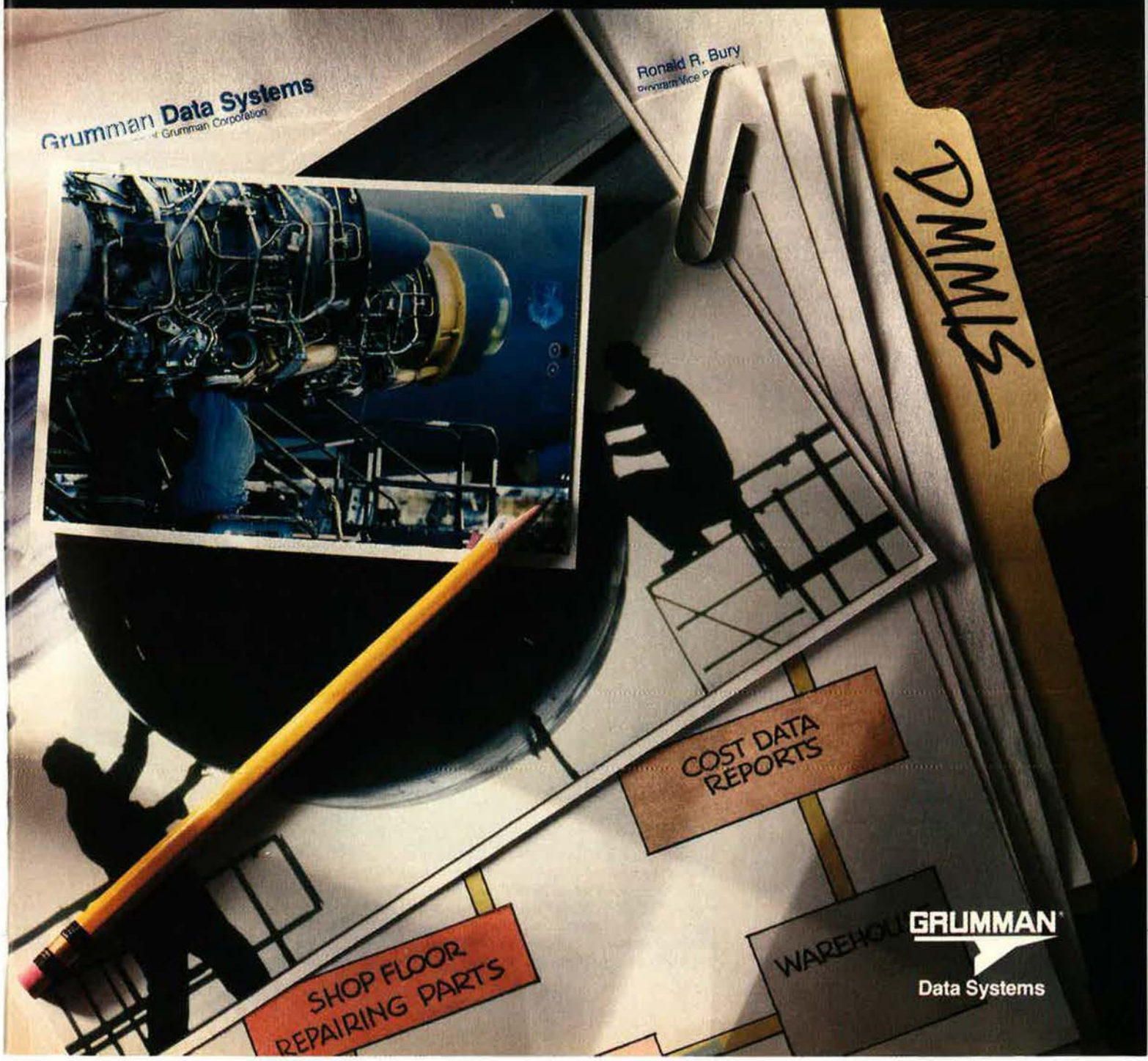

Aerospace World

By Jeffrey P. Rhodes, AERONAUTICS EDITOR

Washington, D. C.

★ Adequate preparation prevented any serious injuries or fatalities to military personnel, but Hurricane Hugo did extensive damage to military facilities in South Carolina when it hit the state shortly after midnight on September 22. Facilities in Charleston were hardest hit, as more than $37 million worth of damage was done at the Air Force base, and damages totaling at least $250 million (which could reach $600 million) were reported at the Navy base and shipyard.

Fifty-five of Charleston AFB's fifty-eight assigned C-141Bs were flown out the day before the storm hit. The three remaining StarLifters were down for maintenance, and two of the aircraft were put in the hangar formerly used to house C-5s. Hugo removed half of the hangar's roof and did major structural damage to the building. The C-141s were unharmed, but the hangar doors had to be cut open and partially removed to free the aircraft after the storm.

The gravel used as a roofing material on an adjacent building became a swarm of projectiles in the winds that gusted up to 170 mph, and the rocks shattered almost all of the windows in the 437th Military Airlift Wing's headquarters building. Roofs were blown off both the Consolidated Base Personnel Office and the NCO Club, and catastrophic damage was done to one end of the supply squadron's building. Of 997 housing units, only four were uninhabitable, but more than ninety-five percent of the housing was damaged in some way.

Crews had the runway cleared by 10:00 a.m. the next day, and restricted routine flying missions began on September 28th. Eighty percent of the base regained power by October 6. The strangest occurrence during the storm involved a 101,165-pound C-124 Globemaster II displayed at the base's airpark. The aircraft, held by anchor cables to a concrete base, was lifted (there were no tire marks on the ground) and turned 180 degrees. The C-124's horizontal stabilizer suffered major damage.

At the Charleston Navy base, eighteen vessels put to sea the day before Hugo hit, but fourteen ships undergoing overhaul had to stay in the yard. Several smaller ships (such as ocean-going minesweepers) were taken upriver and secured, but a couple of the remaining vessels suffered significant damage.

One vessel that could have suffered significant damage but didn't was the nuclear-powered fast-attack submarine USS *Narwhal* (SSN-671). The sub had power but was undergoing a refueling overhaul and was immobilized. All but the stern mooring line broke as the storm passed overhead, and the boat's skipper, Cmdr. Daniel Whitford, and his partial crew of forty found themselves adrift in the middle of the Cooper River.

As the eye of the storm passed overhead, Navy tugs tried to push the submarine back to the pier, but this could not be done before the rest of the storm hit. Under a plan developed three days earlier, Commander Whitford exercised the only option he had left: He submerged. Keeping ten feet of water under the keel, the crew rode out the remainder of the storm.

Nearly every structure at the base suffered damage. Ninety-two percent of the 2,675 housing units were damaged, and thirty-eight were uninhabitable. Several days after the hurricane hit, the Charleston area received two to three inches of rain, and after that downpour, 125 houses were uninhabitable because there had not been time to repair the roof damage.

The storm skirted westward after it touched land, and Myrtle Beach AFB escaped with only minor damage and loss of power. However, Shaw AFB, located near Sumter, lost power, and a number of its buildings were heavily damaged. Three housing units had their roofs blown off, and the base suffered two water-main breaks and a gas leak.

A number of other US bases, including Little Rock AFB, Ark., Dover AFB, Del., Pope AFB, N. C., and Tyndall AFB and Hurlburt Field in Florida,

—Photo by Paul Jackson

The latest version of the Soviet Hind attack helicopter made its Western debut at the Helitech Exposition in Redhill, England, in September. This example, billed as an export "Mi-35P," features a twin-barrel 30-mm cannon on the starboard side of the nose, four underwing pods carrying twenty 80-mm rockets each, and four AT-6 Spiral antitank missiles. The twin-engine helicopter was shown without its infrared protection equipment, which includes a jammer and exhaust deflectors.

detailed engineers or supplies to Charleston to help in the recovery effort. As a footnote, 437th MAW C-141s were flown to NAS Moffett Field, Calif., with three tons of disaster-relief equipment in the aftermath of the earthquake that hit the San Francisco area on October 17.

★ In response to an October 6 article in the Washington *Post* crediting the Northrop B-2 Stealth bomber with less range than the Rockwell B-1B has, the Air Force released declassified figures on October 16 that show the B-2 has twenty to twenty-seven percent better range than its predecessor with a similar bomb load.

The Air Force figures compare the B-2, with a projected fuel load in excess of 160,000 pounds, to the B-1B with the extra bomb bay fuel tank installed (214,600 pounds of fuel) and a B-1 without the tank (196,600 pounds of fuel). Two typical Single Integrated Operational Plan (the nation's nuclear warplan) weapons loads were compared over three typical flight profiles.

The first load consists of eight AGM-69A Short-Range Attack Missiles (SRAMs) and eight B83 (twenty to 150 kiloton yield) free-fall nuclear bombs, which have a combined weight of 37,300 pounds. The second load consists of eight SRAMs and eight B61 (ten to 150 kiloton yield) free-fall bombs, which have a combined weight of 24,000 pounds.

The profiles consisted of a high-altitude unrefueled mission, a high-low-high-altitude unrefueled mission with 1,000 miles flown at low altitude, and a high-low-high-altitude unrefueled mission with minimum possible distance flown at low altitude.

Here are the comparisons: With the first weapons load, the B-2 has a range of 6,300 nm on Profile 1, 4,400 nm on Profile 2, and 5,300 nm on Profile 3. With the second load, the B-2 has a range of 6,600 nm on Profile 1, 4,500 nm on Profile 2, and 5,400 nm on Profile 3.

With the bomb bay tank installed, the B-1B's ranges with the first weapons load are 5,500 nm on Profile 1, 4,000 nm on Profile 2, and 4,680 nm on Profile 3. With the second weapons load, the numbers for the B-1 are 5,600 nm on Profile 1, 4,200 nm on Profile 2, and 4,740 nm on Profile 3.

Without the extra fuel tank, the B-1B's ranges with the first weapons load are 5,070 nm on Profile 1, 3,570 nm on Profile 2, and 4,500 nm on Profile 3. With the second weapons load, the B-1's numbers are 5,200 nm on Profile 1, 3,770 nm on Profile 2, and 4,560 nm on Profile 3.

This artist's concept shows the Galileo Jupiter probe atop its Air Force-developed Inertial Upper Stage after it was released from the space shuttle Atlantis on the recent STS-34 mission. Air Force crews aboard the 4950th Test Wing's EC-135N aircraft provided telemetry data during the launch.

★ National Aeronautics and Space Administration officials had to overcome three major hurdles prior to the successful launch of the STS-34 space shuttle mission in mid-October. The first obstacle, a lawsuit, was a new one for the space program. The second involved a faulty engine computer, and the third hurdle was a familiar one—the weather.

A coalition of antinuclear groups sought an injunction to stop the launch of the shuttle *Atlantis* on the grounds that the forty-eight pounds of plutonium 238, a solid nuclear fuel used to power the Galileo probe to Jupiter (the orbiter's main payload), would endanger the public in the event of a catastrophic explosion similar to the *Challenger* accident. Federal District Judge Oliver Gasch heard the arguments on October 10 and rejected the plea. An appeal by the activists was refused.

About an hour after the decision, launch director Bob Seick announced that the computer that controls the number two main engine on the orbiter had to be replaced. This delayed the launch for five days. The rescheduled launch on October 17 had to be scrubbed because of rain near the approach end of the Kennedy Space Center runway, where the mission crew would have had to land *Atlantis* in the event of an abort after liftoff.

STS-34, the thirty-first shuttle mission, finally lifted off at 12:53 p.m. on October 18. *Atlantis* was commanded by Navy Capt. Donald E. Williams, with Navy Cmdr. Michael J. McCulley, a space rookie, serving as pilot. Mission specialists were Dr. Shannon W. Lucid, Dr. Franklin Chang-Diaz, and Ellen S. Baker, M. D., another first-time astronaut.

The 5,986-pound, two-stage Galileo probe was released from the payload bay on the sixth orbit, six and one half hours into the mission. Once the orbiter was clear, Galileo's booster, the Air Force-developed Inertial Upper Stage, fired and started the probe on its six-year journey to Jupiter. Galileo's launch had been held up for almost eight years because of design revisions and subsequent scheduling delays resulting from the *Challenger* accident.

Using a trajectory called VEEGA (Venus, Earth, Earth Gravity Assist) to pick up speed and conserve fuel, the $1.4 billion probe will first swing around Venus next February. It will take measurements to determine the presence of lightning and take time-lapse photography of the planet's cloud-circulation patterns.

On the way back toward Earth next fall, Galileo's remote sensing equipment will gather data about the far side of the moon. Picking up more speed as it swings around Earth next December, the probe will then take two years to loop around the sun. It will spend ten months studying an asteroid field as it passes through the asteroid belt. Galileo will pass within 600 miles of the asteroid Gaspra.

On the second Earth flyby in December 1992, Galileo's cameras will be trained on the north pole of the moon to determine whether ice exists there. Finally heading for Jupiter, the probe will pass within 600 miles of the

asteroid Ida in August 1993. Both asteroid encounters will focus on surface geology.

Five months prior to Galileo's scheduled December 7, 1995, arrival at the solar system's largest planet, an atmospheric probe will separate from the spacecraft and follow a ballistic trajectory to a point six degrees north of the planet's equator. Entering the Jovian atmosphere at Mach 1, the probe's pilot chute will deploy, followed by a main parachute that will pull a sensing package from the aeroshell. The sensing package will send back data for seventy-five minutes before it is crushed under Jupiter's heavy atmospheric pressure.

The Galileo orbiter will continue its primary mission, returning scientific data from Jupiter and four of its satellites for at least twenty-two months. The Galileo program is under the direction of NASA's Jet Propulsion Laboratory in Pasadena, Calif.

In orbit, the *Atlantis* crew had to fix a flash evaporator (used for cooling), but that had no effect on the few experiments conducted. The mission was shortened by three hours to avoid predicted heavy winds at the Edwards AFB, Calif., landing site, and the crew touched down on Runway 23 at 12:33 p.m. on October 23. Thirty minutes prior to the orbiter's landing, Galileo was traveling at 8,912 mph and was 1,004,021 miles from Earth.

★ **HONORS—Thomas V. Jones,** Chairman of the Board and Chief Executive Officer of Northrop, was named the **recipient of the Wright Brothers Trophy** for 1989. Mr. Jones was cited for his achievements during forty-seven years of guiding the development of advanced aircraft (such as the T-38, F-5, and B-2), electronic systems, and manufacturing technologies. The Wright Brothers Trophy is presented annually by the National Aeronautic Association to an American citizen who, as a civilian, has rendered significant public service of enduring value to aviation in the US.

Capt. David Alan Miller, an F-15 pilot with the 22d Tactical Fighter Squadron at Bitburg AB, Germany, has been named **winner of the Robbie Risner Award** for 1988. The Risner Award is named in honor of Brig. Gen. Robinson Risner, a fighter pilot who was a prisoner of war from 1965 to 1973, and as a tribute to all Vietnam-era POWs. It is presented annually by the Air Force to the flyer judged the best pilot from among the previous year's distinguished Fighter Weapons School graduates.

Rockwell senior engineering test pilot **Addison Thompson** and Air Force Combined Test Force Commander **Lt. Col. Randy Gaston** received the **Iven C. Kincheloe Award** for 1989. The two men work with the B-1B high alpha envelope expansion and flight-control system development programs, unique efforts that test a 425,000-pound B-1 up to and beyond neutral longitudinal stability without the benefit of a spin chute. The Kincheloe Award is presented annually by the Society of Experimental Test Pilots (SETP) in recognition of outstanding professional accomplishment in the conduct of flight-testing.

In an unusual move, SETP's board of directors also voted to name **Ken Dyson as co-winner of the 1978 Kincheloe Award.** That year, Mr. Dyson was one of two pilots who flight-tested the proof-of-concept prototype of the Lockheed F-117A Stealth fighter. He could not be considered for the award at the time because of the classified nature of his work. Mr. Dyson is now Rockwell's chief test pilot.

★ **PURCHASES—The team of Rockwell's Autonetics Sensors and Aircraft Systems Division, its North American Aviation and Collins Government Avionics organizations, and TRW** has been awarded a $69 million contract **to modernize the avionics system of the Air Force's F-111D/F aircraft.** Called Pacer Strike, the program involves the removal of outdated avionics subsystems and installation of a ring-laser gyroscopic Standard Inertial Navigation Unit, a Global Positioning System receiver, and new cockpit displays. The program also includes new computer software, integration and test of two prototype aircraft (one F-111D and one F model), and production of modification kits for the other 161 aircraft to be reworked. The program is being administered by the Sacramento Air Logistics Center at McClellan AFB, Calif. Aircraft modification and flight test will take place at Rockwell's facility at Air Force Plant 42 in Palmdale, Calif.

Lockheed Space Operations Co. received a three-year, $1.6 billion NASA contract extension on September 26 **to continue space shuttle processing work at the Kennedy Space Center** in Florida. The contract covers orbiter checkout, launch operations, landing, post-flight recovery, and operation and maintenance of ground processing equipment and facilities. The company will also maintain the deactivated Space Launch Complex-6 at Vandenberg AFB, Calif. (where shuttles were to be launched), for one year.

Spaw Glass Construction Co. of San Antonio, Tex., received a $13.45 million Army Corps of Engineers con-

—Staff photo by Guy Aceto

The Air Force Academy football team claimed the Commander in Chief's Trophy for the second time in three years and the fifth time overall after beating Navy, 35–7, and Army, 29–3, this fall. The Falcons were led by senior quarterback Dee Dowis (here rushing against the Naval Academy), who was consistently ranked among the nation's top twenty rushers. His 141 yards on twenty-four carries against Army gave Cadet Dowis 3,336 yards for his career, a national rushing record for quarterbacks.

tract **to build a new corrosion-control facility at the San Antonio Air Logistics Center** at Kelly AFB. Instead of using chemical strippers, technicians in the 76,500-square-foot facility will use small, nonabrasive plastic beads blown by compressed air to remove paint from C-5s and B-52s. The new facility is expected to save $4.8 million a year in man-hours and materials to strip the aircraft, because the process is roughly fifty percent less expensive, about sixty percent faster, and considerably less corrosive to the aircraft than is chemical stripping. The facility will be completed in April 1991 and will begin operations the following October.

Raytheon's Equipment Division received a $49.7 million contract in early October **to upgrade forty-nine precision-approach radars** used to ensure accurate approaches and landings of military aircraft. The company will upgrade thirty-eight AN/GPN-22 fixed-base and eleven AN/TPN-25 relocatable radars with newly developed dual-channel receivers. With the upgrade, the radars will provide the Air Force with a system reliability of ninety-eight percent. Development is scheduled to be completed in late 1991, and delivery of production equipment is scheduled to begin in the fall of 1993.

On September 25, Air Force Systems Command's Electronic Systems Division awarded **Westinghouse and Boeing** $223.6 million and $65.3 million contracts, respectively, **to upgrade the Air Force's fleet of thirty-three E-3B/C Sentry airborne warning and control system aircraft.** Called the Radar System Improvement Program (RSIP), the upgrade will improve the ability of the aircraft's AN/APY-1 radar to track small targets, such as cruise missiles, and will in-

Preserving Our Aviation Film Heritage

"If CBS wanted to throw out the news programs from the last twenty years, people would be horrified," said Patricia Woodside, chief of the National Air and Space Museum's film and video production unit. "Well, if this film isn't preserved, that is exactly what will happen to the news from the 1920s and 1930s."

The film to which Ms. Woodside refers is the complete archives of Movietone News, the newsreels shown before many feature presentations at movie houses that were the equivalent of today's network news shows. The Air and Space Museum's interest in Movietone News is in preserving the approximately 800,000 feet of film relating to aviation.

The film was shot on highly volatile 35-mm nitrate stock that is deteriorating rapidly. "Nitrate is similar to a bad apple in a barrel," noted Ms. Woodside. "It deteriorates in spots, and what rubs against it also starts to deteriorate. We don't know how long the film is going to last." Eventually, a reel of nitrate film will turn first to a gooey substance and then disappear into dust.

Most of the 5,000 Movietone newsreels that appeared in theaters have already been converted to safety film, but what hasn't been converted (nearly ninety percent of the archives) is the outtakes and trims that never made it to the silver screen.

"The newsreels are fun, but the trims are invaluable," noted Ms. Woodside. "In one interview, Jack Northrop is talking about the construction of one of the early flying wings. That is big-time stuff for the technical people, but it would have never made the newsreels. As a research tool, film is often overlooked."

Some of the gems unearthed so far include the start of the 1934 MacRobertson England-to-Australia airplane race, Charles Lindbergh testifying before Congress, an interview with famed pilot Al Williams, and Roscoe Turner and his pet lion, Gilmore. Some less important but fascinating footage, such as film coverage of the first bear to fly in a plane, are included in the miles of archival film. "Opening the cans is a lot like Christmas morning," said Ms. Woodside. "You never know what you'll see."

The entire Movietone collection was donated to the University of South Carolina in 1980, and the film cans are now stored in air-conditioned bunkers at Fort Jackson, near USC's main campus in Columbia, S. C. The nitrate stock is so unstable it is considered a Class-C explosive, and the concrete walls of the bunkers would contain both an explosion and a fire.

Preserving the film is generally a simple matter. The film is taken to Bono Films & Video in Washington, D. C., where it is optically printed, and a duplicate positive image is created on a fine-grain safety film. As many frames as possible of the original film are saved, but some frames can't be saved and are lost forever, along with the image they contain. Special methods are used to handle film that has already started to deteriorate.

Videotapes are made of the new positive for research purposes (to eliminate unnecessary handling of the actual film), and then the film is packaged and put in cold storage at the Museum's Paul E. Garber facility in Suitland, Md. Once preserved, it should last at least 100 years.

Film deterioration is evident in this picture of reels of outtakes from the Movietone News archives. The National Air and Space Museum is leading the effort to preserve this valuable research material.

The restored film, in addition to being a priceless research tool, will one day be exhibited in the Air and Space Museum. The high-quality images in the film can also be used as still photographs to document articles and books. Many other uses for the preserved film are possible.

While preserving the film is relatively easy, raising funds to do the job is not. "It never occurred to me that people would want to see Jimmy Stewart as Charles Lindbergh rather than see Charles Lindbergh as Charles Lindbergh," said Ms. Woodside. Since the film preservation effort began in 1986, funds have been raised to transfer only 30,000 feet of nitrate to safety film (10,000 feet of which is being done now).

It costs about $1 per foot to transfer the original nitrate stock to safety film. "If we could get the funds to restore all the film at one time, it would save us a lot of money through volume discounts on film and labor," noted Ms. Woodside. "When you think about it, $500,000 is not a lot of money to preserve history that cannot be replaced."

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crease the distance at which the E-3's crew will be able to detect and track bombers and fighters. The RSIP is the third major upgrade for the AWACS fleet, and the modifications are expected to be completed by 1998.

Westinghouse received a $203.7 million contract and **ITT Avionics** a $216.3 million contract from Naval Air Systems Command in early October **for low-rate initial production of the Air Force/Navy AN/ALQ-165 Airborne Self-Protection Jammer** (ASPJ). Each company will build fifty ASPJ sets. ASPJ, which creates false targets and jams enemy radar tracking systems, will equip Air Force F-16s, Navy F/A-18s and F-14s, and Marine Corps AV-8Bs. The contracts are to be completed by the end of 1994.

★ **DELIVERIES**—The **first of twenty-four Sikorsky HH-60J Medium-Range Recovery helicopters for the Coast Guard was rolled out** in ceremonies at the company's plant in Stratford, Conn., on September 14. The helicopter, dubbed Jayhawk, is based on the Navy's SH-60B Sea Hawk and has a 300-mile range with a forty-five minute on-site margin for rescue operations. The helicopters, which will replace the Sikorsky HH-3F Pelican, will also be used for drug interdiction, environmental protection, and logistic support. The first HH-60J will be turned over to the Coast Guard next March, and the last aircraft will be delivered by 1992. An additional nine HH-60Js are on option.

The new **Optics Development and Beam-Control Facility,** a state-of-the-art laser research facility, **was dedicated on October 11 at the Air Force Weapons Laboratory** at Kirtland AFB, N. M. The facility will house ten laboratories involved in research on ground-based lasers, antisatellite technologies, phased-diode arrays, and advanced nonlinear optical processes research. The laboratories are temperature controlled to within two degrees and have compressed air, chilled and deionized water, and electrical, computer, and phone hookups. A Halon fire-suppression system was also installed. The $3.7 million facility was completed at a cost $4.3 million under its original budget, mostly as the result of competitive bidding.

Air Force Communications Command dedicated its new headquarters building in ceremonies at Scott AFB, Ill., on October 16. Named in memory of Lt. Gen. Harold W. Grant, the first Commander of Air Force Communications Service (AFCC's original name), the building is a three-story, 218,000-square-foot facility that cost approximately $20 million. It was built using the design-build concept that allows the contractor to begin the building's foundation and structural support while the interior electrical and mechanical systems designs are being finalized. The building's three-story atrium houses the AFCC Visitors Center and a variety of historical exhibits.

Lockheed delivered the last of thirty-seven U2R/TR-1 high-altitude reconnaissance aircraft to the Air Force in ceremonies in October. The TR-1 is able to record information from altitudes above 70,000 feet and is equipped with interchangeable noses, mission bay hatches, and wing pods that allow the plane to carry nearly two tons of sensors.

★ **MILESTONES**—The **last of thirty-seven Lockheed U-2R/TR-1A/B** high-altitude reconnaissance aircraft **was delivered to the Air Force** in ceremonies at the company's facility at Air Force Plant 42 in Palmdale, Calif., on October 3. The program was a model procurement, consistently coming in ahead of schedule and under budget ($26 million under budget since 1983). Lockheed received the U-2R/TR-1A/B contract in 1979 as a follow-on to initial U-2 production that ended in 1969, one of the first times a dormant production line was restarted (albeit for a considerably different aircraft). Strategic Air Command operates the nine U-2Rs from several locations and the twenty-six TR-1A (single-seat) and two TR-1B (two-seat trainers) from Beale AFB, Calif., and RAF Alconbury, UK. NASA operates one TR-1A as the ER-2 earth resources research aircraft.

The **US Army took delivery of the 500th McDonnell Douglas AH-64A Apache** attack helicopter in ceremonies at the company's plant in Mesa, Ariz., on September 15. The first AH-64 was delivered in January 1984. The milestone aircraft will be assigned to the 2d Battalion/1st Aviation Regiment, the second Apache unit assigned to the 1st Armored Division. The 2d/1st will be stationed in Hanau, Germany, after its six-month unit combat training exercise at Fort Hood, Tex. A total of 675 Apaches has been funded through FY 1989. McDonnell Douglas also received a $200 million contract earlier this year for design and development of four Longbow Apache prototypes. These AH-64s will be fitted with the Longbow fire-control radar, which offers greater weapons accuracy at longer ranges and an improved night/adverse weather capability.

Bill Park, director of flying operations at Lockheed's "Skunk Works," retired on September 29 after a thirty-year career. One of the most famous "unknown" pilots ever, Mr. Park was formerly chief test pilot for the "Skunk Works" or, as it is more formally known, the Lockheed Advanced Development Projects section, which does highly sensitive work. Mr. Park was the first pilot to take the SR-71A reconnaissance aircraft to its designed speed (Mach 3+), the first to land a U-2 on an aircraft carrier, the first to make a dead-stick landing in a U-2, and the first to fly the F-117A Stealth fighter. Injuries received in a 1978 F-117 crash ended his flying career.

★ **NEWS NOTES—Two Air Force KC-135 tankers were destroyed in separate mishaps two weeks apart in early fall.** On September 20, an Alaska Air National Guard KC-135E had just finished a training flight and had taxied to its parking spot when it exploded. The flight deck crew and two passengers were injured, and two boom operators were killed. On October 4, a KC-135A assigned to the 42d Bomb Wing at Loring AFB, Me., was returning to the base after a six-hour sortie and exploded in midair near Perth Andover, New Brunswick, Canada. The base radar approach control was contacted by the plane's crew a few minutes before the accident, and there was no indication of any problems. The crew of four was killed. After the second mishap, each KC-135 in the fleet was grounded until its fuselage electrical wiring and fuel cells could be inspected. The Air Force is continuing the investigation of both accidents.

The Soviet Union has apologized to the US after a Soviet warship fired one of its main guns in the general direction of an airborne US Navy P-3 Orion. The incident occurred on September 22 in international waters near Crete. A Soviet guided-missile destroyer was conducting gunnery exercises, and the P-3 crew was on a routine surveillance flight. The aircraft approached the ship and was flying off its starboard side when one of the vessel's rear 130-mm guns fired a shell that passed in front of the P-3's nose and exploded. The US protested through diplomatic channels opened by the 1972 Incidents at Sea Agreement. The Soviets apologized several days later, and the matter was considered closed.

A B-1B crew from the 96th Bomb Wing at Dyess AFB, Tex., **made a successful emergency landing at Edwards AFB, Calif.,** October 4 after the plane's nose gear would not extend. After circling for five hours and making several attempts to shake the landing gear down with hard touch-and-go landings and high-G maneuvers around Dyess, the crew refueled from a tanker and flew to California. After circling over Edwards for an hour to burn off remaining fuel, the crew landed the plane on the six-mile-long, hard-packed sand runway used by the space shuttle. After rolling as far as possible on the main bogies, the pilot, Capt. Jeffrey Bean, eased the nose onto the runway. The aircraft slid for several hundred feet before coming to a stop. The gear failure was caused by a malfunction in the number two hydraulic system.

The Air Force has revised its force-realignment plans for Cannon AFB, N. M. Instead of receiving an additional thirty-two F-111s by late 1991, as had previously been announced, the base will now receive forty-eight aircraft. The 18th Tactical Fighter Wing will receive eighteen F-111Gs (Strategic Air Command FB-111s that will be modernized and transferred to Tactical Air Command) from Pease AFB, N. H. (which is scheduled to close), by mid-1990. An additional thirty F-111Gs will be transferred to Cannon by late 1991. Two of Cannon's F-111Ds will be retired. The F-111As at Mountain Home AFB, Idaho, that were scheduled to be transferred to Cannon will now be sent to other units or retired. The move means that Cannon will receive an additional 1,536 military and sixty-four civilian manpower authorizations and will require approximately $66 million in military construction projects.

Air Force Systems Command's **Aeronautical Systems Division** at Wright-Patterson AFB, Ohio, **is testing an automated airplane washer.** The washer, leased from Nordic Aero, Inc., under a $68,000 contract, is expected to cut the time spent in washing a transport or bomber from almost seventy-two man-hours to approximately eighteen man-hours. If the effort is successful, SAC plans to purchase up to twenty-five of the machines. Military Airlift Command and Air Force Logistics Command's depots have also expressed an interest in the washer. Testing will take place

December Anniversaries

- *December 1–16, 1914:* Two-way air-to-ground radio communications are demonstrated in a Burgess-Wright biplane by Army Signal Corps Lts. H. A. Dargue and J. O. Mauborgue in Manila, the Philippines.
- *December 31, 1929:* The Daniel Guggenheim Fund for the Promotion of Aeronautics ends its activities.
- *December 31, 1934:* Helen Richey, flying a Ford Trimotor from Washington, D. C., to Detroit, Mich., becomes the first woman in the US to pilot an airmail transport aircraft on a regular schedule.
- *December 29, 1939:* The prototype Consolidated XB-24 Liberator makes a seventeen-minute first flight from Lindbergh Field in San Diego, Calif., with company pilot Bill Wheatley at the controls. More than 18,100 other B-24s would be built in the next five and one-half years, making for the largest military production run in US history.
- *December 15, 1944:* Bound for France, famed bandleader Maj. Glenn Miller, USAAF, and two others take off from England in a Noorduyn UC-64 Norseman and are never heard from again. Several possible causes for the disappearance have been formulated, but none was ever proven. Also on this date, President Franklin D. Roosevelt signs legislation creating the five-star ranks of General of the Army and Admiral of the Fleet.
- *December 17, 1944:* The 509th Composite Group, assembled to carry out atomic-bomb operations, is established at Wendover, Utah. Also on this date, Maj. Richard Bong, the leading US ace of all time, scores his fortieth and final victory in operations over the Pacific.
- *December 22, 1944:* In what may be the best-known single-word communication in history, Brig. Gen. Anthony McAuliffe of the US 101st Airborne Division writes the word "Nuts" on the envelope that bore the German demand to surrender his besieged troops in Bastogne, Belgium. Bastogne is relieved a few days later, and the Allies claim victory in the Battle of the Bulge by late January.
- *December 10, 1954:* Col. (Dr.) John Paul Stapp, wearing nothing but coveralls and a helmet, successfully withstands stopping forces of between twenty-five and forty Gs and wind pressure of up to two tons in abrupt deceleration tests at White Sands, N. M. His rocket-propelled sled reached a speed of 632 mph in five seconds and was stopped in approximately 700 feet.
- *December 30, 1959:* The first US ballistic missile-carrying submarine, the USS *George Washington* (SSBN-598), is commissioned at Groton, Conn.
- *December 17, 1964:* Air Force Secretary Robert Seamans announces the termination of Project Blue Book, the service's program to investigate reports of unidentified flying objects (UFOs).
- *December 21, 1964:* Company pilots Richard Johnson and Val Prahl make the first flight of the variable-geometry General Dynamics F-111A from Air Force Plant 4 in Fort Worth, Tex. The flight lasted twenty-two minutes.
- *December 22, 1964:* Lockheed is approved by President Lyndon Johnson to start development for the Air Force of the CX-HLS transport. This became the C-5A. Also on this date, the Lockheed SR-71A "Blackbird" strategic reconnaissance aircraft exceeds an altitude of 45,000 feet and a speed of 1,000 mph on its first flight, made from Palmdale, Calif.

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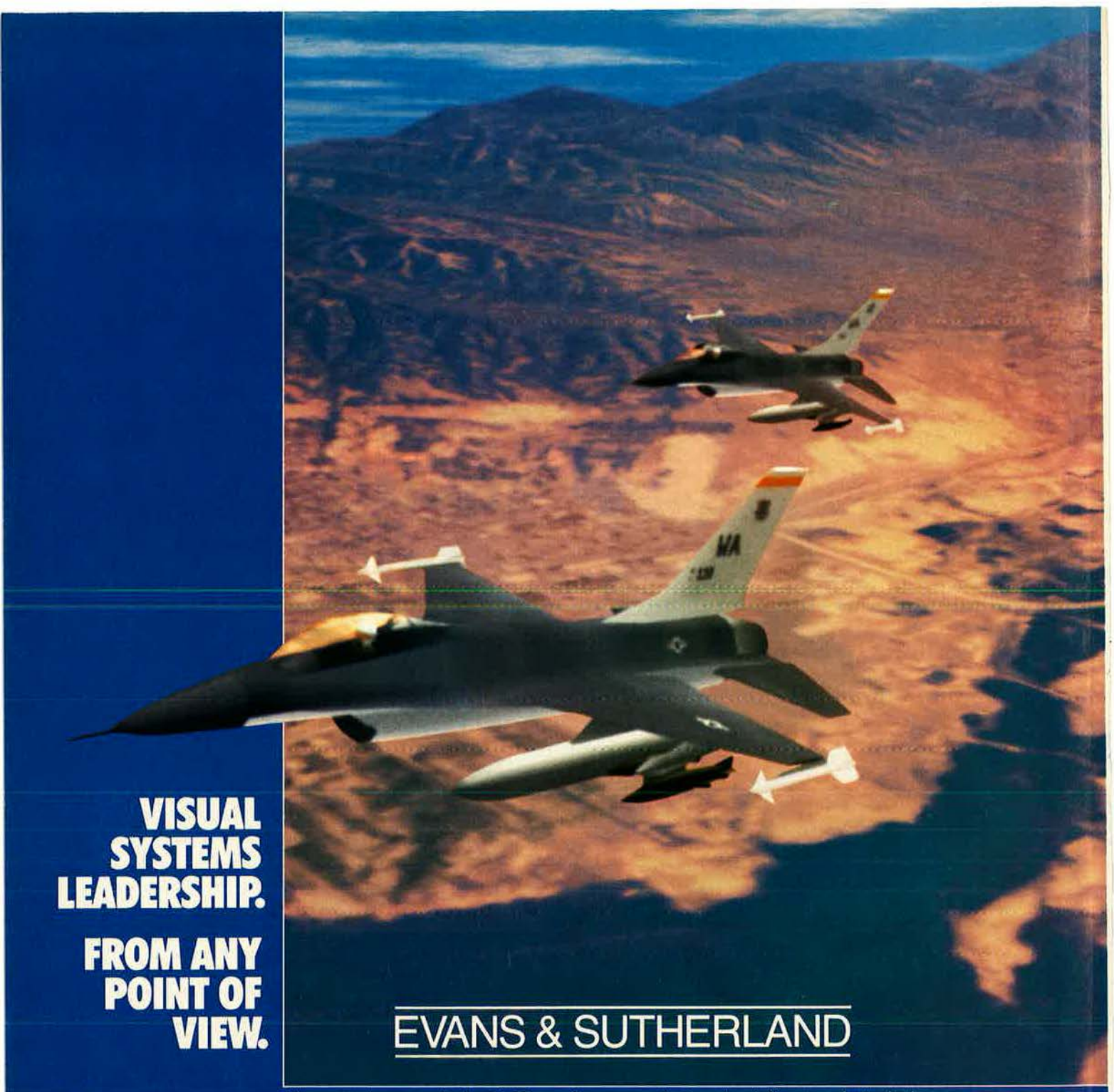

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at three locations. KC-10s, B-1Bs, B-52s, C-130s, and KC-135s will be the aircraft "guinea pigs."

Keep those scissors handy. **Air Force commissary customers saved more than $70.6 million by using cents-off coupons in FY 1989.** Air Force Commissary Service accepted 127,574,183 coupons during the year. Since 1987, the number of coupons used has risen from 107.1 million. The value of those cents-off slips, though, has grown dramatically from the total of $49.8 million two years ago. AFCOMS received almost $9.4 million in coupon-handling fees, which was reinvested in the operations and maintenance fund.

★ **DIED—Wally Floody,** the fighter pilot who engineered the tunnel in the famous mass escape from Stalag Luft III in Germany during World War II, of chronic lung disease in Toronto on September 25. He was seventy-one. A Royal Canadian Air Force Spitfire pilot, Mr. Floody was shot down over France in 1941. He relied on his mining experience to engineer and dig the 350-foot-long tunnel that was used in the March 24, 1944, escape. Of the seventy-six officers who got out of the camp, only three made good on their escapes. Mr. Floody served as technical advisor to the 1963 movie "The Great Escape," which told the story of the Stalag Luft III jailbreak.

★ **UPDATE—The cause of the July 24 accident that destroyed a B-52G bomber** at Kelly AFB, Tex. *[see "Aerospace World," October 1989],* **was determined to be a failure to remove an improperly manufactured vent plug** during refueling operations. The vent plug, which is used during pressure checks, was mistakenly left in, and the fuel system became overpressurized. This, in turn, led to a spill and the explosion that destroyed the aircraft. ■

Index to Advertisers

Senior Staff Changes

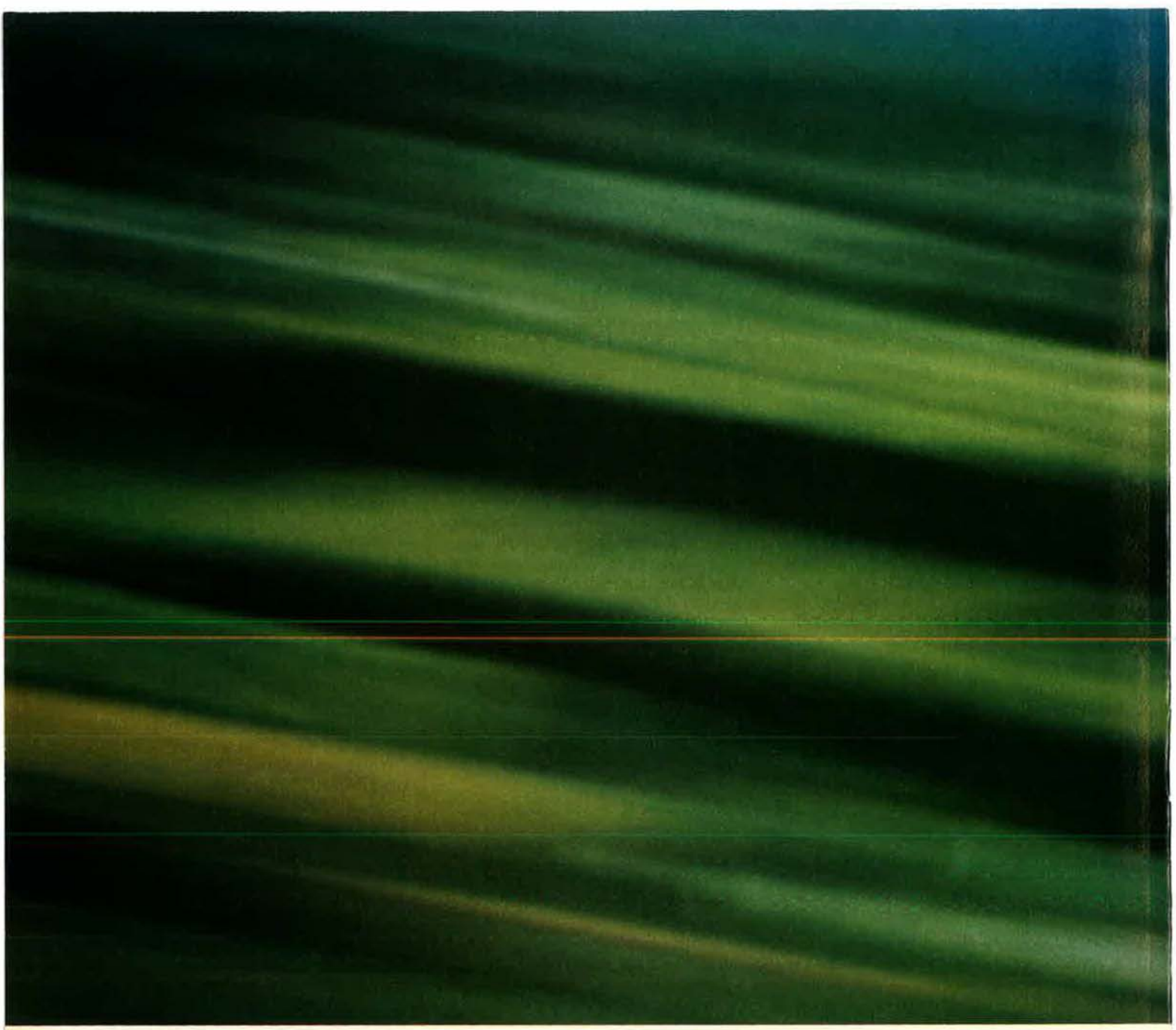
RETIREMENT: M/G Richard B. **Goetze,** Jr.

CHANGES: B/G Chalmers R. Carr, Jr., from Dir. of Inspection, Hq. AFISC, Norton AFB, Calif., to IG, Hq. ATC, Randolph AFB, Tex., replacing retiring B/G Albert A. Gagliardi, Jr. . . . **M/G James E. Chambers,** from DCS/Ops., and Staff Dir., Ops., PACOPS, Hq. PACAF, Hickam AFB, Hawaii, to Cmdr., 17th AF; Cmdr., Allied Sector Three; and Cmdr., ATOC, USAFE, Sembach AB, Germany, replacing M/G (L/G selectee) Robert L. Rutherford . . . **Col. (B/G selectee) Stephen P. Condon,** from Cmdr., AEDC, AFSC, Arnold AFB, Tenn., to Dir., Prgm. Planning & Integration, Ass't Sec'y of the Air Force for Acq., OSAF, Washington, D. C., replacing B/G John W. Douglass . . . **B/G Marvin S. Ervin,** from Ass't DCS/P&R, Hq. MAC, Scott AFB, Ill., to Dep. Cmdr., AFCOS; Dep. Dir., Ops., DCS/P&O, Hq. USAF; and Dep. Dir., Office of Mil. Support, Hq. DAMO/ODZ (Army), Washington, D. C., replacing B/G Donald G. Hard.

M/G Larry D. Fortner, from Dep. Cmdr., 6ATAF, AFSOUTH, NATO, Izmir, Turkey, to Exec. Dir., JSDPS, USSPACECOM, Peterson AFB, Colo. . . . **B/G Donald G. Hard,** from Dep. Cmdr., AFCOS; Dep. Dir., Ops., DCS/P&O, Hq. USAF; and Dep. Dir., Office of Mil. Support, Hq. DAMO/ODZ (Army), Washington, D. C., to Dep. Dir., Plans, DCS/P&O, Hq. USAF, Washington, D. C., replacing M/G Thomas E. Eggers . . . **B/G Orthus K. Lewis, Jr.,** from Ass't DCS/Tech. Training for Resource and Policy, Hq. ATC, Randolph AFB, Tex., to DCS/Tech. Training, Hq. ATC, Randolph AFB, Tex., replacing M/G Donald A. Rigg . . . **B/G Charles F. Luigs,** from Dep. Dir., Ops., J-3, Hq. PACOM, Camp Smith, Hawaii, to Dir. of Inspection, Hq. AFISC, Norton AFB, Calif., replacing B/G Chalmers R. Carr, Jr. . . . **M/G Donald A. Rigg,** from DCS/Tech. Training, Hq. ATC, Randolph AFB, Tex., to Dep. Cmdr., 6ATAF, AFSOUTH, NATO, Izmir, Turkey, replacing M/G Larry D. Fortner.

SENIOR EXECUTIVE SERVICE (SES) RETIREMENT: Frederick T. **Rall,** Jr.

SES CHANGES: Thomas L. Miner, to Dep. Dir., Maintenance, OC-ALC/MA, Tinker AFB, Okla., replacing Maurice LeBlanc . . . **Jerome P. Sutton,** to Dep. Prgm. Dir., AMRAAM SPO, Munitions Systems Div., Eglin AFB, Fla. ■



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All Together at Fort Irwin

BY JEFFREY P. RHODES, AERONAUTICS EDITOR

PHOTOS BY GUY ACETO, ART DIRECTOR

THREE hours after the dawn battle began, the fight is coming to a close. The 2d Brigade of the US Army's 2d Armored Division has made a valiant stand, but now it is being overwhelmed by the Soviet 32d Guards Motorized Rifle Regiment.

Both sides are suffering heavy casualties. On the US side, the 2d has lost eight of its original eleven M1 Abrams tanks, twenty-six of forty-one M2 Bradley Fighting Vehicles, and most of its ten M901 Improved TOW antitank vehicles. The Soviet unit also is getting mauled, having lost twenty-one of forty-eight T-72 tanks, sixty of 106 BMP infantry fighting vehicles, and five of nine BRDM-2 antitank vehicles.

In spite of their losses, however, the Soviet troops move within reach of their objective—a facility that houses the 2d Brigade's fuels and supplies. Then, having punched a gaping hole in the US line with help from MiG-29 aircraft, Soviet attackers pour through the gap, advancing rapidly.

"OK," a voice crackles on the radio. "Change of mission." Forces on both sides grind to a halt.

Above, the battle begins: At first light, a Blue Air OA-10 pilot (one of the "good guys") prepares for takeoff at George AFB, Calif., a short hop away from the training ranges at Fort Irwin. At right, the battle ends: After a hard morning of engaging BLUFOR tanks, OPFOR "bad guys" Capt. Robert Byars (commander), Pvt. Ronald Thomas (gunner), and Sgt. Andrew Speer (driver) keep a wary eye on the battle's progress. OPFOR is the home team at Irwin.

"A PRETTY typical battle out here," says Lt. Col. James Etchechury, the Deputy Regimental Commander of the "Soviet" 32d Guards. The Colonel, who is actually Commander of the US Army's 1st Battalion, 63d Armored, means that it is a typical battle at the National Training Center at Fort Irwin, Calif.

Fort Irwin, home of the National Training Center (NTC), covers nearly 640,000 acres of the blistering Mojave Desert, an area nearly the size of Rhode Island. The NTC is the Army's ultimate training experience, the closest the participants can come to war without firing a shot in anger. Units spend up to a year preparing for their fourteen days in the field at Fort Irwin. Though the NTC's main task is to give highly realistic training to Army brigades and regiments, the Center also plays an important role in Air Force training plans.

"The NTC provides pilots and ALOs [Air Liaison Officers] with the most realistic CAS [close air support] environment in the US," says Lt. Col. Duane Knight, Commander of the 4443d Tactical Training Squadron at George AFB, Calif. "All the players are in place to provide that environment, both in concert and separately, like no place else."

The Starting Lineups

Two Army battalion task forces, their brigade headquarters, and accompanying combat support forces are the "good guys" in each of the fourteen training periods (called "rotations") held annually at the NTC. The 3,500 to 5,000 troops being trained (known as the Blue Force, or BLUFOR) usually fly to nearby Norton AFB, Calif., and are bused to Fort Irwin. Some airborne units make a flashier entrance, dropping in by parachute.

The first three days of a rotation are spent in the Dust Bowl, an area where the BLUFOR troops set up tents and draw food, ammunition, tanks, and other gear and supplies. Rather than waste time and money bringing their own assigned vehicles, BLUFOR units use a "rent-a-tank" operation at the post, similar to drawing on prepositioned wartime stocks that are held in Europe.

Day 4 marks the start of the action and first contact with the Soviet-style opposing force, or "OPFOR."

"The kindest thing you can say about [troops of] the OPFOR is that they are an uncooperative sparring partner," says Colonel Knight. Indeed the "bad guys" are the home team at the NTC. It is a rare occasion when they lose a battle, although keeping track of wins and

The OPFOR takes the offensive: M551 Sheridan tanks modified to look like Soviet T-72 main battle tanks (top) and BMP armored personnel carriers (above) roll out to take on the defending BLUFOR. In many of the battles, the OPFOR has a large numerical advantage, a situation US tank commanders could face in a European war.

losses is not deemed important. The OPFOR is actually the 177th Armored Brigade, but for the purposes of the units that train at Fort Irwin, it is a Soviet Motorized Rifle Regiment.

The OPFOR is thoroughly trained in Soviet tactics and doctrine. Troops even wear Soviet-style uniforms. They ride into battle on American M551 Sheridan light tanks modified with fiberglass and aluminum panels to resemble Soviet T-72s, BMPs, and ZSU-23-4 mobile antiaircraft guns. The units also use "Hummers" (M998 high mobility multipurpose wheeled vehicles, or HMMWVs) modified to represent the Soviet BRDM-2.

Army training doesn't take place just on the ground. Units with aviation assets such as Bell OH-58 Kiowa scout helicopters, Bell AH-1 Cobra gunships, and McDonnell Douglas AH-64 Apache attack helicopters regularly take part in the BLUFOR combined arms team. The OPFOR uses a pair of visually modified Bell UH-1H Hueys to simulate the actions of Mi-24 "Hind" assault helicopters.

USAF involvement at NTC takes two forms—in the air and on the ground. The flying program is called "Air Warrior." During each rotation, three Air Force units deploy aircraft to George to provide air support during the battles. Typically, the Blue Force at Irwin will be supported by crews flying seven A-10s for close air support and four OV-10s or OA-10s as forward air controllers (FACs). The OPFOR's air support comes in the form of five pilots whose F-16s are used to represent MiG-29s.

The Air Force ground element in the training at Fort Irwin comes in the form of ALOs assigned to specific armored units. The ALOs are the eyes and ears of the fighter pilots and are the ones who plan for and call in air strikes or provide last-minute targeting information to the incoming fighters.

"I have to have a good understanding of the maneuvers and the battle as it takes place," says Capt. Dave Brown, a 24th Tactical Air Support Squadron OA-37 pilot who, as an ALO, is assigned to the 2d Armored. "I am talking to the pilots all the time. Because I am a pilot, I can go right from hearing what the Army commander orders to saying what the pilots need to hear."

Some participants in the battles are not really participants at all. They are the observer controllers (OCs), who play several roles. There are at least three groups of OCs at any battle. One group (radio call sign "Scorpion") monitors the infantry, while the "Cobras" monitor the armor. The third group, the "Ravens," is the second Air Force element in the ground war. The Ravens, members of the Air Force's 4445th TTS, serve as air operations monitors.

During engagements, OCs act as referees and have the power to declare a tank or vehicle "dead" if the crew strays out-of-bounds or suffers a malfunction of scoring equipment. They also help ensure the safety of the operations. After the battle, the OCs coach the crews and help them evaluate their performance.

Eating Dust

During a rotation, the two BLUFOR battalion task forces are trained separately and as a group. While separated, one task force moves to the NTC's northern cor-

When their vehicle's amber strobe light goes on (under the machine gun), a crew has gone from being participants to being spectators with front-row seats at the battle. This BLUFOR M1 crew has been "killed" (as scored by the Loral MILES equipment) and is watching and waiting until "change of mission" is called. The MILES gear emits and receives laser pulses to simulate live rounds, and it has a "kill" hierarchy: an M16 can only "kill" infantry, while a main tank gun can "kill" nearly anything.

ridor, where it participates in a live-fire exercise. Meanwhile, the second task force is involved in force-on-force engagements against an OPFOR with vastly superior numbers in the southern and central corridors. After four days, the task forces switch assignments. The remaining six training days of the rotation are spent with both task forces combining to engage the OPFOR.

The OPFOR is a formidable opponent. Soviet attack doctrine, though rigid, does provide commanders with two or three options in any given situation. Detailed knowledge of the terrain, of the OPFOR Commander's options, and of how he uses them allows the OPFOR to bedevil the BLUFOR.

On the battlefield, virtually any tactic is legal. On one occasion, an OPFOR Scout team in a BRDM sneaked into a BLUFOR convoy at night. About the time that the BLUFOR discovered what was going on, the Scout team (members of which had dismounted, except for the driver) launched a surprise attack on the BLUFOR tactical operations center.

The live-fire range consists of more than 1,000 solar-powered, computer-controlled targets. The targets, sited in open pits, mount frontal or lateral silhouettes of Soviet equipment. They pop up in sequence to simulate the movement of the Motorized Rifle Regiment. Tank gunners get a chance to use their thermal sights, as heat collectors are built into the targets.

The targets can also "shoot back" through the use of Hoffman charges that produce a flash and smoke similar to the firing of the main tank gun. Other targets really do shoot back. Styrofoam GTR-18 Smokey SAMs—or, in the words of the troops, "Nerf Rockets"—are actually fired up and in the direction of the BLUFOR vehicles to simulate the Soviet AT-3 "Sagger" antitank missile.

The deployed Air Force units also make use of the live-fire range. In fact, many of the east coast fighter units expend a large part of their yearly allocation of live ordnance during Air Warrior training. The crews launch 2.75-inch rockets and AGM-65 Maverick missiles, using both electro-optical and imaging-infrared seekers. They also get to drop both Mk.82 (500-pound) and Mk.84 (2,000-pound) bombs. A-10 pilots routinely fire their GAU-8/A 30-mm cannon and often destroy two or three targets per rotation.

Even so, the land battle is the NTC's stock-in-trade. Six basic engagement scenarios are conducted: movement to contact, hasty attack, deliberate attack, defend in sector, defend from battle position, and meeting engagement. Force ratios between the OPFOR and the BLUFOR imitate, in numbers and types of equipment, what one might expect to see in a European conflict.

Battles tend to flow from one day to the next. After the battle in which the 2d Armored was defeated, for instance, the OPFOR stopped, regrouped, moved to another part of the central corridor, and dug in to defend its position. The 2d Armored, bolstered by a second task force that had just completed live-fire training, staged a massive counterattack two days later. When change of mission was called nearly five hours after that battle began, the BLUFOR was only about 3,000 yards from its objective.

In joint Air Force/Army AirLand Battle doctrine, one cardinal tenet is that the Air Force must support the Army. That task gets harder to accomplish as the battle progresses. The speed at which events move in these battles points up the need for the airborne FAC. "There is great value in having that guy up there," says Lt. Col. John Higgins, the Director of Operations for the 27th

The Air Force's Air Warrior program shows forward air controllers and tactical aircrews how complex and difficult the close air support mission is. At top, an OA-10 pilot prepares to fly over the battle and "direct traffic." Another key Air Force element in the ground battle is the Air Liaison Officer. Above, from an M113 armored personnel carrier, Capt. Dave Brown, an ALO assigned by name to the 2d Armored Brigade, calls in an air strike. Captain Brown is an OA-37 pilot except when "his" brigade is deployed.

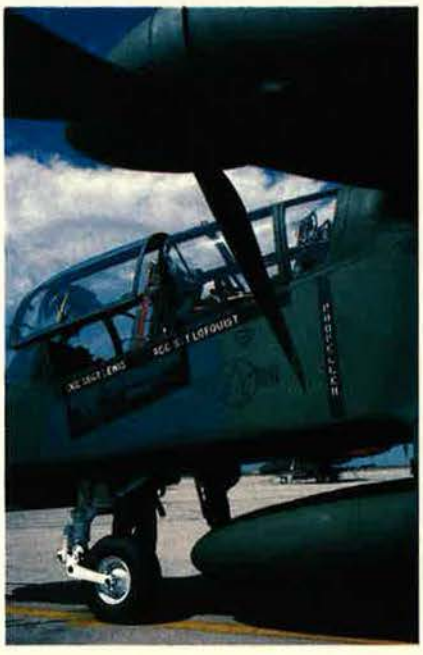
It takes a certain amount of guts to be a "Nail" (forward air controller) when your only armament is white phosphorus rockets (stored in the wing-mounted canister just over the crew chief's head, above). The OA-10s retain the use of their 30-mm guns, though. The turboprop OV-10 Bronco (below) is still used as a FAC aircraft in lower-intensity conflicts. The 27th TASS's OV-10s at George play a key role at Fort Irwin. They play in every other rotation and clear the fighters in during live-fire operations.

TASS, an OV-10 unit based at George. "He can see how the battle is going, and he can react to what he sees."

The highly dangerous battlefield of today has pushed the slow and somewhat vulnerable OV-10 and its crews into the secondary role of communications relay or airborne command post. The Bronco can still do the job in a lower-threat area. The 27th TASS plays in every other rotation and is frequently called on to clear the fighters in during airborne live-fire operations.

The heavily armored A-10 has now been pressed into the role of fast FAC. "The OA-10s operate the same way we do," notes Colonel Higgins. "They are faster, better armored, and have a bit more maneuverability, and they are a little better suited for self-defense." The only difference between an OA-10 and an A-10 is in their employment. A-10s fly into combat fully loaded. OA-10s are armed only with white phosphorous target-marking smoke rockets and a 30-mm gun.

Safety regulations rob the "air war" over Fort Irwin of a bit of realism. But the tradeoff is fair. Aircraft have to perform "dry CAS," that is, without armament, for the obvious reason that it is dangerous to drop bombs. Also, unlike in war, no aircraft are allowed to fly below 300 feet, and no helicopter can fly above 200 feet. A major task of the Ravens is to resolve conflicting demands for the airspace over the battle.



"Intelligence Sets the Stage"

"Without their 'eyes,' the OPFOR is just as blind as the BLUFOR, and they'll do dumb things," says Capt. Gary Cleland, a former OC who now works in the administrative section at Fort Irwin.

In the darkness before the OPFOR's regimental attack on the 2d Armored, the latest intelligence reports were read under the eerie, luminescent glow of chemical lightsticks. A key scout had been "killed" at about 0100 hours, and the OPFOR did not know the location of a particular BLUFOR element. That element, it turned out, had moved to a strategic location, and the dug-in M2, along with two concealed Bradleys and an M1, took out a sizable portion of the OPFOR as it came through.

"Intelligence sets the stage," says Capt. Greg Stanley, an Army ground Liaison officer permanently assigned to 4443d TTS at George. Captain Stanley briefs both Blue Air and OPFOR Air pilots, one group at a time with the other side's maps concealed. By using the same map that Army forces use and by studying a three-dimensional model

board, pilots get a good mental picture of what they will likely find in battle. Captain Stanley and the Air Force intelligence staff also gets reports during the course of a battle to update later flights.

The Army's firing of artillery and launching of battlefield missiles are simulated. Fire-support teams simulate artillery by driving their Hummers to the spot where shells would have fallen had they been fired; once there, the teams drop flash charges to show the results of the barrage.

Small flash charges at the rear of the two main antitank missiles in use, the FGM-77 Dragon and the BGM-71 TOW, and of the FIM-92 Stinger antiaircraft missile, simulate the blowback the missileer would experience. Main tank-gun firings are simulated by Hoffman charges, and the rapid rate of fire on the Bradley's 25-mm Bushmaster chain gun is simulated by a strobe light.

The realism continues well after the battle. "Casualties" are given cards that describe their "wounds," and the medics have to treat them accordingly. Some "wounds" must be treated within a certain length of time or the soldier will "die." Curiously, the most common wound in one recent battle was getting shot in the backside.

Another set of cards that is handed out describes what "maintenance" actions must be taken. Tank mechanics have to go to their supply area and get the "part" needed to fix the problem. The Army has charts that detail how long a repair is supposed to take, and the tank or vehicle is out of action for at least that length of time. A "disabled" vehicle can only be "towed" (driven behind) a vehicle that is capable of towing it. For example, a Hummer can't be used to "tow" an M1 tank.

The pace of planning and fighting the battles takes a toll on BLUFOR commanders. Many times, brigade commanders have had to order their subordinates to get some sleep. That's how realistic the training gets.

The Ultimate Classroom

Though fighting the battles is a valuable learning tool, the keys to effective training at the NTC are the mechanical and human debriefing systems.

The traditional "I-shot-you-first-no-you-didn't" argument during training battles is resolved by the use of the Loral MILES (Multiple Integrated Laser Engagement System) equipment. MILES transmitters, attached to every rifle, machine gun, and missile in use at NTC, emit invisible, eye-safe pulses of laser radiation to simulate live rounds. Each MILES set has its own code, arranged in a hierarchy, so a rifle can "kill," say, an infantryman, but not an M2. A 102-mm main tank gun, on the other hand, is effective against anything.

Receivers are attached to a band wrapped around the helmet and on a vest the soldiers must wear at all times. When hit, the receivers sound a strident tone that can only be turned off with a key. Once "keyed," the soldier is out of the battle.

On vehicles, receivers are attached to exposed areas and vulnerable points. The equipment calculates "near misses," "hits," and "kills" by taking distance and firing angle into account. Results are announced by a bright, flashing, amber light on top of the vehicle.

At the Operations Center at Fort Irwin, every action, movement, and shot fired is recorded. The Center, which the troops have dubbed "The Star Wars complex," records the battles graphically (as shown onscreen above), on videotape (there are two permanent and five mobile cameras), and on audiotape. This information is packaged so that ground troops like the M2 Bradley Fighting Vehicle crew at right can take it home, study it, and learn from their battles in the desert.

After every battle comes an After-Action Review (above) for all participants, including infantry, artillery, intelligence, and armor, then for both forces' senior commanders. Both Blue and Red Air Forces have their own AAR as well. The end-of-rotation AAR involves everybody. The OPFOR crew below will be back for the next battle in a few days.

MILES data and real-time position data on every vehicle on the range are fed back to the Operations Center (or, as the troops call it, "the Star Wars complex"), where they are displayed on terminals and recorded. Ten to fifteen monitors are needed to keep tabs on each task force. At the end of the battle, the system can print a complete, chronological, shot-by-shot record of the action, as well as a list of other significant events.

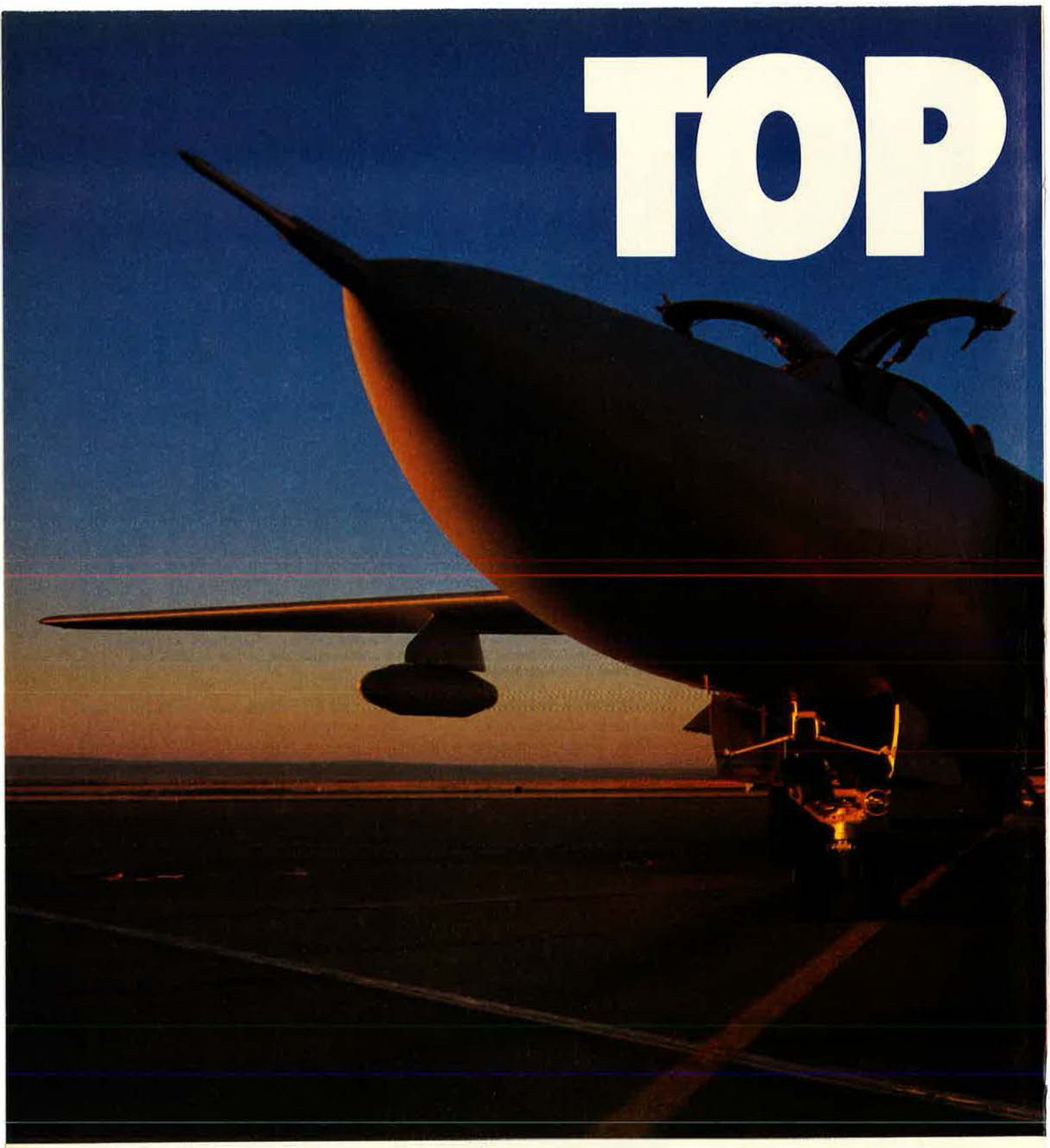
Atop Tiefort and Granite Mountains, the NTC has installed permanent TV cameras, which tape every battle. Five mobile TV trucks are placed in strategic locations to capture the battle during the fighting. Technicians in the Operations Center also monitor and record transmissions from eighty of the ninety available radio nets, including secure ones. All data from all of the battles are assembled into a take-home package the units can study at their home post.

The human debriefing system is nearly as elaborate as the mechanical one. After a battle, both the OPFOR and the BLUFOR commanders hold sit-down, no-holds-barred After-Action Reviews (AARs) with their subordinates.

First, intelligence gives a full report on the other side's battle plan. Then all the company commanders, including those of support forces, such as the engineers, talk about what they think they did right, what they did wrong, and how they can improve. The senior commanders and OCs then meet with their opposite numbers and repeat the process. A final AAR is held at the end of the rotation with all of the players, including the Air Force, present.

At George, the aircrews have their own AARs, get briefed by Captain Stanley, and talk by phone to the Ravens to get an evaluation of how they did. Because there is virtually no MILES equipment for the aircraft, the Ravens play a key role for the pilots. The aircraft OCs determine which aircraft were in a position to get shot down, which ones got shot down, and how effective their bomb runs were. The crews are not always perfect, but they gain knowledge with every sortie.

At the NTC, there are many different levels of learning. From the screech of MILES gear in his ears, the infantryman learns that he can be killed if he sticks his head out of his foxhole at the wrong time. The Army lieutenant who will one day be a general sees the ability of Air Force pilots and aircraft to lend him support, and the pilots get to see firsthand how important their help is to the ground forces. ■



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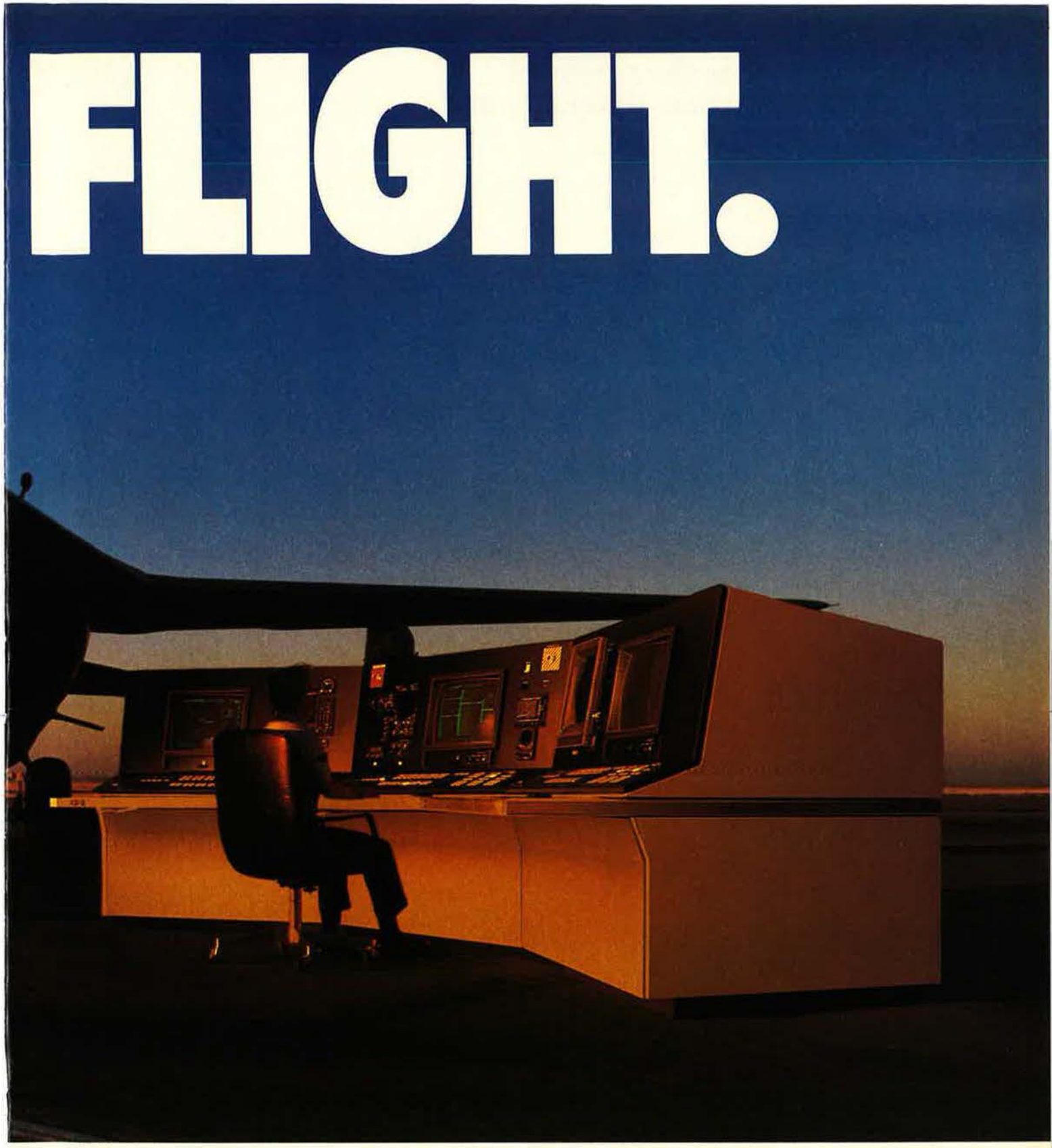

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THE SENSIBLE SOLUTION

Ellsworth becomes the center of knowledge for tactics, weapons, and low-level training.

—USAF photo by Sgt. Tony Evans

SAC's New Graduate School

BY JEFFREY P. RHODES, AERONAUTICS EDITOR

"HISTORICALLY, *strategic airpower* only meant *nuclear deterrent*," says Maj. Craig Scherzberg, a B-52 instructor pilot with the 25th Strategic Training Squadron at Ellsworth AFB, S. D. "But the conventional mission is increasing in importance. With the threats we are facing out there, we have got to get smarter at this business all the way around."

Strategic Air Command crews will get smarter by making use of the staff and facilities at the Gen. Curtis E. LeMay Strategic Warfare Center (SWC), activated last August at Ellsworth. The SWC's purpose is simple: to teach aircrews to wring maximum combat power from B-52s, FB-111s, and B-1s.

The SWC, when it becomes fully operational in 1992, will consist of six main activities—the tactics and intelligence directorates, the Strategic Weapons School, the Strategic Training Center, the 1st Electronic Combat Range Group, and aircraft maintenance support. Developmental, academic, and operational advanced bomber crew training thus will be combined in one state-of-the-art learning center.

—USAF photo by A1C Milla Gaffney

The purpose of the Curtis E. LeMay Strategic Warfare Center is to teach Strategic Air Command bomber crews to get the most out of their aircraft. Crews learn more effective mission-planning techniques from instructors like Maj. Steve Himber (above) and practice their skills on actual aircraft (right).


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"We are here to concentrate on preparing SAC and its crews for anything they could be called on to do," explains Col. James McKeon, Commander of the 99th Strategic Weapons Wing, the SWC's unit designation. "We have a staff selected on the basis of talents and experience. They are . . . enthusiastic people who are not constrained by 'This is how it's always been done before.' I'm really excited about the whole thing."

Three Main Branches

Tactics were formerly developed at SAC Hq. at Offutt AFB, Neb., and were taught at the SAC Tactics School at Nellis AFB, Nev. Detachment 1 of the 99th SWW will stay at Nellis to keep tabs on Tactical Air Command's tactics work, but both the developers and the tactics school will move to Ellsworth by 1991.

The 99th SWW staff will work to improve bombing techniques, especially those pertaining to low-level flight, and develop new ones. Other areas to be enhanced include threat detection and identification capabilities in target areas and survivability of aircrews. An in-house intelligence unit will update the tactics branch on what potential aggressors are doing in air defense and electronic countermeasures.

"We will be able to get tactics information out to the operators in a much more timely manner than we do now," says Colonel McKeon. "With intel[ligence] and operations next to each other, we will be able to get the crews who are training here to test things for us. We can then analyze the new tactics and quickly get the information out to the field."

SWC's second major branch, the Strategic Weapons School, is in the early stages of development. This graduate-level school will use classroom instruction to teach operations and tactics—including those developed across the street by the Strategic Tactics Development Center (STDC)—to competitively selected individuals, who will then instruct other crews at their respective home bases.

A graduate of the weapons school will become the acknowledged expert in his squadron or wing in such matters as instructor techniques, aircraft capabilities, planning, employment, and execution. The curriculum would require a minimum of fifty-five training days and fifteen flying sorties. Classroom training will cover bombing techniques and threat study, while the flying training will concentrate on weapons delivery and defeating enemy air defenses. Plans call for the weapons school to be in full operation next summer.

SWC's third main branch, the Strategic Training Center, supervises the hands-on portion of aircrew training. Already up and running at near full speed, the training center eventually will come into direct contact with every bomber crew in SAC. The training center, once it becomes fully operational next July, will see six B-52G/H, two B-1B, and two FB-111A crews deploy to Ellsworth every week. In addition, two B-1 crews from Ellsworth will participate in exercises every seven days.

Actual air training is conducted by the 25th Strategic Training Squadron, whose lineage dates back to the 25th Aero Squadron formed in World War I. The 25th STS's main tasks are to design challenging scenarios for crews flying along the fourteen low-level training routes that make up the Strategic

—USAF photo by A1C Mila Gaffney

Air Training at the Strategic Warfare Center is conducted by the 25th Strategic Training Squadron, which can trace its lineage to World War I. The 25th STS's home is this new $5.4 million structure that houses the mission-planning and briefing rooms, the Strategic Training Route Complex range control center, and other offices.

The 28th Consolidated Aircraft Maintenance Squadron (right) has an unusual job in that none of the B-52s or FB-111s it services belongs to its parent unit. The 28th CAMS maintains the aircraft of the crews that come to the LeMay Center to train. The transient B-1B aircraft (below) are maintained by the 28th Organizational Maintenance Squadron, whose technicians normally work on Ellsworth's B-1s.

—USAF photo by Sgt. Tony Evans

Training Route Complex (STRC) and to debrief crews to enhance their performance in weapons delivery and survivability.

Over the Plains

The STRC routes cover a 250,000-square-mile area spread over parts of North and South Dakota, Wyoming, and Montana. The routes are intertwined, permitting many variations in flight paths, so crews don't get overly familiar with any one route. These ribbons of restricted airspace allow bomber crews to drop to as low as 400 feet, though efforts are made to avoid farms and other areas where aircraft noise provokes complaints.

Despite such courtesies, there can be no doubt that the crews are training for war. Training attacks have to be made at low altitude, using terrain-masking to minimize the chance of detection by enemy radars. Dashing in at low altitude also gives SAM and other anti-aircraft artillery crews less time to track and shoot at aircraft as they pass overhead. Along the routes, ground threats are simulated by technicians operating the AN/MST-T1A Multiple Threat Emitter System (MUTES). This equipment can imitate the signals of ninety different threat radars, although only five types of emissions can be sent out at one time.

For a variety of reasons, no live drops are made on the STRC runs. Instead, the simulated drops are assessed and scored by radar.

A ground-based AN/TPQ-43 Seek Score radar, which tracks the subject aircraft, makes known the plane's position relative to the target. Meanwhile, equipment on board the aircraft emits a tone. When the navigator on a B-52 "releases" the weapon, the tone is broken. Ground observers know what type of weapon is being simulated, and, because the bomb's ballistic properties are also known, they can establish where the bomb falls relative to the target. The system, though not 100 percent accurate, has a small margin of error.

MUTES, Seek Score, and the AN/MSR-T4 Threat Reaction Analysis Indicator System—which records and measures aircrew response to threats emitted by MUTES—are always located close to each other. All of the radars are mobile and are located at twelve (six permanent and six migratory) radar bomb scoring sites along the STRC.

Located near Forsyth, Conrad, and Havre in Montana, Powell, Wyo., Dickinson, N. D., and Belle Fourche, S. D., the permanent radar sites are manned by two Air Force officers and some sixty enlisted personnel assigned to the 1st Electronic Combat Range Group. Representatives from Martin Marietta and General Dynamics are also present to train blue-suiters to operate and maintain the radar equipment.

Low-level flight, of course, is inherently dangerous. With the addition of ground threats, even though they are simulated, the environment becomes stressful indeed. Crew

members' reactions to these situations and their degree of cooperation are almost as important as putting bombs on target.

"The whole crew has to get involved when flying a mission," maintains Maj. Randy Jameson, a B-52 instructor radar navigator with the 25th STS. "Historically, the crew was compartmentalized. The pilots could react to threats, but that was it. But now, because the number of threats in combat will be so great, all six people have to know what's going on. For example, a pilot can turn to avoid a SAM site, but he needs to tell me so I can make corrections to my bomb calculations. Otherwise, we'll miss the target."

How the Crews Improve

The STRC is a valuable training tool because every action, reaction, radio transmission, and emission from both aircraft and ground units is recorded. After each of the three sorties that transient crews fly during their week at Ellsworth, the 25th STS instructors give them a thorough debriefing and replay the mission.

"We're not here to evaluate the crews that come in," says Major Jameson. "We say, 'Here is what you did, and here is how we think you can do better.' What we want is for them to learn and improve."

In each of the eight debriefing rooms in the STC building is a large screen with a graphic symbol generator. The record of the mission can be displayed from several perspectives. Crews can see their overall route, if they wish, or just a part of it in greater detail. They can see the radar track. They can take a broad, comprehensive view of the flight. Or, because different images can be cast simultaneously onto four different sections of the screen, they can view a combination of any of these. The rooms also contain two VCRs for watching videotape recorded from the aircraft or from a ground-tracking station.

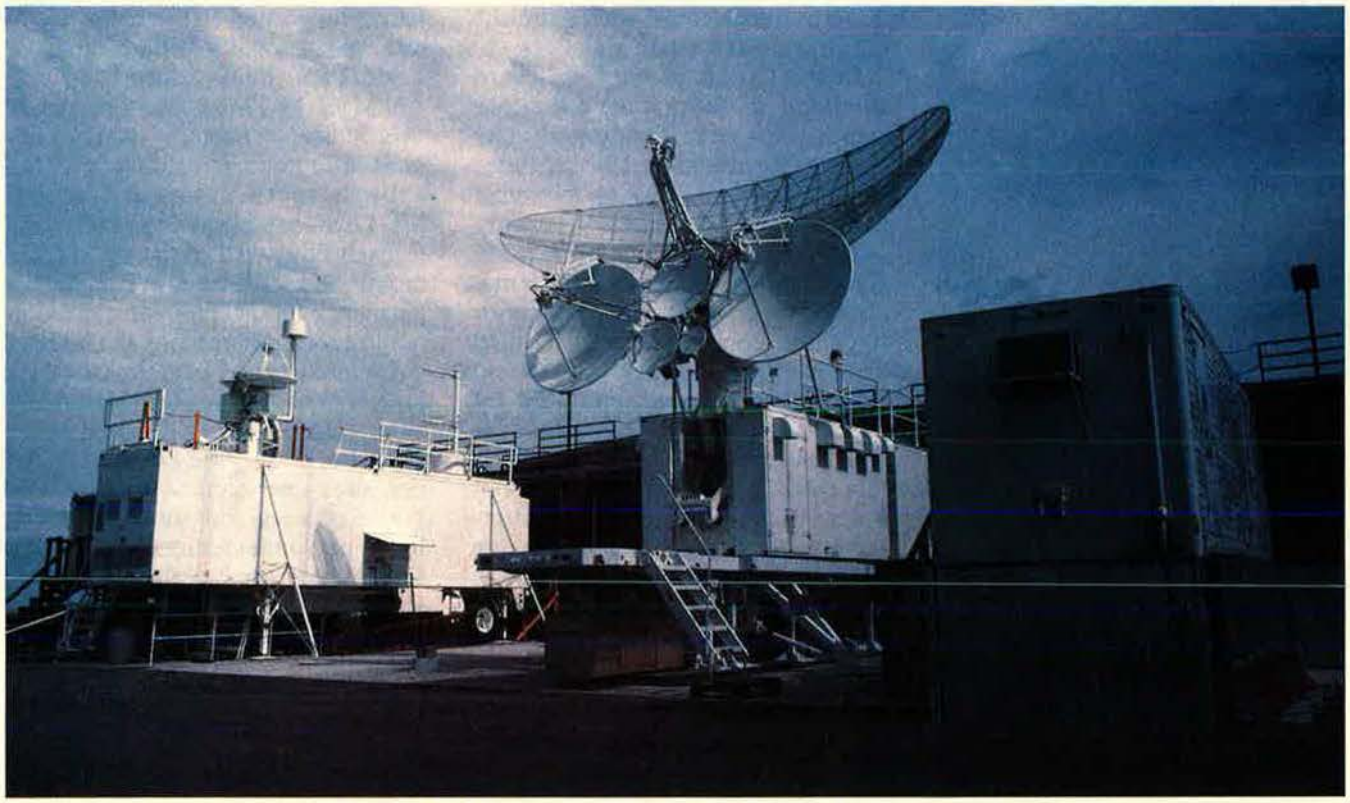
The mission-debrief system's Digital Vax mainframe computers have an artificial-intelligence-based subsystem, permitting crews to play "what if" with the mission. Instead of showing events as they occurred, the computer can take the terrain and threat data and show what would have happened if the crew had chosen another attack axis or had performed a different evasive maneuver.

Unlike events at the Air Force's Fighter Weapons School course or the Navy's Top Gun program, STC training sorties are not rigidly structured and don't always get progressively harder. Crews can fly a completely "canned" profile, in which everything is known in advance. Or, says TSgt. Tim Ruening, an instructor gunner with the 25th STS, "we can throw some surprises at them if they have progressed." Even reflies of the same profile can be arranged, if the crew or instructors think it is necessary.

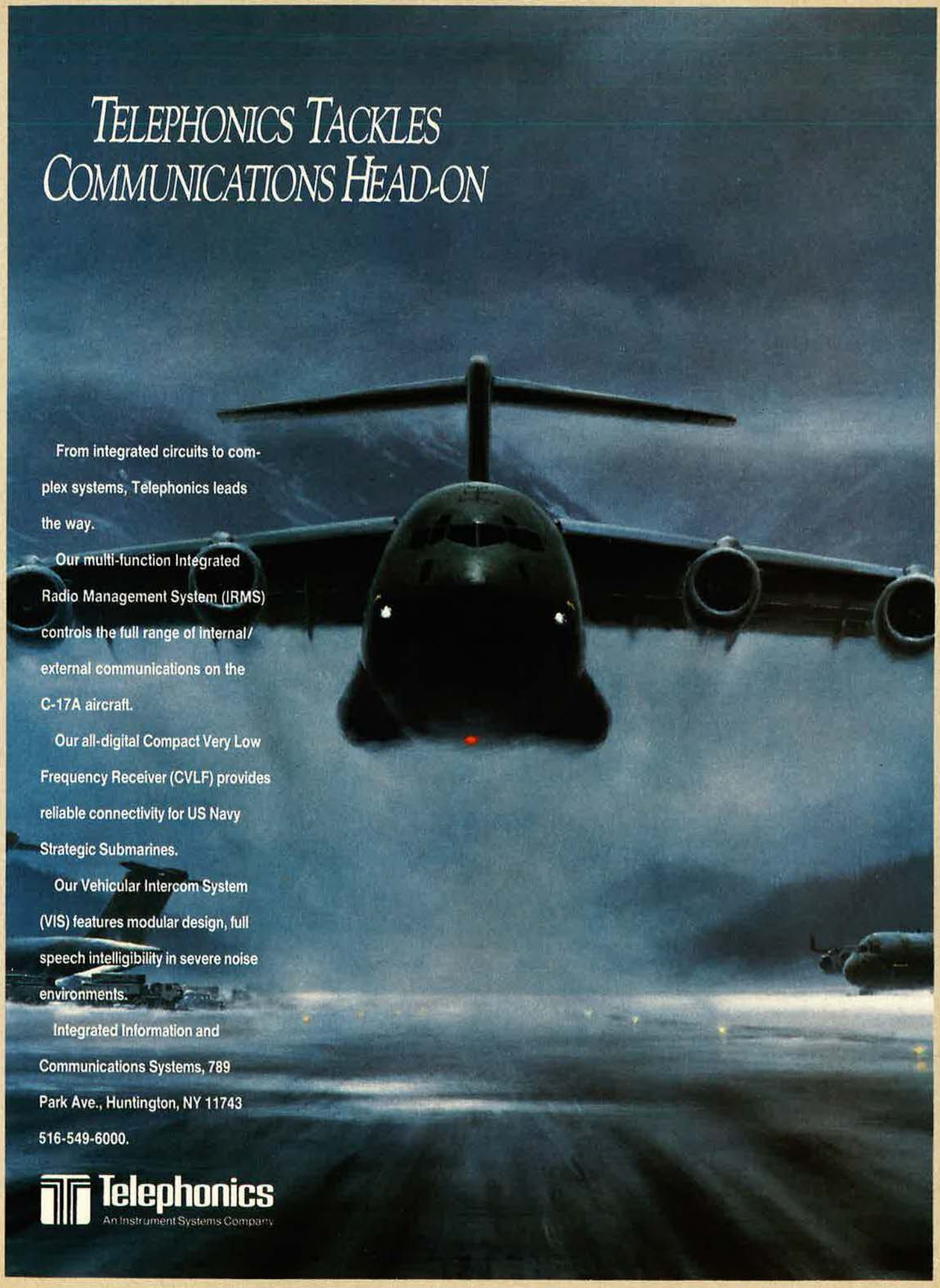
"The talent level is different across the command," notes Colonel McKeon. "We develop different scenarios to fit the talent level. The same basic things will happen each week at the Center, but at different levels of intensity. The one-week type of operation we run allows us to get the training done and keep maintenance to a minimum."

"We have a unique relationship here, in that none of the aircraft we service belongs to us," says Maj. Christine Nelson, Commander of the 28th Consolidated Aircraft Maintenance Squadron at Ells-

—USAF photo by SSgt. Melba Tamayo



Six permanent radar bomb scoring sites, such as this one near Belle Fourche, S. D., are scattered over the fourteen low-level training routes that make up the Strategic Training Route Complex. Shown are the MUTES and TRAINS, a pair of systems that first imitate the signals of up to ninety threat radars and then record the bomber crew's reaction to those signals.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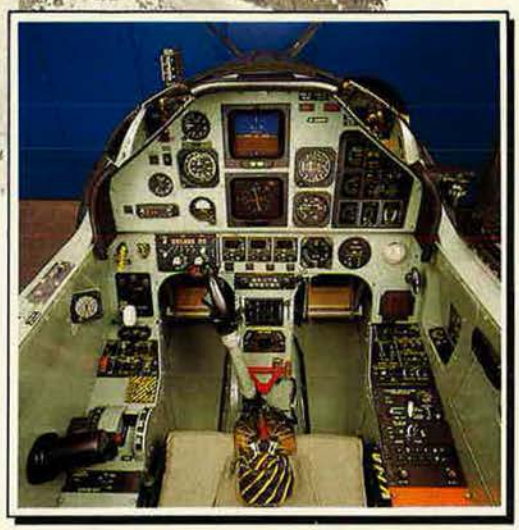

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—USAF photo by A1C Milia Gaffney

How well the entire crew works together is a key to mission success, both in training and on actual missions. Crew coordination is emphasized during training at the LeMay Center. At right, a 25th STS crew gets ready for the day's flight. The lessons learned in South Dakota not only improve the performance of individual crews but also may be passed on to other squadron and wing crews once a crew returns to its home base after training.

worth. Also unique is the fact that the 28th CAMS must keep two types of aircraft (B-52G/H and FB-111) repaired and flying, though neither type is assigned to the base.

With help from Air Force Logistics Command, Major Nelson and her staff looked at the types of parts that the two aircraft need most frequently and laid in a supply. Her spares stock even includes replacement engines, and it has been necessary for the unit to install some. Maintenance for transient B-1Bs is handled by Ellsworth's 28th Organizational Maintenance Squadron.

What's in the Works

The 99th SWW is the third active wing at Ellsworth, a first for a SAC base. New facilities built for the wing include the STC, a futuristic $5.4 million structure that houses the debriefing rooms, mission-planning rooms, a large squadron-briefing room, the STRC range control center, an intelligence and weather section (with all the attendant equipment), and offices and locker rooms for the 25th STS instructors and visiting aircrews.

Other new construction includes a companion building to the STC that will house the STDC and the wing's executive offices and a third building that will serve as quarters for the crews that come in to train. Groundbreaking for the STDC building will occur this winter, and work is under way on the crew quarters.

An integral system soon to be installed at the STC will be a Route Integration Instrumentation System, which will enable the STRC range control center to use a series of land lines to direct scenarios and monitor aircraft in real time. The system will also allow the operations staff and radar sites staff to change a mission profile much more rapidly. GTE is installing this system for operational use in a few months.

Though the STRC is designed to train one bomber crew to penetrate a target area, drop its bomb load, and survive a return trip, plans are being made to include other aircraft in the missions. In some, fighters will participate as adversaries. In others, the "fast movers" will join the bombers to create a force package that attacks a target.

Plans are even being made to include the Northrop B-2A Stealth bomber in the STC curriculum. Though still in the earliest stages, the current plan is to have the B-2 crews fly the STRC from home base at Whiteman AFB, Mo., return to base, and then get the debrief information over the telephone and the mission data from installed computer terminals or some other means.

The underlying concept of the Strategic Warfare Center is summed up well by Colonel McKeon. "We may get all the buildings and computers," he says, "but we will never reach full-up capability, because we are dealing with ideas. You take the talent and intellect of the crews we have in Strategic Air Command, and there is no limit to what we can do here." ■

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Force quality begins with Air Training Command.

The Foundation

BY LT. GEN. ROBERT C. OAKS

THE Air Force has taken enormous strides during the past decade, and Air Training Command has been in the forefront—enhancing readiness through top-quality, highly trained people. As the Air Force moves toward the new challenges of the twenty-first century, Air Training Command continues to provide the foundation for its success.

A decade ago, all indicators pointed toward a less capable Air Force—declining defense budgets, aging weapon systems, and dwindling numbers of young people to man the force. All services missed their recruiting goals in 1979, and pilot retention was alarmingly low. New problems were constantly arising to challenge the quality and capability of America's armed forces.

Now, just ten years later, our Air Force is better prepared than ever to carry out its vital mission.

The turnaround occurred because of a renewed commitment by the American people to a strong defense and the hard work and innovation of blue-suiters from the flight lines to the Pentagon. The cornerstone of this recovery is also the cornerstone of today's Air Force readiness: high-quality people.

ATC is proud of its contributions to the Air Force's success, but it is not resting on its laurels. By continuing a tradition of superb recruiting, ATC continues to attract the nation's best young people. By constantly refining its training techniques, ATC continues to provide the world's best aerospace training. On this solid foundation will be built the Air Force of our future.

ATC today is a command of change and challenge. From its basic structure to its teaching methods, the entire command is permeated by change.

—Photo by Paul Kennedy

At Sheppard AFB, Tex., enlisted men study for an ATC course. Sheppard Technical Training Center conducts courses in specialties from aircraft maintenance to biomedical sciences.

—USAF photo by CMSgt. Don Sutherland

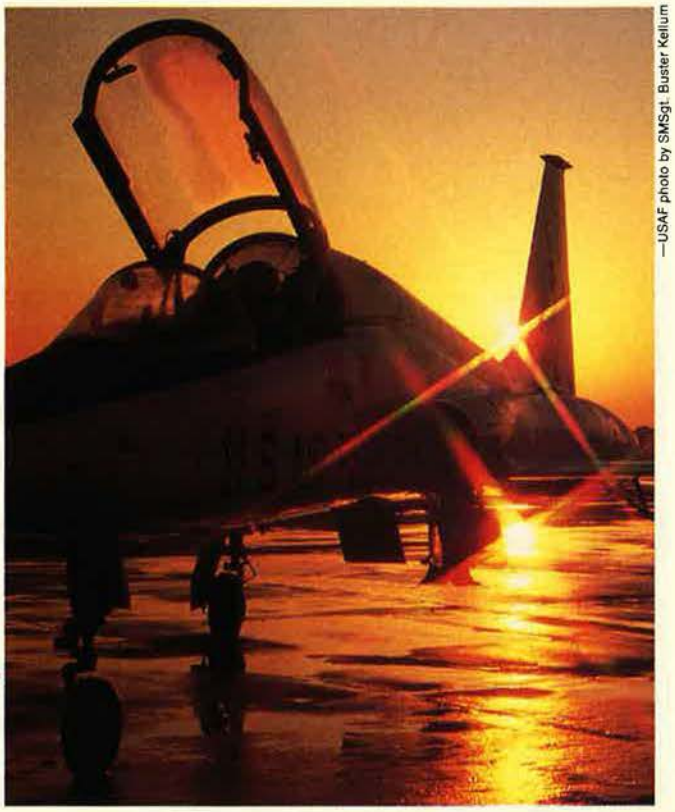
One of the most noticeable changes is the plan to close two of ATC's thirteen installations. The President's Commission on Base Realignments and Closures marked Chanute AFB, Ill., and Mather AFB, Calif., for closure, with their missions to be relocated. Planning is under way to relocate Chanute's technical training, one sixth of the total Air Force load, to ATC's other technical training centers and to relocate Mather's navigator-training mission to Beale AFB, Calif. By early 1990, the Command will begin the systematic transfer of training courses, which will ensure that the last graduates at Chanute and Mather receive the same high-quality training provided to their predecessors.

Another change is the diminished number of airmen carrying out maintenance on ATC flight lines. Over the past year, aircraft maintenance activities at Reese AFB, Tex., Laughlin AFB, Tex., and Williams AFB, Ariz., have begun conversion to either contract or in-house civilian maintenance, joining the previously contracted flight lines of Sheppard AFB, Tex., Vance AFB, Okla., and Columbus AFB, Miss. Only one more command base remains to be converted—Mather. That conversion should begin in early 1990.

Change in the Air

The heart of ATC's modernization was the USAF Trainer Master Plan, released in April 1988. In February 1989, the plan was updated with the Department of Defense's 1989 Aircraft Trainer Master Plan. This plan included a report on progress by the Air Force and Navy toward a joint-service acquisition schedule for trainer aircraft and related systems. The core of joint acquisi-

ATC's SLEP and Pacer Classic programs extend the life of its T-37 and T-38s, respectively. Above, T-37 navigator training at Mather AFB, Calif., soon to be relocated to Beale AFB, Calif.; below, a T-38 used for high-performance pilot training.



—USAF photo by SMSgt. Buster Kellum

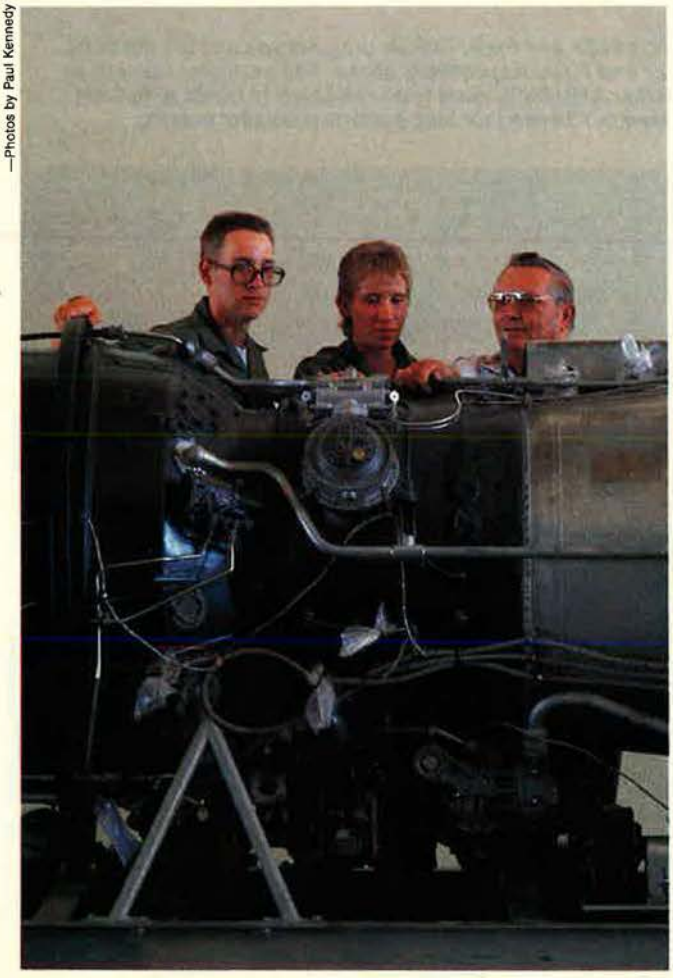
tion is the joint specification of requirements. Air Force and Navy experts are currently developing documentation for the Primary Aircraft Training System. The goal is to meet both services' near- and long-term needs with maximum opportunities for joint procurement of training systems.

Delivery of the DoD master plan to Congress represented a renewed commitment to Specialized Undergraduate Pilot Training (SUPT) and to modernization of the trainer aircraft fleet. A major step in converting the plan from paper to hardware occurred in August, when Air Force Systems Command requested proposals from aerospace industries for the Tanker/Transport Training System (TTTS). Source selection is ongoing and is scheduled to be completed in March 1990. Current plans call for the purchase of 211 off-the-shelf business aircraft (modified for Air Force needs), up to fourteen simulators, courseware, and other related training devices. Students are scheduled to begin SUPT in late 1992 at Reese AFB, Tex.

Delivery of the TTTS is critical for two reasons. We need the aircraft in order to begin dual-track SUPT. Equally important, the TTTS will relieve pressure on the aging T-38 fleet by reducing the number of sorties that the 1950s-vintage aircraft must fly. That relief is vital if the T-38s are to continue to serve as an advanced trainer into the twenty-first century.

Even that won't be enough to keep the current trainer fleet flying as long as needed. The T-37 Tweet and the T-38 Talon are undergoing modifications to extend their lives. This year, Air Force Logistics Command awarded a contract to provide kits for the T-37 Service Life Extension Program (SLEP). The program will replace two fatigue-critical components of the Tweets: the forward wing spar lower cap and the "302" fittings, where the wing attaches to the fuselage. The horizontal stabilizer, the wing center carry-through structure, and the banjo fittings in the tail will be inspected and, if necessary, replaced. With these modifications, along with changes to our inspection program, the T-37's life can be safely extended. SLEP combines with the ongoing Pacer Classic program for the Talon.

—Photos by Paul Kennedy



ATC recruits the nation's brightest young people and gives them the world's best aerospace training. Above, a recruit takes an electronics laboratory course; left, recruits receive instruction from civilian aerospace experts.

Along with equipment changes, ATC has taken a hard look at how it trains. During 1989, the Command conducted Broad Area Reviews on both flying training and technical training. Experts throughout the Air Force looked at everything from training philosophy to facilities and developed more than 100 initiatives to improve training.

The Diminishing Pool

One of the greatest challenges facing ATC is to recruit top-quality young people, and this challenge grows more demanding each year. Last year, the Air Force delivered 43,000 high-quality enlistees to achieve its recruiting goals. But there is reason for concern. America's labor pool is shrinking, and the competition from schools and industry for America's best and brightest is intense. Increased recruiting goals in 1990 bring a magnified challenge, but it is one that ATC's recruiters—2,555 volunteers—will tackle and, with the support of America's people, achieve.

As the 1990s loom, the nation and the Air Force face a world changing faster than at any time since the end of World War II. ATC, in its current climate of change, is out in front as it restructures to meet the needs—many of which have yet to be determined—of tomorrow's Air Force. ■

Lt. Gen. Robert C. Oaks, USAF, is Commander of Air Training Command.

AERMACCHI

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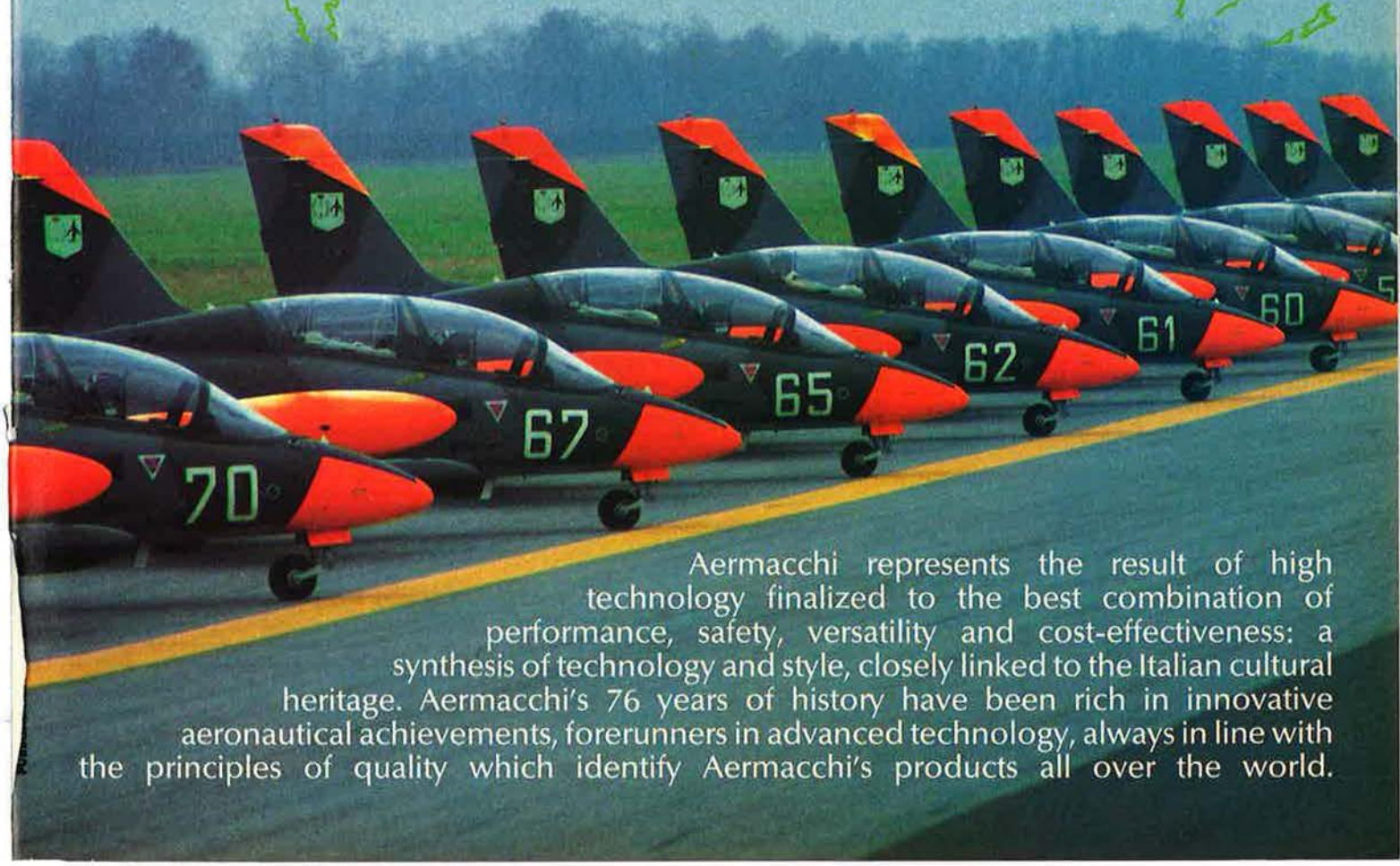


Aermacchi represents the result of high technology finalized to the best combination of performance, safety, versatility and cost-effectiveness: a synthesis of technology and style, closely linked to the Italian cultural heritage. Aermacchi's 76 years of history have been rich in innovative aeronautical achievements, forerunners in advanced technology, always in line with the principles of quality which identify Aermacchi's products all over the world.

World Gallery of Trainers

BY JOHN W. R. TAYLOR and KENNETH MUNSON

Piston-Engine Trainers

AIRTRAINER CT4

Australian Henry Millicer's Airtourer *ab initio* trainer, winner of a Royal Aero Club design competition, first flew in March 1959, and over 170 were built in Australia for civil flying clubs. The prototype CT4, a New Zealand redesign for military primary training, first flew on 23 February 1972. When production ended in 1977, PAC had delivered a total of 94 CT4As and CT4Bs to the air forces of Australia (51), New Zealand (19), and Thailand (24). PAC is now offering three new variants, of which the CT4D is a more powerful development of the CT4A/B with a 282 hp Textron Lycoming TIO-360 turbocharged piston engine and nonretractable landing gear. The CT4C is similar, but with a 420 shp Allison 250-B17 turboprop and length of 23 ft 5 in. The CT4CR differs from the CT4C in having retractable landing gear.

Contractor: Pacific Aerospace Corporation Ltd, New Zealand.
Power Plant (CT4D): one Textron Lycoming TIO-360 piston engine; 282 hp.
Dimensions (CT4D): span 26 ft 0 in, length 23 ft 2 in, height 8 ft 6 in.
Weight (CT4C/CR/D): gross 2,650 lb.
Performance (CT4D): max speed at S/L 179 mph, at 20,000 ft 216 mph; stalling speed (flaps down) 51 mph, T-O run 647 ft, max range 728 miles.
Performance (CT4CR): max speed at S/L 269 mph, at 10,000 ft 276 mph, stalling speed (gear and flaps down) 51 mph, service ceiling 32,500 ft, T-O run 384 ft, landing run 525 ft, max range 834 miles.
Accommodation: two seats side by side. Space to rear for optional third seat or 115 lb of baggage.
Armament: none.

AS 202 BRAVO

This popular little trainer originated with SIAI-Marchetti in Italy, but was taken over at an early stage by the Swiss FFA company. Initial production (of 34 aircraft) centered on the AS 202/15 version, with a 150 hp O-320 engine, but the principal version since the early 1980s has been the still-current AS 202/18A, with a more powerful engine. Customers for the latter have included the British Aerospace Flying College (11, which have the name Wren), Royal Air Maroc (5), the Royal Flight of Oman (4), the Uganda Central Flying School (8), and the air forces of Indonesia (40), Iraq (48, some of which were transferred to Jordan), and Morocco (10). Subvariants differ in having electrical instead of mechanical trim, a 24V instead of 12V electrical system, special instrumentation, or an extended canopy. Fully aerobatic, the Bravo is used for the screening and training of both commercial and military pilots, and can operate from grass strips. *(Data for AS 202/18A.)*

Contractor: FFA Flugzeugwerke Altenrhein, Switzerland.
Power Plant: one Textron Lycoming AEIO-360-B1F piston engine; 180 hp.
Dimensions: span 31 ft 11¾ in, length 24 ft 7¼ in, height 9 ft 2¾ in.
Weights: empty 1,565 lb, gross (aerobatic) 2,160 lb, max gross 2,380 lb.
Performance (at max gross weight): max speed at S/L 150 mph, max cruising speed at 8,000 ft 141 mph, stalling speed (flaps down) 56 mph, service ceiling 17,000 ft, T-O run 705 ft, landing run 690 ft, max range (no reserves) 707 miles, *g* limits +6/−3.
Accommodation: crew of two side by side in aerobatic version; space behind these in utility version for third seat or 220 lb of baggage.
Armament: none.

CAP 10

Fifty-six of these side by side two-seaters were supplied to the French Air Force and six to the French Navy.

PAC CT4B Airtrainer, Royal New Zealand Air Force (Paul Jackson)

FFA AS 202/18A Bravo, Oman

Mudry CAP 10 B, French Air Force (Paul Jackson)

Socata Epsilon, Portuguese Air Force

Socata Oméga prototype

Their design was based on that of the popular Piel Emeraude sporting aircraft, retaining a wooden airframe with fabric-covered rear fuselage. They are fully aerobatic, and the current CAP 10 B is FAA certificated for day and night VFR operation. French Air Force CAP 10s are based at the École de l'Air at Salon de Provence and EFIPN 307 (École de Formation Initiale du Personnel Navigant) at Avord. Twenty delivered to the Mexican Air Force's flying school are equipped almost to IFR standard.

Contractor: Avions Mudry et Cie, France.
Power Plant: one Textron Lycoming AEIO-360-B2F piston engine; 180 hp.
Dimensions: span 26 ft 5¼ in, length 23 ft 6 in, height 8 ft 4½ in.
Weights: empty 1,213 lb, max aerobatic 1,675 lb, gross 1,829 lb.
Performance: max speed at S/L 168 mph, max cruising speed 155 mph, stalling speed (flaps down) 50 mph IAS, service ceiling 16,075 ft, T-O run 1,149 ft, landing run 1,182 ft, max range 621 miles, *g* limits +6/−4.5.
Accommodation: crew of two side by side; space behind these for 44 lb of baggage.
Armament: none.

CJ-6 (PT-6)

This basic training aircraft was developed in China to replace the Yak-18A, and the uprated Chinese CJ-5 version of that aircraft, in service with the PLA Air Forces. The configuration remains generally unchanged, but construction is all-metal with a fully retractable tricycle landing gear, fitted with low-pressure tires for operation from grass strips. More than 2,000 CJ-6s (Westernized designation PT-6) have been delivered, including exports to Albania, Bangladesh, Cambodia, North Korea, Tanzania, and Zambia. Civil variants, adapted for a wide variety of duties such as cropspraying, seed-sowing, forest firefighting and patrol, fisheries surveillance, photogrammetry, aerial photography, geological survey, and coastal and border patrol, are also available, under the name Haiyan (Petrel). *(Data for CJ-6.)*

Contractor: Nanchang Aircraft Manufacturing Company, People's Republic of China.
Power Plant: one Zhuzhou Huosai-6A nine-cylinder radial engine; 285 hp.
Dimensions: span 33 ft 4¾ in, length 27 ft 9 in, height 10 ft 8 in.
Weights: empty 2,584 lb, gross 3,128 lb.
Performance: max speed 178 mph, service ceiling 16,665 ft, T-O run 920 ft, landing run 1,150 ft, endurance 3 h 36 min.
Accommodation: two seats in tandem.
Armament: none.

EPSILON and OMEGA

Developed to meet a French Air Force requirement for a propeller-driven aircraft that would improve the cost-effectiveness of its initial pilot training, the Epsilon prototype flew for the first time on 22 December 1979. The 150 production Epsilons ordered subsequently for the French Air Force were delivered at the rate of 30 a year. They equip Groupement École 315 at Cognac/Chateaubernard and had logged a total of 110,000 flying training hours by mid-1989. The first of 18 ordered for the Portuguese Air Force was delivered by Socata in January 1989. The remainder are being assembled by OGMA in Portugal. An armed version is available for export, with four underwing hardpoints for a total of 661 lb of stores with pilot only. Armed with two twin 7.62 mm machine-gun pods, it can loiter for 30 min at low altitude over a combat area 195 miles from its base. First customer for this version was the Togolese Air Force, which acquired three, plus an attrition replacement.

At the 1989 Paris Air Show, Socata demonstrated a turboprop development of the Epsilon, built as a private venture and named Oméga. The two trainers have a 60 percent commonality of components. Main innovations in the Oméga are a 488 shp Turbomeca TP 319-1A2 turboprop, derated to 360 shp, Martin-Baker 15FC lightweight ejection seats, a two-piece canopy, and increased

fuel to permit two full training missions without refueling. Max cruising speed is 269 mph; design *g* limits are +7/−3.5. *(Data for standard unarmed Epsilon.)*

Contractor: Socata (subsidiary of Aérospatiale SNI), France.

Power Plant: one Textron Lycoming AEIO-540-L1B5D piston engine; 300 hp.

Dimensions: span 25 ft 11¾ in, length 24 ft 10¾ in, height 8 ft 8¾ in.

Weights: empty 2,055 lb, gross 2,755 lb.

Performance: max speed at S/L 236 mph, max cruising speed at 6,000 ft 222 mph, stalling speed (gear and flaps down) 72 mph, service ceiling 23,000 ft, T-O run 1,345 ft, landing run 820 ft, endurance 3 h 45 min, *g* limits +6.7/−3.35.

Accommodation: two seats in tandem. Rear seat raised.

Armament (optional): two Matra CM pods each containing two 7.62 mm machine-guns, or four Matra F2D packs each containing six 68 mm rockets, or two 275 lb bombs, or two grenade launchers, or four survival kits.

FFA-2000 EUROTRAINER

Expected to make its first flight in May 1990, the FFA-2000 was developed to meet the requirements of Swissair, the Swiss national airline, as a replacement for the piston engined Piaggio P.149s that have been used at the company's national pilot training school for the past quarter of a century. The Eurotrainer will be suitable for IFR training and limited aerobatics, with an airframe of proven composite materials (glassfibre and carbonfibre). The wings, which have an advanced laminar flow section, are being designed and built by Gyroflug in West Germany. The aircraft's design has also been configured to meet military pilot selection and *ab initio* training requirements, up to the point of transition to a tandem-seat turboprop or jet advanced trainer. Two prototypes are being built; Swissair has placed an initial order for eight Eurotrainers, with a possibility of others to follow. Deliveries to the airline are scheduled to begin in 1991.

Contractor: FFA Flugzeugwerke Altenrhein, Switzerland.

Power Plant: one Textron Lycoming AEIO-540-L1B5 piston engine; derated to 270 hp. Porsche PFM 3200-T03 engine of similar rating may become available later.

Dimensions: span 34 ft 0¾ in, length 26 ft 6½ in, height 8 ft 11¾ in.

Weights: empty 1,962 lb, gross 3,152 lb.

Performance (estimated, at two-seat trainer T-O weight): max speed at S/L 212 mph, econ cruising speed (65% power) at S/L 186 mph, stalling speed (gear and flaps down) 59 mph, service ceiling 19,685 ft, T-O to 50 ft 1,083 ft, landing from 50 ft 1,411 ft, endurance (45 min reserves) 4 h, *g* limits +6/−3.

Accommodation: two or four persons, in side by side pairs.

Armament: none.

HPT-32 and HTT-34

The Indian Air Force (40) and Navy (8) are the only known customers for this Bangalore-designed two-seater, deliveries to the former having started in about 1982–83. Development of the HPT-32 was somewhat protracted, four and a half years elapsing between the initial flights of the first prototype (6 January 1977) and the third (production standard) prototype on 31 July 1981. The all-metal HPT-32 was designed to FAR Pt 23 standards, to fulfill the roles of *ab initio*, aerobatic, night flying, instrument flying, and navigation training. Secondary roles can include liaison, observation, glider or target towing, and search and rescue. In June 1984, HAL began test-flying a private-venture turboprop version known as the HTT-34—actually the third prototype HPT-32 refitted with a 420 shp Allison 250-B17D engine—and in early 1989 rollout of the first preproduction example was accompanied by the news that the Nigerian Air Force had ordered 48 of this version.

Contractor: Hindustan Aeronautics Ltd (Kanpur Division), India.

Power Plant (HPT-32): one Textron Lycoming AEIO-540-D4B5 piston engine; 260 hp.

Power Plant (HTT-34): one Allison 250-B17D turboprop; 420 shp.

Dimensions: span 31 ft 2 in, length 25 ft 4 in (HTT-34, 26 ft 5¾ in), height 9 ft 5½ in.

Weights (HPT-32): empty 1,962 lb, gross 2,756 lb.

Weights (HTT-34): empty 1,909 lb, gross 2,866 lb.

Performance (HPT-32): max speed at S/L 164 mph IAS, max cruising speed at 10,000 ft 132 mph, stalling speed (flaps down) 69 mph, service ceiling 18,045 ft, T-O run 1,132 ft, landing run 720 ft, max range 462 miles, *g* limits +6/−3.

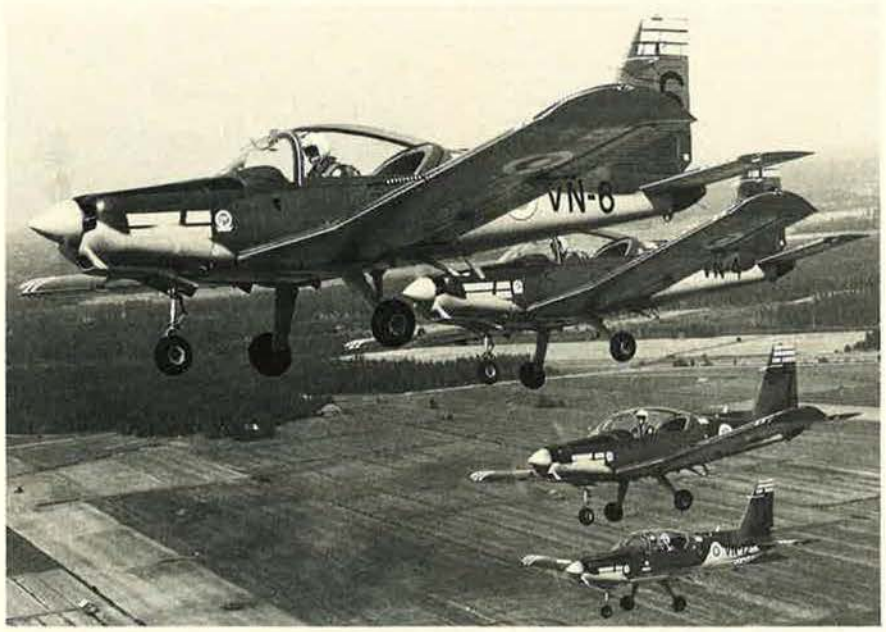
Performance (HTT-34): max speed at 9,850 ft 171 mph, stalling speed (flaps and gear down) 67 mph, service ceiling 26,000 ft, T-O to 50 ft 811 ft, landing from 50 ft 1,247 ft, max range at 11,480 ft 435 miles, *g* limits +6/−3.

Accommodation: two seats side by side.

Armament: none known.

Model of FFA-2000 Eurotrainer in wind tunnel at Swiss Federal Aircraft Factory

HAL HTT-34 prototype



Valmet L-70 Vinkas, Finnish Air Force

PZL Mielec M-26 01, second Iskierka prototype (Lech Zielaskowski)

L-70 VINKA

The Vinka (named after a cold Arctic wind) is a versatile, fully aerobatic two/four-seater with a general configuration reminiscent of that of the Socata/Morane-Saulnier Rallye. It was developed under a 1973 contract from the Finnish Air Force, flying for the first time two years later and entering service in 1980. As a two-seater, it meets the requirements of FAR Pt 23 in the aerobatic and utility categories; as a four-seater for liaison, air ambulance, and other duties, it conforms to normal category FAR Pt 23 standards. Fatigue life in military service is more than 8,000 hours, and it can be adapted for ski takeoffs and landings. Standard roles are those of primary, aerobatic, night, instrument, and tactical training, but the Vinka can be used also for casevac, search and rescue, supply dropping, weapon training, target towing, and reconnaissance. The Finnish Air Force, which received 30 Vinkas, remains the L-70's only military operator, but the aircraft is available for export, under the name Miltrainer.

Contractor: Valmet Aviation Industries, Finland.

Power Plant: one Textron Lycoming AEIO-360-A1B6 piston engine; 200 hp.

Dimensions: span 31 ft 7¼ in, length 24 ft 7¼ in, height 10 ft 10¼ in.

Weights: empty 1,691 lb, gross (aerobatic) 2,293 lb, max gross 2,756 lb.

Performance (at 2,205 lb gross weight): max speed at S/L 146 mph, max cruising speed at 5,000 ft 138 mph, stalling speed (flaps down) 53 mph, service ceiling 16,400 ft, T-O run 755 ft, landing run 575 ft, max range 590 miles, *g* limits +6/−3.

Accommodation: crew of two side by side; space behind these for two more seats or up to 617 lb of baggage.

Armament: two hardpoints under each wing for (as two-seater) total of up to 661 lb of bombs, flare pods, rocket pods, machine-gun pods, antitank missiles, TV or still camera pods, or rescue/liferaft packs and a searchlight.

M-26 ISKIERKA

One of two new piston-engined trainers at present being developed by the Polish aerospace industry, the Iskierka is designed to FAR Pt 23 and is intended to meet the requirements for both civilian pilot training and pilot selection for military training. Still undergoing flight test in 1989, it flew for the first time on 15 July 1986 with a PZL-F (Polish Franklin) engine, but is being developed also, with a view to possible export, in more powerful form with a Textron Lycoming flat-six fuel injection engine, as fitted to the M-26 01 second prototype, which made its first flight on 24 June 1987. The Iskierka (little spark) has clearly been designed for low-cost production and operation, utilizing selected wing, tail, landing gear, and other components of Poland's license-built version of the Piper Seneca III, the PZL Mielec M-20 Mewa.

Contractor: WSK-PZL Mielec, Poland.

Power Plant: one PZL-F 6A-350CA piston engine; 205 hp (M-26 00), or one Textron Lycoming AEIO-540-L1B5D engine; 300 hp (M-26 01).

Dimensions: span 28 ft 2½ in, length 27 ft 2¾ in, height 9 ft 8½ in.

Weights (M-26 00): empty 1,874 lb, gross 2,645 lb.

Performance (M-26 00): max speed at S/L 165 mph, stalling speed (flaps down) 61 mph, T-O to 50 ft 1,476 ft, landing from 50 ft 1,411 ft, max range (30 min reserves) 584 miles, *g* limits +6/−3.

Accommodation: crew of two in tandem. Rear seat elevated.

Armament: none.

PILLÁN

Design of this fully aerobatic basic and instrument flying trainer was based on the Piper Cherokee series, using in particular many components of the PA-28 Dakota and PA-32 Saratoga. The first of two prototypes built

by Piper was flown on 6 March 1981. Three further aircraft were delivered from the US as kits for assembly in Chile by ENAER, a state-owned company established by the Chilean Air Force. By mid-1989, this Air Force was due to have received all 60 of the T-35A Pillán (Devil) primary trainers, and 20 T-35B instrument trainers, covered by initial contracts. Forty T-35Cs, supplied in kit form by ENAER for assembly in Spain by CASA, serve with the Spanish Air Force as E.26 Tamiz primary trainers. Ten instrument trainer T-35Ds were delivered to the Panamanian Air Force in 1988–89. A single-seat T-35S is under evaluation, following a first flight on 5 May 1988. This prototype has the standard piston engine, but the T-35S is intended to have a 420 shp Allison 250-B17 turboprop if ordered into production. *(Data for T-35A.)*

Contractor: Empresa Nacional de Aeronáutica de Chile (ENAER), Chile.

Power Plant: one Textron Lycoming IO-540-K1K5 piston engine; 300 hp.

Dimensions: span 29 ft 0 in, length 26 ft 3 in, height 8 ft 8 in.

Weights: empty 2,050 lb, gross (aerobatic) 2,900 lb, max gross 2,950 lb.

Performance: max speed at S/L 193 mph, max cruising speed at 8,800 ft 166 mph IAS, stalling speed (gear and flaps down) 72 mph, service ceiling 19,160 ft, T-O run 940 ft, landing run 780 ft, max range (with reserves) 748 miles, *g* limits +6/−3.

Accommodation: two seats in tandem. Rear seat raised.

Armament: none.

PZL-130 ORLIK and PZL-130TM TURBO-ORLIK

First flown on 12 October 1984, the piston engined PZL-130 received Polish aerobatic and utility category certification in early 1988. Like the smaller M-26 Iskierka (which see), the Orlik (Spotted Eaglet) was designed to train both civilian and military pilots, though over a wider spectrum ranging from preselection through basic, aerobatic, instrument, navigation, formation, weapons, and aerial combat training, as well as for such roles as reconnaissance, target acquisition, and target towing. Cockpit instruments and displays are installed in modular units similar to those of modern combat aircraft, to permit quick changes of avionics and equipment and enable the Orlik to act as a 'flying operational simulator' for jet powered military aircraft. One of the three prototypes was fitted with a 550 shp Pratt & Whitney Canada PT6A-25A turboprop, in a more slimline cowling, as the Turbo-Orlik, but was lost on an early test flight. Seven preseries aircraft have followed, two with piston engines, one with a PT6A-25A, and three of the others as PZL-130TMs, each powered by a Czechoslovak turboprop engine. This last-mentioned Turbo-Orlik variant flew for the first time on 12 January 1989. A production decision for the Orlik and/or Turbo-Orlik was expected before the end of 1989.

Contractor: WSK-PZL Warszawa-Okecie, Poland.

Power Plant (PZL-130): one Vedeneyev M-14Pm nine-cylinder radial engine; 330 hp.

Power Plant (PZL-130TM): one Motorlet Walter M 601 E turboprop; 751 shp.

Dimensions: span 26 ft 3 in, length 27 ft 8¾ in (PZL-130TM 28 ft 7¾ in), height 11 ft 7 in.

Weights (PZL-130): empty 2,529 lb, gross (aerobatic) 3,196 lb, max gross 3,527 lb.

Weights (PZL-130TM): empty 2,976 lb, gross (aerobatic) 3,307 lb, max gross 4,358 lb.

Performance (PZL-130, aerobatic): max speed at S/L 211 mph, max cruising speed at S/L 180 mph, stalling speed (gear and flaps down) 74 mph, service ceiling 14,000 ft, T-O run 1,115 ft, landing run 821 ft, max range (no reserves) 880 miles, *g* limits +6/−3.

Performance (PZL-130TM): max speed at S/L 315 mph, max cruising speed at 15,000 ft 309 mph, stalling speed (gear and flaps down) 69 mph, service ceiling 32,800 ft, T-O run 656 ft, landing run 1,247 ft, max range (no reserves) 652 miles, *g* limits +6/−3.

ENAER T-35D Pillán, Panamanian Air Force

Preproduction PZL Warszawa-Okecie PZL-130 Orlik

Preproduction PZL Warszawa-Okecie PZL-130TM Turbo-Orlik (Andrzej Glass)

SIAI-Marchetti SF.260M, Italian Air Force (Alex Hay Porteous)

SIAI-Marchetti SF.260TP

Slingsby T67M Firefly 200, Royal Hong Kong Auxiliary Air Force

Accommodation: crew of two in tandem. Rear seat elevated.

Armament: two hardpoints under each wing for practice bombs, gun and rocket pods, or other weapon training stores. Max external load (Turbo) 1,411 lb.

SF.260 and SF.260TP

Like the Jet Squalus (which see), the SF.260 family of fully aerobatic trainers originated in a design by the talented Italian engineer, Dott Ing Stelio Frati. The initial two/three-seat military SF.260M was flown for the first time on 10 October 1970 and was sold to Belgium, Bolivia, Burma, Ecuador, Libya, Morocco, the Philippines, Singapore, Thailand, Tunisia, Zaïre, and Zambia, as well as becoming the standard primary trainer of the Italian Air Force. It can be used for basic flying training, instrument flying, aerobatics including spinning, night flying, navigation, and formation training. From it was developed the SF.260W Warrior dual-role trainer/tactical support version, with underwing pylons for up to 661 lb of stores, which was bought by the air forces of Comoros, Dubai, Ireland, the Philippines, Rhodesia (now Zimbabwe), Singapore, and Tunisia. The later SF.260TP has a 350 shp Allison 250-B17D turboprop instead of the piston engine of the SF.260M/W, but is virtually unchanged aft of the firewall. More than 60 SF.260TPs have been ordered by Dubai, Ethiopia, Sri Lanka, Zimbabwe, and other military customers. *(Data for SF.260M except where indicated.)*

Contractor: SIAI-Marchetti SpA, Italy.

Power Plant: one Textron Lycoming O-540-E4A5 piston engine; 260 hp.

Dimensions: span over tiptanks 27 ft 4¾ in, length 23 ft 3½ in, height 7 ft 11 in.

Weights: empty 1,797 lb, gross (aerobatic) 2,425 lb, max gross 2,645 lb. (SF.260W and SF.260TP have gross weight of 2,866 lb.)

Performance (SF.260M): max speed at S/L 207 mph, max cruising speed at 4,925 ft 186 mph, stalling speed (gear and flaps down) 79 mph, T-O run 1,260 ft, landing run 1,132 ft, max range 1,025 miles, *g* limits (aerobatic) +6/−3.

Performance (SF.260TP): max speed at 10,000 ft 262 mph, max cruising speed at 8,000 ft 248 mph, stalling speed (gear and flaps down) 79 mph, T-O run 978 ft, landing run 1,007 ft, max range (with reserves) 589 miles.

Accommodation: two seats side by side, with third seat to rear.

Armament: none on SF.260M.

T67M FIREFLY

The original Slingsby T67A was a license-built version of the French Fournier RF6B light aircraft of wooden construction. All subsequent models, including T67M Firefly two-seat military basic trainers, have airframes built of glassfibre reinforced plastics. The basic Firefly 160, first flown on 5 December 1982, has a 160 hp Textron Lycoming AEIO-320-D1B engine, and a new canopy with fixed windscreen and upward hinged/rearward opening rear section, instead of the one-piece canopy of the civil T67s. The uprated Firefly 200, flown for the first time on 16 May 1985, differs in having an AEIO-360-A1E engine. Customers for the Firefly 200 include the Royal Hong Kong Auxiliary Air Force (4), the Norwegian Government's air academy (6), and the Turkish Aviation Institute at Ankara (10). All versions of the T67 are aerobatic. *(Data for Firefly 200.)*

Contractor: Slingsby Aviation Ltd, England.

Power Plant: one Textron Lycoming AEIO-360-A1E piston engine; 200 hp.

Dimensions: span 34 ft 9 in, length 24 ft 0¼ in, height 8 ft 3 in.

Weights: empty 1,560 lb, gross 2,150 lb.

Performance: max speed at S/L 161 mph, max cruising speed at 8,000 ft 150 mph, stalling speed (flaps down) 59 mph, T-O run 725 ft, landing run 870 ft, max range (with reserves) 575 miles, *g* limits +6/−3.

Accommodation: two seats side by side.

Armament: none.

UTVA-75A

There are three current versions of this Yugoslav light aircraft. The basic version, as described in detail, is the two-seat UTVA-75A21, which was first flown in prototype form on 19 May 1976. More than 135 have since been delivered to the Yugoslav Air Force and civilian flying clubs for basic training, glider towing, and utility duties. Light weapon loads can be carried on a pylon under each wing. The UTVA-75A41 is generally similar, but has four seats, in pairs, with no provision for armament. It entered production about two years ago, with a gross weight of 2,564 lb and slightly reduced overall performance. The UTVA-75A11 is an agricultural version, first flown on 3 March 1989. *(Data for UTVA-75A21.)*

Contractor: UTVA—Sour Metalne Industrije, Ro Fabrika Aviona, Yugoslavia.

Power Plant: one Textron Lycoming IO-360-B1F piston engine; 180 hp.

Dimensions: span 31 ft 11 in, length 23 ft 4 in, height 10 ft 4 in.
Weights: empty 1,510 lb, gross 2,116 lb.
Performance: max speed 133 mph, max cruising speed 115 mph, stalling speed (flaps down) 51 mph, service ceiling 13,125 ft, T-O run 410 ft, landing run 328 ft, max range 497 miles, *g* limits +6/−3.
Accommodation: two seats side by side.
Armament: pylon under each wing for a bomb, 220 lb cargo container, two-round rocket launcher, or machine-gun pod.

VENTURE

Known formerly as the SAH-1, representing the initials of its designer Sydney A. Holloway, this much-admired two-seat primary trainer is to be manufactured by Brooklands Aerospace as the Venture. An assembly line is being set up in parallel with that for the company's Optica Scout observation aircraft, and the first production Venture will be rolled out in summer 1990. The original SAH-1 prototype flew for the first time on 23 August 1983, and had obtained a full Public Transport Category Certificate of Airworthiness by the end of 1985. It has been flown by more than 500 civil and military pilots, and, in addition to the basic civil trainer, Brooklands Aerospace intends to offer an uprated military version with a 160 hp AEIO-320-DB engine and constant-speed propeller. *(Data for prototype.)*
Contractor: Brooklands Aerospace Group plc, England.
Power Plant: one Textron Lycoming O-235-L2A piston engine; 118 hp.
Dimensions: span 30 ft 8½ in, length 21 ft 10¼ in, height 7 ft 7½ in.
Weights: empty 1,100 lb, gross 1,750 lb.
Performance: max speed at S/L 140 mph, max cruising speed at S/L 127 mph, stalling speed (flaps down) 55 mph, service ceiling 16,400 ft, T-O to 50 ft 1,285 ft, max range (with reserves) 714 miles, *g* limit +6.
Accommodation: two seats side by side.
Armament: none.

Yak-52

The Yakovlev Yak-52 primary trainer is likely to represent the ultimate development of the lengthy series of aircraft that began more than 43 years ago with the venerable Yak-18. In addition to serving as two-seat trainers throughout the air forces of the Warsaw Pact nations and their friends, these aircraft set the standard for international aerobatic competition flying for many years in single-seat forms. Configuration and structure have changed little through the years, except for the switch from fabric covered to metal semi-monocoque rear fuselage, the use of more powerful engines, and the adoption in the Yak-52 of a unique tricycle landing gear in which all three wheels remain almost totally exposed under the fuselage and wings when retracted, to offer greater safety in a wheels-up emergency landing. Production of the Yak-52 is centered at the IAv Bacau plant in Romania, which delivered the 1,000th example in 1987. This plant is expected to manufacture also the Yak-53 single-seat counterpart of the Yak-52.
Contractor: Intreprinderea de Avioane Bacau, Romania.
Power Plant: one Vedeneyev M-14P nine-cylinder radial engine; 360 hp.
Dimensions: span 30 ft 6¼ in, length 25 ft 5 in, height 8 ft 10¼ in.
Weights: empty 2,205 lb, gross 2,844 lb.
Performance: max speed at 1,640 ft 186 mph, max cruising speed at 3,280 ft 167 mph, stalling speed (gear and flaps down) 53–56 mph, service ceiling 19,685 ft, T-O run 558 ft, landing run 984 ft, max range 341 miles, *g* limits +7/−5.
Accommodation: two seats in tandem.
Armament: none.

Turboprop Trainers

EMB-312 TUCANO

Among the world's most successful turboprop basic trainers is Brazil's Embraer Tucano (Toucan), the first prototype of which made its initial flight on 16 August 1980. It soon proved its ability to meet the design objectives of high maneuverability, short takeoff and landing, suitability for operation from unprepared runways, and a high degree of stability. The Brazilian Air Force ordered 118, as replacements for its Cessna T-37Cs. Designated T-27, the first six were delivered to the Esquadrilha da Fumaça (Smoke Squadron), its premier aerobatic team, and two others to the Air Force Academy. The Egyptian Government has ordered 134 Tucanos, 54 for its own Air Force and 80 for Iraq, of which all but the first ten were delivered by Embraer in kit form for assembly by the Arab Organization for Industrialization (AOI) at Helwan, near

UTVA-75A21 (Air Portraits)

SAH-1 prototype of Brooklands Aerospace Venture (J. M. G. Gradidge)

Cairo. Other customers include the air forces of Argentina (30), Honduras (12), Iran (15), Paraguay (6), Peru (20), and Venezuela (31). The re-engined S312 version (which see) is being built by Shorts in the UK for the Royal Air Force. Latest customer is the French Air Force, which earlier this year announced its intention to order 60. These will have strengthened wings like those of the Shorts S312 version, but will otherwise be Brazilian-standard aircraft.
Contractor: Empresa Brasileira de Aeronáutica SA, Brazil.
Power Plant: one Pratt & Whitney Canada PT6A-25C turboprop; 750 shp.
Dimensions: span 36 ft 6½ in, length 32 ft 4¼ in, height 11 ft 1¾ in.
Weights: empty 3,991 lb, gross (aerobatic) 5,622 lb, max gross 7,000 lb.
Performance (at 5,622 lb weight): max speed at 10,000 ft 278 mph, max cruising speed at 10,000 ft 255 mph, stalling speed (gear and flaps down) 77 mph, service ceiling 30,000 ft, T-O run 1,250 ft, landing run 1,214 ft, max range on internal fuel (with reserves) 1,145 miles, *g* limits +6/−3.
Accommodation: two crew in tandem, on Martin-Baker BR8LC ejection seats. Rear seat raised.
Armament: four underwing hardpoints for up to 2,205 lb of stores, including (typically) two 0.30 in machine-gun pods, four 250 lb bombs, or four 7-tube rocket launchers.

OMÉGA

See Epsilon piston-engine trainer entry.

FANTRAINER 400 and 600

The Fantrainer is unique among current military trainers in having a ducted fan propulsion system, a concept studied and developed by RFB for many years. Production aircraft have an Allison turboshaft, mounted aft of the cockpits with shaft drive to the five-blade ducted fan. Designed for primary and basic flying training, to IFR standard, the Fantrainer is available in two versions: the 400, with a 420 shp Allison 250-C20B engine, and the more powerful but otherwise similar Fantrainer 600. Sixteen of the latter version have entered service with the Royal Thai Air Force since January 1987, of which 14 were assembled in Thailand, and the RTAF is now assembling 31 Fantrainer 400s. The first two 600s were built in Germany; all 16 have glassfibre reinforced plastics wings, the rest of the airframe being all-metal. German-built kits for the Fantrainer 400s exclude the wings, which are of all-metal construction and are manufactured in Thailand. *(Data for Fantrainer 600.)*
Contractor: Rhein-Flugzeugbau GmbH, Federal Republic of Germany.
Power Plant: one Allison 250-C30 turboshaft; 650 shp.
Dimensions: span 31 ft 11½ in, length 31 ft 1¼ in, height 10 ft 4½ in.
Weights: empty 2,557 lb, gross (aerobatic) 3,527 lb, max gross 5,070 lb.

EMB-312 Tucano, Brazilian Air Force

RFB Fantrainer 600 (Paul Jackson)

Valmet L-90 TP Redigo prototype

Performance (at aerobatic gross weight): max speed at 18,000 ft 259 mph, cruising speed at 10,000 ft 230 mph, stalling speed 71 mph, service ceiling 25,000 ft, T-O and landing run 820 ft, range (internal fuel, 45 min reserves) 645 miles, *g* limits +6/−3.
Accommodation: crew of two in tandem. Rear seat elevated. UPC [Stencel] Ranger zero/zero rocket assisted escape system standard, ejection seats optional.
Armament: none, but has provision for carrying four drop fuel tanks under wings.

HTT-34

See HPT-32 piston-engine trainer entry.

L-90 TP REDIGO

The Redigo was designed to fit into a training system that will enable student pilots to graduate directly to an advanced jet trainer such as the British Aerospace Hawk. It has therefore been optimized to cover primary and basic, aerobatic, night, instrument, navigation, formation, and tactical flying training, drawing upon experience gained by Valmet with its piston engined predecessor, the L-70 Vinka. Two prototypes have been flown, one with an Allison 250 turboprop and the other with a similarly rated Turbomeca TP 319, and in January 1989 the Finnish Air Force placed an initial order for ten of the Allison engined version, to be delivered in 1991–92. Like the Vinka, the Redigo has an optional second pair of seats, enabling it to be configured for liaison or observation missions; other roles can include search and res-

cue, photographic reconnaissance, and target towing.
Contractor: Valmet Aviation Industries, Finland.
Power Plant: one Allison 250-B17F turboprop; 420 shp (flat rated).
Dimensions: span 33 ft 11 in, length 25 ft 11 in, height 9 ft 4¼ in.
Weights: empty 1,962 lb, gross (aerobatic) 2,976 lb, max gross 4,189 lb.
Performance (at aerobatic gross weight): max speed at 5,000 ft 208 mph, max cruising speed at 9,850 ft 189 mph, stalling speed (flaps down) 58 mph, service ceiling 25,000 ft, T-O run 640 ft, landing run 689 ft, max range 932 miles, *g* limits +7/−3.5.

Pilatus PC-7, Royal Netherlands Air Force

Pilatus PC-9/A, Royal Australian Air Force

Accommodation: crew of two side by side; space behind these for two more seats or 440 lb of baggage. Zero/zero rocket assisted escape system optional.
Armament: three hardpoints under each wing for (as two-seater) total of up to 1,764 lb of gun or rocket pods, antitank missiles, bombs, flares, or other stores.

PC-7 TURBO-TRAINER

More than 400 of these fully aerobatic turboprop basic trainers have been sold, and most of them have been delivered, since the prototype flew for the first time in 1975. The PC-7 can be used for basic, transition, and aerobatic training, and, with suitable equipment installed, for IFR and tactical training. Swiss law does not permit Pilatus to export aircraft equipped for combat use. However, some customers have installed weapon pylons. PC-7s have been sold to the air forces of Abu Dhabi (24), Angola (18), Austria (16), Bolivia (36), Burma (17), Chad (2), Chile (Navy, 10), Guatemala (12), Iran (35), Iraq (52), Malaysia (44), Mexico (75), Netherlands (10), Switzerland (40), some undisclosed countries, and a few civilian customers, including three to the French *Patrouille Martini* display team.
Contractor: Pilatus Flugzeugwerke AG, Switzerland.
Power Plant: one Pratt & Whitney Canada PT6A-25A turboprop; 550 shp (flat rated).
Dimensions: span 34 ft 1 in, length 32 ft 1 in, height 10 ft 6 in.
Weights: empty 2,932 lb, gross (aerobatic) 4,188 lb, max gross 5,952 lb.
Performance (at 4,188 lb weight): max cruising speed at 20,000 ft 256 mph, stalling speed (gear and flaps down) 74 mph, service ceiling 33,000 ft, T-O run 787 ft, landing run 968 ft, max range (with reserves) 745 miles, *g* limits +6/−3.
Accommodation: two seats in tandem; Martin-Baker Mk CH 15A lightweight ejection seats optional. Space for 55 lb of baggage aft of seats.
Armament: see above.

PC-9

The first of two preseries PC-9s was flown for the first time on 7 May 1984, and aerobatic category certification was received on 19 September 1985. Current production PC-9s comply with FAR Pt 23 (Amendments 1–28), special conditions specified by the Swiss Federal Office for Civil Aviation, and selected parts of US military specifications. Nearly all sales have been military, the first two

Shorts S312 Tucano T. Mk 1, Royal Air Force

Jaffe/Swearingen SA-32T Turbo Trainer (J. M. G. Gradidge)

customers being the Union of Burma Air Force (4) and Royal Saudi Air Force (30). Principal customer is the Royal Australian Air Force, which is acquiring 67 of a modified version known as the PC-9/A. Of these, the first two were supplied in flyaway form by Pilatus, followed by kits for the next six, and major components for 11 more. The remaining 48 are being built jointly by Hawker de Havilland and Aerospace Technologies of Australia (ASTA). Deliveries to the RAAF began on 14 December 1987. Other customers include Angola (5), Iraq (believed 20), Switzerland (4), Cyprus, and the UK. Despite its resemblance to the PC-7 (which see), the PC-9 shares only a 10 percent structural commonality with that aircraft. Differences include a more powerful engine, raised rear cockpit, ejection seats as standard, a ventral airbrake, modified wing profiles and wingtips, new ailerons, a longer dorsal fin, mainwheel doors, and larger wheels with high-pressure tires.
Contractor: Pilatus Flugzeugwerke AG, Switzerland.
Power Plant: one Pratt & Whitney Canada PT6A-62 turboprop; 950 shp (flat rated).
Dimensions: span 33 ft 2½ in, length 33 ft 4¾ in, height 10 ft 8¼ in.
Weights: empty 3,715 lb, gross (aerobatic) 4,960 lb, max gross 7,055 lb.
Performance (at 4,960 lb weight): max speed at S/L 311 mph, max speed at 20,000 ft 345 mph, stalling speed (gear and flaps down) 81 mph, service ceiling 40,000 ft, T-O run 745 ft, landing run 1,368 ft, max range (with reserves) 1,020 miles, *g* limits +7/−3.5.
Accommodation: two crew in tandem, on Martin-Baker Mk CH 11A ejection seats. Rear seat raised. Space for 55 lb of baggage aft of seats.
Armament: see remarks under PC-7 entry.

PZL-130TM Turbo-Orlik

See PZL-130 Orlik piston-engine trainer entry.

S312 TUCANO

On 21 March 1985, the UK Government announced that this developed version of the Brazilian EMB-312 Tucano (which see) had been chosen as a replacement for the Royal Air Force's Jet Provost basic trainers. In order to exceed the requirements of MoD Air Staff Target 412, the S312 Tucano embodies a changed power plant to improve speed, particularly at low altitude, and to provide an increased rate of climb; a ventral airbrake to control speed during descent; structural strengthening for increased maneuver loads and fatigue life; a new cockpit layout; and extensive British equipment. For export sales, four underwing hardpoints provide armament training and light attack capability. The first of 130 production Tucano T. Mk 1s ordered to date for the RAF flew on 30 December 1986. Deliveries began on 16 June 1988, initially to the Central Flying School at RAF Scampton, which will have 15. Other operators will be No. 7 Flying Training School, Church Fenton (25); No. 1 FTS, Linton-on-Ouse (39); and the RAF College, Cranwell (30). The first course of students will begin training on Tucanos at Church Fenton during December. First export customers are the Kenyan Air Force (12 T. Mk 51) and the Kuwait Ministry of Defense (16 T. Mk 52).
Contractor: Short Brothers plc, Northern Ireland.
Power Plant: one Garrett TPE331-12B turboprop; 1,100 shp.
Dimensions: span 37 ft 0 in, length 32 ft 4¼ in, height 11 ft 1¾ in.
Weights: empty (aerobatic) 4,447 lb, gross (aerobatic) 5,952 lb, max gross 7,716 lb.
Performance (aerobatic gross weight): max cruising speed 315 mph at 10,000–15,000 ft, econ cruising speed 253 mph at 20,000 ft, stalling speed (gear and flaps down) 80 mph, service ceiling 34,000 ft, T-O run 1,010 ft, landing run 1,030 ft, max range (internal fuel, with reserves) 1,035 miles, *g* limits +7/−3.6.
Accommodation: two crew in tandem, on Martin-Baker Mk 8LCP ejection seats. Rear seat raised.
Armament: export version will carry up to 1,000 lb of stores on four underwing hardpoints, typically two 500 lb or four 250 lb bombs, four rocket packs or practice bombs, two 0.50 in or two twin 0.30 in machine-gun pods.

SA-32T TURBO TRAINER

First flown on 31 May this year, the turboprop SA-32T is a joint project by the Jaffe and Swearingen companies of San Antonio, Tex., based on Ed Swearingen's high-performance SX300 piston-engined sporting aircraft, but with wings of modified design. Thickness of the metal skin of the airframe has been increased by 50 percent; larger wheels, tires, and brakes are fitted; and the side by side two-seat cockpit can be equipped with either a rocket extraction system or Martin-Baker lightweight ejection seats, under a one-piece canopy with miniature detonating cord. The manufacturers claim that the combination of turboprop power and a NASA-designed laminar-flow wing section gives handling characteristics similar to those of a jet aircraft, making the SA-32T suitable for forward air control and reconnaissance missions, as well as training. An uprated version is proposed for single-seat antihelicopter combat.
Contractors: Jaffe Aircraft Corporation and Swearingen Engineering and Technology Inc, USA.
Power Plant: one Allison 250-B17D turboprop; 420 shp.
Dimensions: span 24 ft 4½ in, length 22 ft 6 in, height 7 ft 9¼ in.
Weights: empty 1,560 lb, gross 2,600 lb.
Performance: max speed at S/L 332 mph, normal cruising speed at 20,000 ft 315 mph, stalling speed (gear and flaps up) 100 mph, (gear and flaps down) 76 mph, service ceiling 25,000 ft, T-O run 1,400 ft, landing run 1,100 ft, max range, no reserves 1,105 miles.
Accommodation: crew of two side by side; baggage space behind seats.
Armament: none.

SF-260TP
See SF-260 piston-engine trainer entry.

T-5
Fuji began building its own licensed variants of the piston engined Beechcraft T-34 Mentor in the mid-1950s, all differing from the US design in having wider centerfuselages to accommodate side by side seating. Japanese models have included the LM-1 Nikko four-seat liaison aircraft, LM-2 Nikko (uprated engine and optional fifth seat), KM-2 two/four-seat primary trainer for the Maritime Self-Defense Force, and a two-seat KM-2B counterpart for the Japanese Air Self-Defense Force (JASDF designation T-3). In 1984 Fuji replaced the 340 hp piston engine of a company-owned KM-2 with an Allison 250 turboprop, this KM-2D prototype flying for the first time on 28 June that year. This has led to a program, launched in March 1987, to replace the JMSDF's existing fleet of 31 KM-2s with a KM-2Kai (modified) version of the KM-2D embodying additional changes to the cabin structure and equipment. Deliveries to the JMSDF, under the designation T-5, began in August 1988. Five T-5s have so far been ordered, two in FY 1988 and three in FY 1989.
Contractor: Fuji Heavy Industries Ltd, Japan.
Power Plant: one Allison 250-B17D turboprop; 350 shp (flat rated).
Dimensions: span 32 ft 11¼ in, length 27 ft 8¼ in, height 9 ft 8½ in.
Weights: empty 2,385 lb, gross (aerobatic) 3,494 lb, max gross 3,979 lb.
Performance (at aerobatic gross weight except where indicated): max speed at 8,000 ft 222 mph, econ cruising speed at 8,000 ft 178 mph, stalling speed (gear and flaps down) 65 mph, service ceiling 25,000 ft, T-O run 990 ft, landing run 570 ft, range (at max gross weight, with reserves) 587 miles.
Accommodation: two persons side by side in aerobatic configuration. Second pair of seats behind these in utility version.
Armament: none.

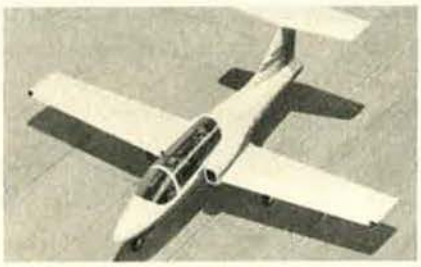
T-9 STALKER
Listed in last year's Trainer Gallery as the Arocet AT-9, the T-9 Stalker is one of an increasing number of cost-effective military training, utility, and light combat aircraft based on civilian homebuilt, kitbuilt, and even ultralight designs. The airframe of the prototype, flown for the first time on 24 July 1988, is generally similar to that of Stoddard-Hamilton's Glasair III all-composites homebuilt, modified to accept a turboprop power plant in place of the standard piston engine. The production T-9 Stalker is being marketed as a low-cost, high-performance, fully aerobatic military trainer adaptable to combat roles such as close air support, air defense, patrol, and search and rescue.
Contractor: Stoddard-Hamilton Aircraft Inc, USA.
Power Plant: one Allison 250-B17D turboprop; 420 shp.
Dimensions: span 23 ft 3½ in, length 21 ft 9½ in, height 7 ft 3 in.
Weights: empty 1,500 lb, gross 2,700 lb.
Performance (estimated): max speed at S/L 345 mph, at 10,000 ft 381 mph, max cruising speed at 25,000 ft 366 mph, stalling speed 70 mph, service ceiling 37,000 ft, T-O run 525 ft, landing run 360 ft, max range, with reserves 1,587 miles, *g* limits +6.9/−4.
Accommodation: two seats side by side, with zero/zero pilot extraction system. Full IFR avionics, with gunsight and armament management system.
Armament: two underwing hardpoints, each with max capacity of 275 lb, for 7- or 19-tube rocket launchers, practice bomb racks, machine-gun pods, cartridge launchers, or rescue packs.

T-34C
Developed as a turboprop version of the piston-engined T-34A and T-34B Mentor, built for USAF and the US Navy respectively, the first of two YT-34C prototypes was flown on 21 September 1973. Beech delivered 334 new-production T-34C primary trainers to the Navy between November 1977 and April 1984, and is currently building 19 more. These aircraft have logged well over one million flight hours, with the lowest accident rate for aircraft in the Navy's current inventory. Six were transferred to the Army, to serve as chase and photographic aircraft for the Airborne Special Operations Test Board at Fort Bragg, N. C. A T-34C-1 armament systems trainer version, with FAC and tactical attack training capability, has been exported to Argentina (Navy, 15), Ecuador (Air Force, 20; Navy, 3), Gabon (Presidential Guard, 4), Indonesia (Air Force, 25), Morocco (Air Force, 12), Peru (Navy, 7), Taiwan (Air Force, 40), and Uruguay (Navy, 3). *(Data for T-34C except where indicated.)*
Contractor: Beech Aircraft Corporation, USA.
Power Plant: one Pratt & Whitney Canada PT6A-25 turboprop; 400 shp (550 shp version available optionally).
Dimensions: span 33 ft 4 in, length 28 ft 8½ in, height 9 ft 7 in.
Weights: empty 2,960 lb, gross 4,300 lb.
Performance: max cruising speed 246 mph at 17,000 ft, stalling speed (gear and flaps down) 61 mph, service ceiling 30,000 ft, T-O run 1,155 ft, landing run 740 ft, max range 814 miles, *g* limits +6/−3.
Accommodation: two seats in tandem.
Armament (T-34C-1): four underwing hardpoints for total 1,200 lb of stores, including practice bomb/flare containers, LAU-32 or LAU-59 rocket packs, Mk 81 bombs, SUU-11 Minigun pods, BLU-10/B incendiary bombs, AGM-22A wire-guided antitank missiles, and target towing equipment.

Fuji T-5, Japan Maritime Self-Defense Force

Stoddard-Hamilton T-9 Stalker prototype (J. M. G. Gradidge)

Beech T-34C-1s for Navy of Uruguay



Artist's impression of Aerodis AA300 Rigel

Jet Trainers

AA300 RIGEL
Aerodis America, assisted by the experienced light-aircraft engineer David B. Thurston, is developing a family of aircraft utilizing the same basic all-composites airframe. First to fly is a four-seat piston-engined cabin monoplane, with tail-pusher propeller, known as the AA200 Orion. Scheduled to follow in mid-1991 is the tandem two-seat AA300 Rigel, which Aerodis hopes to market at around $800,000 (in 1989 dollars), one-third the cost of competing primary jet trainers. Components of graphite and glassfibre, with honeycomb sandwich skins, will be manufactured for production aircraft by P. T. Cipta Restu Sarana Svaha of Indonesia, and assembled by Asian Aviation International of Bangkok, Thailand. This conforms with Aerodis' intention of focusing its sales efforts initially on Third World regions.
The cockpit of the Rigel will be pressurized at 6.5 lb/sq in, and is being designed to withstand a 20*g* impact. A centerline hardpoint will be provided, with another in each wing. Also projected is a single-seat light tactical version, known as the AA330 Theta. Like the Rigel, this would be fully aerobatic and stressed to +9/−6*g*.
Contractor: Aerodis America Inc, USA.
Power Plant: one Williams International FJ44 turbofan; derated to 1,200 lb st.
Dimensions: span 29 ft 0½ in, length 25 ft 11 in, height 8 ft 7 in.
Weights: empty 1,850 lb, gross 3,350 lb.
Performance (estimated): max speed at 30,000 ft 426 mph, stalling speed (flaps down) 71 mph, range (with reserves) 740 miles.
Accommodation: crew of two in tandem.
Armament: none.

ALPHA JET
Production of the Alpha Jet was authorized by the French and Federal German Governments in March 1975. Production lines were established by Dassault-Breguet and Dornier, from which 176 trainers were delivered to the French Air Force and 175 close support Alpha Jets to the German Air Force between 1978 and 1985. Export orders for the trainer/light attack model were received from Belgium (33), Egypt (30, designated MS1), Ivory Coast (7), Morocco (24), Nigeria (24), Qatar (6), and Togo (6). The Arab Organization for Industrialization (AOI) assembled most of the aircraft for the Egyptian Air Force at Helwan. When Dassault-Breguet developed an alternative close support version, with added inertial platform, head-up display, and laser rangefinder, seven were ordered by Cameroon and 15 (as MS2s) by Egypt, of which 11 were coproduced by AOI. The further developed Alpha Jet 2 and Lancier are dedicated combat versions, offering day/night attack, antishipping strike, and antihelicopter capabilities. Also available but not yet ordered is the Alpha Jet 3 trainer, with a CRT raster HUD combined with collimated head-level display, rear cockpit CRT monitor, and lateral multifunction displays and keyboards in each cockpit.
Contractors: Avions Marcel Dassault-Breguet Aviation, France, and Dornier GmbH, Federal Republic of Germany.
Power Plant: two SNECMA/Turbomeca Larzac 04-C6 turbofans standard; each 2,976 lb st. Two 3,175 lb st Larzac 04-C20s now standard for German close support aircraft, optional for other variants.
Dimensions (trainer): span 29 ft 10¾ in, length 38 ft 6½ in, height 13 ft 9 in.
Weights (trainer): empty 7,374 lb, gross 11,023 lb, max gross with external stores 17,637 lb.

Alpha Jet MS2, Egyptian Air Force

Performance (at 11,023 lb weight, 04-C6 engines): max speed at 32,800 ft Mach 0.85, max speed at S/L 621 mph, stalling speed (gear and flaps down) 104 mph, service ceiling 48,000 ft, T-O run 1,215 ft, landing run 1,640 ft, radius of action (with reserves) at high altitude 764 miles on internal fuel, 901 miles with external tanks, *g* limits (ultimate) +12/−6.4.

Accommodation: crew of two in tandem on Martin-Baker AJRM4 zero height/104 mph, or B10N series zero/zero, ejection seats.

Armament: centerline stores pylon, or pod for 30 mm DEFA or 27 mm Mauser gun. Provision for two hardpoints under each wing for 18-tube rocket packs, bombs of up to 882 lb, cluster bombs, 30 mm gun pods, Sidewinder or Magic air-to-air missiles, Maverick air-to-surface missiles, a reconnaissance pod, drop tanks, and other stores. Max load on five pylons 5,510 lb.

AT-3

Reportedly given the name Tsu-Chiang by the Chinese Nationalist Air Force, the twin-turbofan AT-3 resulted from a 1975 design contract, and fulfills the roles of both basic and advanced military jet trainer for the CNAF, which is its only customer. Deliveries of 60 AT-3s, beginning in the spring of 1984, were due to be completed earlier this year. The AT-3's primary control surfaces are actuated hydraulically, with electrical actuation for the single-slotted flaps, and the tandem cockpits are fully pressurized and air-conditioned. With a 6,000 lb external stores capacity, the AT-3 has useful potential for ground attack and/or maritime strike missions, and can carry a pair of air-to-air missiles for self-defense; a single-seat A-3 attack version, said to be named Lui-Meng, has been reported to be in production. Two AT-3s were being refitted as close support aircraft in 1989, with a Westinghouse AN/APG-66 radar and fire control system. *(Data for standard two-seat AT-3.)*

Contractor: Aero Industry Development Center, Taiwan.

Power Plant: two Garrett TFE731-2-2L turbofans; each 3,500 lb st.

Dimensions: span 34 ft 3¾ in, length 42 ft 4 in, height 14 ft 3¾ in.

Weights: empty 8,500 lb, gross ('clean') 11,500 lb, max gross 17,500 lb.

Performance (at max gross weight): max speed at S/L 558 mph, max cruising speed at 36,000 ft 548 mph, stalling speed (gear and flaps down) 104 mph, service ceiling 48,000 ft, T-O run 1,500 ft, landing run 2,200 ft, max range (internal fuel) 1,416 miles.

Accommodation: crew of two on tandem zero/zero ejection seats. Rear seat elevated.

Armament: two hardpoints under each wing and one under fuselage for up to 6,000 lb of bombs, flare dispensers, or rocket launchers. Centerline hardpoint can be occupied instead by a semirecessed machine-gun pack or (in conjunction with outboard underwing pylons) an aerial target system. Provision for air-to-air missiles on wingtip launch rails.

ATTA 3000

A Promavia development of the side by side Jet Squalus (which see), the ATTA 3000 (Advanced Trainer/Tactical Aircraft) was announced in mid-1989, when a cockpit mockup was displayed at the Paris Air Show. Twin engines and tandem seating are the most significant differences from the earlier aircraft, providing the ATTA design with both a much-enhanced performance and the ability to serve also as a light strike aircraft. A full EFIS (electronic flight instrumentation system) avionics fit will enable pupil pilots to follow on from the Jet Squalus through the entire advanced (including weapons) training regime. Promavia has also projected a dedicated light strike version, the ARA 3600 (Attack/Reconnaissance Aircraft), which would be a single-seater with slightly more powerful (1,800 lb st) TFE109-3 engines. Both the Jet Squalus and the ATTA 3000 have been entered as contenders for USAF's PATS (Primary Air Training System) requirement. First flight of the ATTA 3000 is forecast for the second quarter of 1991.

Contractor: Promavia SA, Belgium.

Power Plant: two Garrett TFE109-2 turbofans; each 1,500 lb st.

Dimensions: span 30 ft 2¼ in, length 32 ft 8 in, height 11 ft 9¾ in.

Weights (estimated): empty 3,900 lb, gross 7,200 lb.

Performance (estimated, without external stores): max speed 558 mph or Mach 0.8, stalling speed (gear and flaps down) 83 mph, service ceiling 40,000 ft, T-O run 800 ft, landing run 1,200 ft, ferry range 1,094 miles, *g* limits +7/−3.5.

Accommodation: crew of two in tandem on McDonnell Douglas Minipac zero/zero ejection seats. Rear seat raised.

Armament: underwing hardpoints for two infrared air-to-air missiles, two 20 mm gun pods, four single or twin 7.62 mm gun pods, four Mk 82 or smaller bombs, or four 7-tube 70 mm rocket pods.

C-101 AVIOJET

The Aviojet is a fully aerobatic basic/advanced trainer that can also perform ground attack, reconnaissance, escort, weapons training, electronic warfare, and photographic missions. The first of four prototypes flew on 27 June 1977, after which the Spanish Air Force ordered 88 C-101EB trainers (later increased to 92), with 3,500 lb st Garrett TFE731-2-2J engines, under the military designation E.25 Mirlo (Blackbird). An armed export version, with a 3,700 lb st TFE731-3-1J engine, was ordered by Chile (14 C-101BB-02) and Honduras (4 C-101BB-03). All but the first four of the BB-02s were assembled by ENAER in Chile, with partial local manufacture, and have the official Chilean Air Force designation T-36 Halcón (Hawk). During 1982, ENAER and CASA initiated development of a dedicated attack version of the Aviojet, designated C-101CC-02 in Spain and A-36 Halcón by the Chilean Air Force. The first of two prototypes flew in November 1983, and 23 similar production A-36s, with more powerful TFE731-5-1J engines, are currently ordered. The first four are Spanish-built, the remainder by ENAER. The Royal Jordanian Air Force has taken delivery of 16 C-101CC-04s. An enhanced training version, with the same power plant and additional avionics, including a Ferranti HUD, flew for the first time on 20 May 1985 as the C-101DD, but has not yet been ordered. *(Data for C-101CC.)*

Contractor: Construcciones Aeronauticas SA, Spain.

Power Plant: one Garrett TFE731-5-1J turbofan; 4,300 lb st, with military power reserve (MPR) rating of 4,700 lb st.

Dimensions: span 34 ft 9½ in, length 41 ft 0 in, height 13 ft 11¼ in.

Weights: empty 7,716 lb, gross (trainer, 'clean') 10,692 lb, max gross 13,890 lb.

Performance (at 9,921 lb weight, except where indicated): max speed at 15,000 ft with MPR 518 mph, stalling speed (gear and flaps down) 102 mph IAS, service ceiling 42,000 ft, T-O run 1,835 ft, landing run 1,575 ft, ferry range (with reserves) 2,303 miles, *g* limits at 10,582 lb weight +7.5/−3.9.

Accommodation: two crew in tandem on Martin-Baker Mk 10L zero/zero ejection seats. Rear seat raised.

Armament: bay beneath rear cockpit for quick-change packages, including a 30 mm DEFA gun with 130 rounds, twin 12.7 mm Browning machine-guns, reconnaissance camera, ECM package, or laser designator. Six underwing hardpoints for up to 4,960 lb of stores, including four LAU-10 rocket packs, six 250 kg bombs, two Maverick air-to-surface missiles, or four BIN200 napalm bombs.

G-4 SUPER GALEB

First flown on 17 July 1978, and continuing in production, the Super Galeb replaced the earlier G2-A Galeb and Lockheed T-33 in basic and advanced training units of the Yugoslav Air Force and single-seat Jastrebs in the light strike elements. Its configuration is very like that of the BAe Hawk, but it has a lower-powered engine and is lighter in weight, with correspondingly lower performance. Nonetheless, its impressive weapon-carrying ability suits it well for the tactical missions that are of primary importance to the Yugoslav Air Force, and its indigenous design contributes to Yugoslavia's aim of increasing self-sufficiency in its military procurement.

Contractor: Vazduhoplovna Industrija SOKO, Yugoslavia.

Power Plant: one Rolls-Royce Viper Mk 632 turbojet; 4,000 lb st.

Dimensions: span 32 ft 5 in, length 38 ft 11 in, height 14 ft 0½ in.

Weights: empty 7,165 lb, gross (training) 10,495 lb, max gross 13,955 lb.

Performance (10,495 lb weight): max speed at 19,680 ft 565 mph, landing speed 103 mph, absolute ceiling 49,200 ft, T-O run 1,745 ft, landing run 1,805 ft, range with two drop tanks (with reserves) 1,635 miles, *g* limits +8/−4.2.

Accommodation: two crew in tandem on Martin-Baker Mk J10 zero/zero ejection seats. Rear seat raised.

Armament: removable centerline gun pod containing 23 mm GSh-23L twin-barrel cannon with 200 rounds. Two pylons under each wing for such weapons as napalm tanks, cluster bombs containing eight 35 lb fragmentation munitions, containers for 40 antipersonnel or 54 antitank bomblets, 16-tube rocket packs, triple carriers for 220 lb bombs, 12.7 mm gun pods, or drop fuel tanks.

HAWK

The BAe Hawk T. Mk 1, powered by a 5,200 lb st Adour 151 turbofan, has been the standard basic/advanced flying and weapons trainer of the Royal Air Force since the autumn of 1976. Eighty-eight of the 175 production Hawks delivered to the RAF, including those of the renowned Red Arrows aerobatic display team, have since been wired to carry a Sidewinder missile under each wing, in addition to the standard underbelly 30 mm gun pack, to accompany radar-equipped Phantoms and Tornados on medium-range air defense sorties as components of the UK Mixed Fighter Force. The initial export Hawk 50 series, with more powerful (5,340 lb st) Adour 851 turbofan, 70 percent greater disposable load, and 30 percent longer range, was sold to Finland (50 Mk 51), Kenya (12 Mk 52), and Indonesia (20 Mk 53). The further

AIDC AT-3, Chinese Nationalist Air Force

CASA C-101EB Aviojet, Spanish Air Force (Press Office Sturzenegger)

SOKO G-4 Super Galeb, Yugoslav Air Force (Ivo Sturzenegger)

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improved Hawk 60 series, described below, has been bought by Zimbabwe (8 Mk 60), Dubai (9 Mk 61), Abu Dhabi (16 Mk 63), Kuwait (12 Mk 64), Saudi Arabia (30 Mk 65), and Switzerland (20 Mk 66). More specialized and higher-performance two-seat and single-seat combat versions are available as the Hawk 100 and 200 series respectively. First customer for the 200 series is Saudi Arabia, whose huge defense orders under the *Al Yamamah* project include 60 Hawks. The US Navy's T-45A Goshawk version is described separately. *(Data for Hawk 60 series.)*

Contractor: British Aerospace plc, UK.

Power Plant: one Rolls-Royce Turbomeca Adour 861 turbofan; 5,700 lb st.

Dimensions: span 30 ft 9¾ in, length (including probe) 38 ft 11 in, height 13 ft 1¼ in.

Weights: empty 8,267 lb, gross ('clean') 11,350 lb, max gross 18,739 lb.

Performance: max speed 644 mph, max Mach number in dive 1.2, service ceiling 50,000 ft, T-O run 1,800 ft, landing run 1,700 ft, ferry range 2,530 miles, *g* limits +8/−4.

Accommodation: two crew in tandem on Martin-Baker Mk 10B zero/zero ejection seats. Rear seat raised.

Armament: centerline pack for 30 mm Aden gun with 120 rounds, or pylon, plus two pylons under each wing. Typical loads include gun and four 18-tube rocket packs; seven 1,000 lb bombs; thirty-six 80 lb runway denial bombs; five 600 lb cluster bombs; four Sidewinder/Magic air-to-air missiles; two Maverick air-to-surface missiles and two drop tanks; or a Sea Eagle antiship missile, two Sidewinders, and two drop tanks.

HJT-16 KIRAN

The Kiran flew for the first time in September 1964, and deliveries of 118 Viper engined Mk Is to the Indian Air Force began in the spring of 1968. This version, for basic flying training only, was followed by a Mk IA with a hardpoint under each wing to permit the carriage of practice armament for weapons training; Mk IA production, for both the IAF and Indian Navy, amounted to about 80 examples before being supplanted in 1982 by the more powerful Kiran Mk II, which utilizes the same Orpheus turbojet as HAL's Ajeet version of the Folland/Hawker Siddeley Gnat light fighter, combined with updated instruments and avionics, an improved hydraulic system, and an extra pair of underwing stations for enhanced weapon-carrying capability in either training or counter-insurgency roles. The Kiran Mk II flew for the first time on 30 July 1976, and deliveries of 61 to the Indian Air Force were due for completion in March of this year. *(Data for Mk II.)*

Contractor: Hindustan Aeronautics Ltd (Bangalore Complex), India.

Power Plant: one Rolls-Royce Orpheus 701-01 turbojet; 4,200 lb st.

Dimensions: span 35 ft 1¼ in, length 34 ft 9½ in, height 11 ft 11 in.

Weights: empty 6,603 lb, gross ('clean') 9,369 lb, max gross 11,023 lb.

Performance (at max gross weight): max speed at S/L 418 mph, max cruising speed at 15,000 ft 386 mph IAS, stalling speed (gear and flaps down) 98 mph IAS, service ceiling 39,375 ft, T-O run, 1,772 ft, landing from 50 ft 4,725 ft, max range (internal fuel) 457 miles.

Accommodation: side by side Martin-Baker H4HA zero-height ejection seats for crew of two.

Armament: two 7.62 mm machine-guns in nose; two hardpoints under each wing for 551 lb bombs, 18-tube rocket pods, or drop tanks.

I-22 IRYD

Flown for the first time on 3 March 1985, this Polish jet trainer was clearly designed as a potential successor to the long-serving TS-11 Iskra, production of which at PZL Mielec came to an end in 1987 after 550 (including 50 for India) had been manufactured during the previous 24 years. A third prototype joined the flight test program on 13 May 1989. The I-22 is a larger and potentially more capable design than the Iskra, intended to perform as a reconnaissance and close support aircraft in addition to its principal function as an advanced jet trainer. It was designed to cover the full spectrum of pilot, navigation, air combat, reconnaissance, and ground attack training, day or night and in bad weather, and will be able to operate from unprepared airstrips. Service life has been calculated on the basis of 2,500 flying hours or 10,000 takeoffs and landings, and the airframe is stressed for later introduction, if required, of more powerful engines and an increased ordnance load. A 3,305 lb st engine designated K-15 is under development in Poland, and may be intended for the I-22.

Contractor: Instytut Lotnictwa (Aviation Institute), Poland.

Power Plant: two PZL Rzeszów SO-3W22 turbojets; each 2,425 lb st.

Dimensions: span 31 ft 6 in, length 43 ft 4½ in, height 14 ft 1¼ in.

Weights: empty 8,735 lb, gross 16,519 lb.

Performance: max speed at S/L 568 mph, max cruising speed at altitude 574 mph, service ceiling 41,340 ft, T-O run 2,525 ft, landing run 1,085 ft, max range (internal fuel) 1,037 miles, *g* limits +8/−4.

Accommodation: crew of two on tandem zero-height/94 mph ejection seats; rear seat elevated.

Armament: one 20 mm GSh-23L cannon in underfuselage pack, plus two hardpoints under each wing for up to 2,645 lb of bombs, guided or unguided rockets, or (inboard stations only) drop tanks.

British Aerospace Hawk T. Mk 1A, Royal Air Force (R. J. Wilson)

HAL HJT-16 Kiran Mk II, Indian Air Force

PZL I-22 Iryd, third prototype (Lech Zielaskowski)

IAR-99 Soim prototype

IA 63 PAMPA

The Fuerza Aérea Argentina initiated the Pampa program in 1979, enlisting the technical and design assistance of Dornier of West Germany. Flight testing began on 6 October 1984, the airframe configuration eventually chosen bearing a considerable resemblance to that of the Dassault/Dornier Alpha Jet (which see). On 9 May 1988 the first three production Pampas were delivered to the 4th Air Brigade of the FAA at Mendoza, and all 18 aircraft on the initial contract were due to have been delivered by the end of this year. The Pampa's first objective is to replace the Morane-Saulnier Paris III, some three dozen of which still survive after more than two decades of service, in the basic, advanced, and weapons training roles. At least 50 more are expected to be ordered, with an uprated engine being introduced from the 19th aircraft onward; a version for the Argentine Navy is also believed to be under development. In addition to underwing weapons, the Pampa can be equipped with a 145-round 30 mm underbelly gun pod, and has a weapons management system described as adequate for several different tactical configurations, indicating the likely emergence of a combat proficiency trainer/light close support version once the original training requirement has been satisfied.

Contractor: Fábrica Argentina de Materiales Aeroespaciales, Argentina.

Power Plant: one Garrett TFE731-2-2N turbofan in first 18 aircraft; 3,500 lb st. Subsequent aircraft will have 4,500 lb st version of this engine.

Dimensions: span 31 ft 9¼ in, length 35 ft 9¼ in, height 14 ft 1 in.

Weights: empty 6,219 lb, gross 11,023 lb.

Performance: max speed at 22,965 ft 509 mph, max cruising speed at 13,125 ft 464 mph, service ceiling 42,325 ft, T-O run (at 8,157 lb weight) 1,477 ft, landing run 1,411 ft, range (standard fuel) 621 miles, max range (auxiliary fuel) 932 miles, *g* limit +4.5.

Accommodation: crew of two on tandem UPC (Stencel) zero-height ejection seats. Rear seat elevated.

Armament: hardpoint under fuselage and two under each wing for up to 2,557 lb (with standard fuel) of gun pods, bombs, and rockets. With uprated engine, external load can be increased to 3,748 lb.

IAR-99 SOIM

Craiova is the location of both the CIIAR, the national flight test center, and the aircraft factory responsible for Romania's part in the program that produces the IAR-93/Orao close support and ground attack aircraft jointly with Yugoslavia. The fact that IAv Craiova had designed an indigenous jet trainer first became known in 1983, when a photograph and brief details appeared in an industry leaflet released at that year's Paris Air Show. That illustration proved subsequently to have shown a mockup. The first prototype eventually made its initial flight in December 1985, and the accompanying photograph of this aircraft, received earlier this year, is still the only picture of the IAR-99 known to have appeared publicly outside Romania. The Soim (Hawk) is of all-metal construction, and is powered by a non-afterburning version of the engine—built in Romania under Rolls-Royce license—used in the IAR-93. Development flying has apparently been completed, IAv Craiova stating earlier this year that the Soim is now in production.

Contractor: Intreprinderea de Avioane Craiova, Romania.

Power Plant: one Rolls-Royce Viper Mk 632-41 turbojet; 4,000 lb st.

Dimensions: span 33 ft 4 in, length 36 ft 1½ in, height 12 ft 9½ in.

Weights: empty 7,416 lb, gross 12,436 lb.

Performance: max speed at S/L 528 mph, service ceiling 41,350 ft, T-O run at 9,700 lb weight 2,165 ft, landing run at 7,430 lb weight 2,378 ft.

Accommodation: crew of two on tandem ejection seats. Rear seat raised.

Armament: two hardpoints under each wing for weapons, drop tanks, or other stores.

JET SQUALUS F1300 NGT

The Jet Squalus is intended to cover all stages of flying training from initial pilot screening, primary, and basic through to part of the advanced syllabus, including weapons training. Squalus is Latin for 'Shark', and the initials NGT in its designation indicate its conception as

an 'all-through' jet trainer to a specification similar to that issued for the USAF Next Generation Trainer (Fairchild T-46A) program. Promavia entrusted design and prototype construction to the well-known Italian designer Dott Ing Stelio Frati, and the first flight was made on 30 April 1987. This aircraft had accumulated approximately 250 hours' flying by mid-1989; it was due to have been joined in the second half of 1989 by the second aircraft, which has an uprated engine. A third prototype, with pressurized cockpit, is under construction. First customer for the Jet Squalus is the Portuguese Government, which has signed a letter of intent for at least 100, to be produced in that country by OGMA. Some 35–45 of these would be for the Portuguese Air Force, another 15 for the civil flying academy, and the rest for other Portuguese civilian agencies or for export. Sabena, the Belgian national airline, has announced a commitment for an unspecified number of Jet Squalus, and the type is also a candidate for the USAF PATS (Primary Air Training System) requirement. *(Data for first prototype.)*

Contractor: Promavia SA, Belgium.

Power Plant: one Garrett TFE109-1 turbofan; 1,330 lb st. Second prototype has TFE109-3 of 1,600 lb st.

Dimensions: span 29 ft 8 in, length 30 ft 8½ in, height 11 ft 9¾ in.

Weights: empty 2,866 lb, gross 5,291 lb.

Performance (TFE109-1 engine): max speed at 14,000 ft 322 mph, normal operating speed 299 mph, stalling speed (gear and flaps down) 77 mph, service ceiling 37,000 ft, T-O run 1,100 ft, landing run 1,200 ft, ferry range (max internal fuel at 20,000 ft) 1,150 miles, *g* limits (aerobatic) +7/−3.5.

Accommodation: crew of two side by side on Martin-Baker Mk 11 ejection seats.

Armament: two hardpoints under each wing for up to 1,323 lb of gun pods, rocket launchers, practice bombs, or fuel tanks.

KARAKORUM 8

At the Paris Air Show in June 1987 the People's Republic of China displayed the model of a new jet trainer, then designated L-8 and envisaged as a project to be undertaken with an international partner. Pakistan has since emerged as that partner, and the aircraft has been named after the mountain range forming part of the border between the two countries. The PLA Air Force and the Pakistan Air Force both require a new tandem-seat jet trainer, their combined needs being estimated at a total of about 200 aircraft. The Karakorum 8, or K-8, is now in the prototype fabrication stage. It is designed to provide not only all basic flying training needs but also parts of the primary and advanced syllabi, and in addition will have a capability for weapons training and/or light air-to-ground close support. Five prototypes are being built. A first flight is expected to take place in mid-1990, with initial production deliveries following about a year later.

Contractors: Nanchang Aircraft Manufacturing Company, People's Republic of China, and Pakistan Aeronautical Complex.

Power Plant: one Garrett TFE731-2A turbofan; 3,500 lb st.

Dimensions: span 31 ft 7¼ in, length 34 ft 1½ in, height 13 ft 9¾ in.

Weights: empty 5,637 lb, max gross 9,259 lb.

Performance (estimated, at max gross weight): max speed at S/L 497 mph, service ceiling 43,600 ft, T-O run 1,323 ft, landing run 1,680 ft, max range (with drop tanks) 1,398 miles.

Accommodation: crew of two on Martin-Baker Mk 10L tandem ejection seats. Rear seat elevated.

Armament: one 23 mm gun pod under center fuselage; two hardpoints under each wing for gun or rocket pods, bombs, missiles, drop tanks (inboard only), or a single reconnaissance pod.

L-39 ALBATROS

Successor to the still widely used L-29 Delfin, the Albatros has been the standard basic and advanced jet trainer of the Czechoslovak Air Force since 1974, being used for all pilot training including that of helicopter pilots. In its basic L-39 C version, it is also the principal jet trainer used by the Soviet Air Force, and has been supplied to Afghanistan (18), Cuba (30), and the German Democratic Republic. The L-39 Z0, with strengthened wings for additional stores-carrying, has been exported to Iraq (80), Libya (170), and Syria (100); Romania received 35, and Bulgaria 18, of the ground attack/reconnaissance version designated L-39 ZA. The overall number of L-39s built now exceeds 2,500, with Algeria (16), Ethiopia (12), Nigeria (10), and Vietnam (25) among the other operators worldwide, and production is scheduled to continue well into the early 1990s. On 30 September 1986 Aero made the first flight of a new L-39 MS advanced training version for the Soviet Air Force, with an uprated (4,850 lb st) ZVL DV-2 engine, head-up display, zero/zero seats, and improved avionics, but is withholding further details until its flight test program is completed. *(Data for L-39 C except where indicated.)*

Promavia Jet Squalus F1300 NGT prototype

Contractor: Aero Vodochody Národní Podnik, Czechoslovakia.

Power Plant: one Ivchenko AI-25TL turbofan; 3,792 lb st.

Dimensions: span 31 ft 0½ in, length 39 ft 9½ in, height 15 ft 7¾ in.

Weights: empty 7,617 lb, max gross 10,362 lb.

Performance (at 'clean' T-O weight of 9,921 lb): max speed at S/L 435 mph, max speed at 16,400 ft 466 mph, stalling speed 103 mph, service ceiling 36,100 ft, T-O run 1,740 ft, landing run 2,135 ft, range (internal fuel) 683 miles, max range (internal/external fuel) 1,087 miles, *g* limits +8/−4.

Accommodation: crew of two on tandem zero height/94 mph ejection seats. Rear seat elevated.

Armament: one hardpoint under each wing of L-39 C, for up to 626 lb of practice weapons or drop tanks. L-39 Z0 has two underwing hardpoints each side for up to 2,535 lb of stores including bombs, rocket pods, IR air-to-air missiles (outer pylons only), or (port inner pylon only) a daylight camera pod. External load increased to 2,844 lb on L-39 ZA.

MB-339

Of 158 initial production MB-339As built in 1978–87, the Italian Air Force received 101, including four MB-339RM calibration aircraft and the MB-339PANs of its Frecce Tricolori aerobatic display team which have the normally standard wingtip tanks deleted to aid formation keeping. Primary role of the basic MB-339As is for all phases of advanced training, but the Italian trainers are camouflaged for use as an emergency close air support force. Other customers for this version, powered by a 4,000 lb st Viper Mk 632-43 turbojet, include the Argentine Navy and the air forces of Dubai, Ghana, Malaysia, Nigeria, and Peru. In 1985, Aermacchi introduced the uprated MB-339B, and the MB-339C with advanced avionics, including a digital nav/attack system, each with a Viper Mk 680-43 turbojet. An initial batch of 20 MB-339Cs is being delivered to the Italian Air Force. Also available with a Viper 680 is the single-seat MB-339K, optimized for light close air support and operational training, with increased weapons load and additional equipment such as a head-up display, cockpit CRTs, and ECM optional. *(Data for MB-339B.)*

Aero L-39 Cs, Czechoslovak Air Force

Aermacchi MB-339PAN of the Frecce Tricolori

Third preproduction Microjet 200 B (Paul Jackson)

Contractor: Aermacchi SpA, Italy.

Power Plant: one Rolls-Royce Viper Mk 680-43 turbojet; 4,400 lb st.

Dimensions: span over tiptanks 36 ft 9¾ in, length 36 ft 0 in, height 13 ft 1¼ in.

Weights: empty, equipped 7,297 lb, gross (training) 10,218 lb, max gross 14,000 lb.

Performance (at training gross weight): max speed at S/L 560 mph, time to 30,000 ft 6 min 42 sec, max range (clean) 1,221 miles, *g* limits +8/−4.

Accommodation: two crew in tandem on Martin-Baker IT10F zero/zero ejection seats. Rear seat raised.

Armament: six underwing hardpoints for rockets of 50 mm to 5 in caliber, 500 lb bombs, 100 mm runway demolition bombs, AIM-9L Sidewinder and Magic air-to-air missiles, and other weapons.

MICROJET 200 B

There has been little news of this diminutive twin-jet trainer during the past year, except that the third preproduction example appeared at the 1989 Paris Air Show with vertical extensions to its V tail unit, for improved directional stability. The first prototype of the Microjet began flight trials on 24 June 1980. By utilizing small turbojets manufactured by Microturbo, it proved possible to offer high performance in an aircraft with low initial and operating costs. The potential of the Microjet was further demonstrated by the second preproduction example, which introduced underwing hardpoints. The specification data apply to the planned initial production version. Takeoff rating of each engine will be increased progressively to 405 lb st, to improve performance and payload, with particular emphasis on the Microjet's suitability for an antihelicopter combat role.

Contractor: Microjet SA, France.

Power Plant: two Microturbo TRS 18-1 turbojets; each 326 lb st.

Dimensions: span 24 ft 9¾ in, length 21 ft 10½ in, height (excluding fin extensions) 7 ft 11¼ in.

Weights: empty 1,719 lb, gross (aerobatic) 2,513 lb, max gross 2,866 lb.

Performance: max cruising speed 287 mph at 18,045 ft, stalling speed (gear and flaps down) 83 mph, service ceiling 30,000 ft, T-O run 2,600 ft, landing run 1,280 ft, max range (with reserves) 541 miles, *g* limits (aerobatic) +7/−3.5.

Accommodation: two seats side by side. Starboard seat staggered aft of port seat for added comfort.

Armament: no details available.

S.211

With some 60 percent of its surface area manufactured in GRP composites, the prototype of this small, lightweight basic jet trainer/light attack aircraft was flown for the first time in April 1981. The S.211 has a minimum air turning radius at sea level of less than 1,000 ft, and is claimed to have particularly safe stalling and spinning qualities. The first customer, for 30, was the Republic of Singapore Air Force, which received six as Italian-built complete aircraft and the remaining 24 in CKD (component knocked down) form for assembly by Singapore Aircraft Industries (SAI). Four other S.211s were delivered to the Air Force of Haiti; the Philippine Air Force has ordered 18, with a second 18 on option. The first four of these were completed in Italy; the others are being assembled locally by Philippine Aerospace Development Corporation. SIAI-Marchetti is developing an improved attack version with a lightweight HUD and Omega navigation computer, and has offered the Royal New Zealand Air Force, as a Strikemaster replacement, the S.211A with more powerful JT15D-5 engine and increased use of composites, notably in the wings.

Contractor: SIAI-Marchetti SpA (subsidiary of Agusta SpA), Italy.

Power Plant: one Pratt & Whitney Canada JT15D-4C turbofan; 2,500 lb st.

Dimensions: span 27 ft 8 in, length 30 ft 6½ in, height 12 ft 5½ in.

Weights: empty 4,078 lb, gross ('clean') 6,063 lb, max gross 6,944 lb.

Performance (at 5,511 lb gross weight): max cruising speed at 25,000 ft 414 mph, stalling speed (gear and flaps down) 86 mph, service ceiling 40,000 ft, T-O run 1,280 ft, landing run 1,185 ft, max range (internal fuel, 30 min reserves) 1,036 miles, *g* limits +6/−3 'clean', +5/−2.5 with external stores.

Accommodation: crew of two on tandem Martin-Baker Mk 10 zero/zero ejection seats. Rear seat raised.

Armament: two hardpoints under each wing for up to 1,455 lb of single- or twin-gun machine-gun pods, cannon pods, rocket launchers, bombs, napalm tanks, cartridge throwers, two camera/IR reconnaissance pods, or two drop tanks.

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LJTTTS-3-7/89

Su-28 (NATO 'Frogfoot-B')

Although described on a placard as an Su-25UB operational training version of the Su-25 attack aircraft, known to NATO as 'Frogfoot-A', the tandem two-seater exhibited at the 1989 Paris Air Show had 'Su-28' painted on its engine nacelles. It has been identified as a derivation of the Su-25UBK, used by the paramilitary DOSAAF organization as an advanced trainer, and available for export.

Except for the humpback appearance resulting from elevation of the rear seat, under a continuous framed canopy, and a taller tail fin, the basic airframe of the Su-28 differs little from that of the Su-25K. It was displayed in Paris without the gun and underwing weapon pylons of the operational versions, and with a blanking plate replacing the flat nose window for a laser rangefinder and marked target seeker. Up to four underwing auxiliary fuel tanks can be carried for ferrying.

Contractor: P. O. Sukhoi OKB, USSR.

Power Plant: two Tumansky R-95Sch non-afterburning turbojets; each 8,980 lb st.

Dimensions: span 47 ft 1½ in, length 50 ft 8 in, height 17 ft 10¼ in.

Weights: normal T-O 29,100 lb, max gross 37,965 lb.

Performance: max speed at S/L 621 mph, min speed (clean) 146 mph, T-O run (clean) 1,640 ft, landing run 1,640 ft, range (clean) 348 miles at low altitude, 652 miles at 23,000 ft, ferry range 1,335 miles, *g* limits (ultimate) +8/−2.

Accommodation: crew of two in tandem on ejection seats.

Armament: normally none, although provisions retained.

T-2 and T-2A

This advanced jet trainer was the first supersonic aircraft to be designed and developed by the Japanese aerospace industry, and in addition to its training objectives formed the basis of the Mitsubishi F-1 single-seat close air support fighter. Ninety examples of the two-seat model were delivered to the Japan Air Self-Defense Force's 4th Air Wing at Matsushima, of which 28 were configured as T-2 advanced trainers and the other 62 as T-2A combat proficiency trainers. Since 1982, six of the latter version have been flown by the JASDF's official display team, the 'Blue Impulse,' and the tractability of this aircraft was further demonstrated when one was successfully test flown after conversion by Mitsubishi for use in a control configured vehicle (CCV) research program. Production of the T-2 and T-2A ended in early 1988. The Japan Defense Agency has initiated a program known as ATX aimed at developing a new advanced supersonic trainer to replace the T-2. This will involve also a new afterburning engine in the 8,200 lb st class.

Contractor: Mitsubishi Heavy Industries Ltd, Japan.

Power Plant: two Ishikawajima-Harima TF40-IHI-801A (license Rolls-Royce Turbomeca Adour Mk 801A) afterburning turbofans; each 7,305 lb st.

Dimensions: span 25 ft 10¼ in, length 58 ft 7 in, height 14 ft 5 in.

Weights: empty 13,905 lb, gross 28,219 lb.

Performance ('clean'): max speed Mach 1.6, service ceiling 50,000 ft, T-O run 2,000 ft.

Accommodation: crew of two on tandem Daiseru/Weber zero/zero ejection seats. Rear seat elevated.

Armament: one Vulcan JM61 multibarrel 20 mm cannon in lower fuselage, aft of cockpit on port side. Hardpoints on underfuselage centerline and two under each wing for drop tanks or weapons. Wingtip attachments for air-to-air missiles.

T-4

The first dozen T-4s, of an eventual total expected to reach about 200, began to be delivered to the Japan Air Self-Defense Force in September 1988. Classified as intermediate jet trainers, the T-4s have begun to replace the JASDF's existing fleet of aging Lockheed T-33As and Fuji T-1A/Bs serving with the air training wing at Hamamatsu, near Tokyo. The T-4, which made its first flight on 29 July 1985, was required to demonstrate high subsonic maneuverability, and is fully aerobatic, with pressurized and air-conditioned accommodation for instructor and pupil. It is an all-Japanese program, with Mitsubishi contributing the intakes and central portion of the fuselage, Fuji building the rear fuselage, wings, and tail assembly. Sumitomo the landing gear, and IHI the engines. The T-4 is expected to be used by the JASDF for liaison and other duties, in addition to its primary role as a training aircraft, and has been chosen to replace the T-2s of that service's 'Blue Impulse' display team.

Contractor: Kawasaki Heavy Industries Ltd, Japan.

Power Plant: two Ishikawajima-Harima F3-IHI-30 turbofans; each 3,680 lb st.

Dimensions: span 32 ft 7½ in, length 42 ft 8 in, height 15 ft 1¼ in.

Weights: empty 8,157 lb, gross ('clean') 12,125 lb, max gross 16,535 lb.

Performance (at 'clean' gross weight): cruising speed Mach 0.75, service ceiling 50,000 ft, T-O run 1,800 ft, landing run 2,200 ft, max range (with two drop tanks) 1,036 miles, *g* limits +7.33/−3.

Accommodation: crew of two on tandem UPC (Stencel) SIIIS-3J ejection seats. Rear seat elevated.

Armament: two hardpoints under each wing for drop tanks or other stores; underfuselage pylon for target towing equipment, an ECM/chaff dispenser, or an air sampling pod.

SIAI-Marchetti S.211, Republic of Singapore Air Force (Ivo Sturzenegger)

Sukhoi Su-28 (NATO 'Frogfoot-B') (Paul Jackson)

Mitsubishi T-2 of the Blue Impulse, JASDF (Katsumi Hinata)

Kawasaki T-4, Japan Air Self-Defense Force

T-45A GOSHAWK

When the British Aerospace Hawk (which see) was selected in November 1981 to replace the T-2C Buckeye and TA-4J Skyhawk as the US Navy's new undergraduate jet pilot trainer, changes made to meet USN requirements included new main and nose landing gear, an arrester hook, and airframe strengthening to make the T-45A carrier compatible. The nose gear is twin-wheel and steerable, with a catapult launch bar/nosewheel tow; two fuselage-side airbrakes replace the Hawk's single large underfuselage airbrake; twin ventral strakes were replaced by a single surface serving also as a fairing for the arrester hook; avionics and cockpit displays are different; and weapons delivery capability for advanced training is standard. The effect on weight distribution and overall weight, combined with the USN's original decision to adopt a derated version of the Adour engine, not unnaturally resulted in the proposed production model being underpowered and subject to unacceptable stall and stability characteristics. These have been overcome during the past year by adopting an uprated engine, making aerodynamic changes to the wing leading-edges and airbrakes, and increasing the vertical keel area by enlarging the fin and adding additional ventral strakes. As a result of these corrective measures, the original Lot 1 production order (for 12 aircraft) was accordingly followed in August 1989 by approval of the FY 1989 Lot 2 contract for a further 24 T-45As. IOC with the first 12 aircraft is scheduled for early 1991 at NAS Kingsville, Tex. Douglas Aircraft Co. manufactures the front fuselage of the T-45A at Long Beach, Calif.; the remainder of the airframe is supplied by its principal subcontractor, British Aerospace. Present plans envisage delivery of 300 production Goshawks by 1997.

Contractors: McDonnell Douglas Corporation, USA, and British Aerospace, UK.

Power Plant: one Rolls-Royce Turbomeca F405-RR-400L (Adour Mk 871) turbofan; 5,860 lb st.

Dimensions: span 30 ft 9¾ in, length (including probe) 39 ft 3¼ in, height 13 ft 5 in.

Weights: empty 9,399 lb, gross 12,758 lb.

Performance: max speed at 8,000 ft 620 mph, max Mach number in dive 1.1, service ceiling 42,250 ft, T-O to 50 ft 3,744 ft, landing from 50 ft 3,900 ft, ferry range (internal fuel) 1,150 miles, *g* limits +7.33/−3.

Accommodation: two crew in tandem on Martin-Baker Mk 14 NACES zero/zero ejection seats. Rear seat raised.

Armament: one pylon under each wing for practice multiple bomb rack, rocket pod, or drop fuel tank. Provision for centerline stores pylon.

McDonnell Douglas T-45A Goshawk prototype, US Navy

Computers can digitize a million picture elements per scene and update it sixty times a second.

The Simulator Revolution

BY JOHN RHEA

WHEN the Apollo astronauts first landed on the moon some twenty years ago, they were thoroughly prepared for that first step because they had rehearsed the mission hundreds of times in simulators back on earth.

Mission rehearsal was the key to the success of the Apollo program. Now it is becoming critical to success—and survival—in the increasingly demanding world of tactical warfare. Fortunately for the US Air Force, supporting technologies are keeping pace with the challenge.

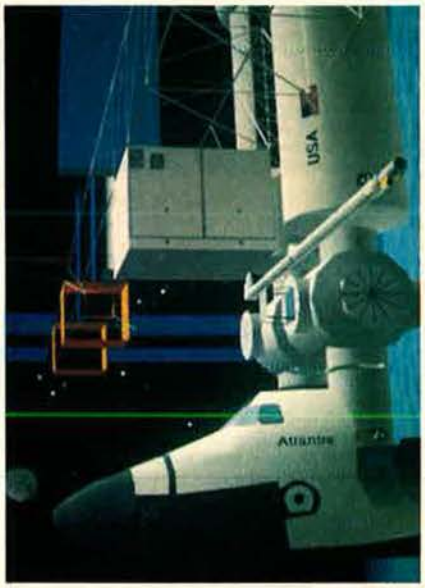
Apollo astronauts trained rigorously for two years in a mission simulator that would be considered primitive by today's standards. They "landed" a replica of their lunar module, using actual flight controls, on a simulated area of the Sea of Tranquillity known as a model board. They viewed this subscale world out the window via closed-circuit television. As the astronauts manipulated their controls, the TV camera moved correspondingly to give them a realistic sense of motion.

Until the computer revolution hit the simulation business with gale force within the past decade, that's all mission-rehearsal simulators were: TV cameras, model boards, and replicas of flight vehicles. Now the outside world is being reproduced digitally in the bowels of computers and displayed to the trainees in a way that allows them to interact with a broad range of stress-inducing situations.

This new technology is called computer-generated imagery (CGI), and it is the foundation for new training methods with sufficient realism to prepare today's warriors for tomorrow's challenges.

A Broad Geographic Sweep

Unlike TV model boards, CGI simulators can provide trainees with pictures of large geographic areas (including the routes to and from targets as well as the targets themselves) in which all the threats are accurately located with the aid of timely intelligence data. The astronauts could be reasonably confident that there wouldn't be anybody on the moon shooting at them, but that would not be the case for Special Operations Forces on missions to such areas as the Middle East.



On an Evans & Sutherland ESIG-1000 computer image-generation system, a NASA space shuttle is shown undertaking a space mission.

Furthermore, in the increasingly threatening environment of electronic warfare, mission success will depend on sensor data from outside the narrow visual portion of the spectrum. These data can also be computer-generated during mission rehearsals. So can fog, smoke, and haze. Just as the new sensor suites are intended to give fighter aircraft all-weather, day/night capabilities, their supporting mission-rehearsal simulators must do likewise.

George H. Branch III, manager of military marketing at General Electric's Simulation and Control Systems Department in Daytona Beach, Fla., sees a trend toward greater reliance on nonvisual data in both training and actual missions. Ten years ago, the out-the-window view amounted to 100 percent of tactical-warfare simulation, he says. Today it's seventy-five percent and dropping. He sums up the situation succinctly: "There's more avionics to simulate."

These nonvisual data, which occupy much larger portions of the electromagnetic spectrum, include forward-looking infrared (FLIR) and narrow-field infrared, synthetic aperture radar, night-vision goggles, and low-light-level TV (LLLTV). This increased data flow requires sensor fusion techniques to funnel vital information to the pilot *[see "Sensors Across the Spectrum," November '87 issue]* in both the operational vehicles and the mission-rehearsal simulators.

Fifty Billion Instructions

That, in turn, increases the need for computer power to run today's state-of-the-art CGI simulators. For example, the MH-53J helicopter weapon system trainer, which GE is developing for the Air Force's Special Operations Forces, uses a combination of general- and special-purpose computers with processing speeds ranging from ten to fifty billion instructions per second, according to Mr. Branch. That is much faster than even the most powerful supercomputers of today, although the two classes of machines aren't quite comparable because of the specialized nature of simulation computing.

The data-storage requirements are equally demanding. To simulate a 300,000-square-mile area of the United States used for Air Force training exercises (essentially from Arkansas to Kentucky and parts of California), GE used four 300-million-byte disk storage devices. To simulate the 3.6 million square miles of the fifty states would require twelve times that amount. Of course, for mission rehearsals the areas to be simulated would be mostly in the Eastern Hemisphere, and the database for that is available from the Defense Mapping Agency and from what are known in the trade as "national technical means."

The visual fidelity of CGI simulators is good and getting better, to the point where further improvements may not be necessary. As a rough measure of the capability of the human eye, if the normal field of view is digitized, it amounts to about a million pixels (picture elements) of direct vision and roughly another million pixels of peripheral vision.

Today's CGI simulators update the scene sixty times a second to give the illusion of reality. The human eye cannot sense individual pictures at rates greater than twenty-four a minute; therefore, that is the rate used in motion pictures (although each frame is projected twice to eliminate the jerky motion of the early silent films).

This rate, providing a further smoothness of motion, is essential in interactive mission simulations because conflicting visual cues can cause motion sickness among the trainees.

Thus the computational requirement for CGI is dictated by the need both to provide at least a million digitized picture elements per scene and to do it sixty times a second. That's where today's computers built out of very-large-scale integration (VLSI) components have taken over, muscling out TV model boards in the process. "The picture quality is there," says Mr. Branch. "No more pixels are needed."

Antithesis of "Simnet"

This approach of high fidelity, rel-

On GE's Compu-Scene V (above), a simulated MH-53J helicopter flies over Nevada. The real thing is shown below. The MH-53J weapon system trainer, now being developed for the Special Operations Forces, uses specialized simulation computers that are much faster than the most powerful supercomputers of today.

The Air Force did not introduce visual simulation in trainers until the recent F-16 upgrade program. The new F-16 simulator (above), a relatively low-cost system, is not a traditional full-mission simulator, but its field-of-view device can simulate takeoffs, landings, and some missions with convincing realism (below).

atively high costs, and limited interaction for simulators based on powerful stand-alone central computers can be thought of as the antithesis of the Defense Advanced Research Projects Agency's Simnet (simulator network) approach. Simnet uses low-cost distributed computers to produce maximum interaction among participants in training exercises, but at this point it is capable of only relatively crude graphics *[see "Planet Simnet," August '89 issue, p. 60]*. It is reasonable to expect that, in the future, these approaches could converge to create even more powerful simulators.

According to Michael R. Willmore, a staff scientist at Link Flight Simulation, Binghamton, N. Y., a division of Toronto-based CAE Industries, effective mission rehearsal depends on countering three kinds of uncertainty: situational uncertainty, probabilistic uncertainty, and operational uncertainty.

Situational uncertainty applies to the purely physical nature of a region where the conflict is to be modeled, essentially terrain and weather. Probabilistic uncertainty includes the capabilities of the weapons that all the participants bring to the battlefield: system performance, reliability, probabilities of hit and kill, even electronic signatures. Both of these are well within the realm of current simulation technology, Dr. Willmore maintains.

The outlook is not so bright for operational uncertainty. Dr. Willmore calls it the most difficult aspect of warfare to simulate or even account for in reality. It is the result of how cohesively the command structure is organized, how efficient the control processes are in directing force responses on the battlefield, and the connectivity strength of communications systems in passing essential information among the entire command control and communications (C^3) architecture.

"It is pointless to design a static threat simulation for mission rehearsal that can only record and play back one presupposed set of conclusions about the mission environment or what the conflict should look like during mission rehearsal," Dr. Willmore states. "Such 'tactical' simulations, created by writing scripts from a set choreography, cannot possibly respond to the dynamics generated by a single participant, let alone several others who may be operating together as a mission unit.

"Instead, mission rehearsal should serve as an adjunct to the final mission planning activity that occurs just prior to executing tactical missions in reality," he continues. "Participants explore the planned missions by asking themselves, 'What if we did this?' and 'What if the enemy does that?' and 'What if this happens?' and the entire litany of other questions designed to better prepare themselves for the uncertainty at hand."

High Costs—For Now

Then there's the issue of costs. Simulators aren't cheap. GE's MH-53J system, for example, is projected to cost more than $30 million. But they are getting cheaper, at least on a cost-per-function basis. Through the use of VLSI components (and soon, it is hoped, transportable software), simulators are getting smaller, cheaper, and easier to support. Mr. Branch estimates this price decline at about ten percent a year, but he cautions that simulator prices are likely to remain steady because the military customers are likely to opt for increased performance instead of lowered system costs.

A rule of thumb in the industry is that the customer will pay about ninety percent of the unit cost of the aircraft for its simulator. In the case of the Air Force's Advanced Tactical Fighter (ATF), which has a projected $35 million program unit cost, that means a likely ceiling price of close to $32 million for the simulator.

Development of the simulators for ATF, as well as those for the X-30 National Aerospace Plane, the aircrew training system for the Special Operations Forces, and the upgrade of the F-16 simulators, are all managed now out of the System Program Office for Training Devices

(still referred to as SIM/SPO) under Col. Wayne Lobbestael at Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

This is a departure from past Air Force practice, in which the simulator efforts had been under the SPO managing the weapon system development. The Army and Navy have centralized their simulator development and procurement under the Program Manager for Training Devices (PM-TRADE) and the Naval Training Systems Center, respectively, both located in Orlando, Fla. Centralizing the simulator effort removes it by at least one step from the budgetary pressures that normally afflict weapons development programs—a distinct advantage.

At the Marine Corps Air Station, Cherry Point, N. C., a Marine Corps pilot in a McDonnell Douglas Operational Flight Trainer lands an AV-8B Harrier II light attack aircraft on a deck of a simulated carrier. The trainer's digital recording system adds realistic sound as part of the mission simulation.

Navy, USAF Take Different Paths

Because of the differing natures of their tactical air missions, the Air Force and Navy have taken different approaches to flight simulation. Since Navy fighters customarily operate off the decks of aircraft carriers, the Navy early on recognized the benefits of simulation to reduce the number of risky carrier operations. A classic example is an engine flameout during a carrier landing, something no pilot wants to practice in a real aircraft.

The Air Force has not felt such a need for flight simulators and did not introduce visual simulation until the recent F-16 upgrade program recently won by Evans & Sutherland of Salt Lake City, Utah. Dave Eccles, manager of strategic planning at E&S, describes the new F-16 simulators as relatively small field-of-view devices capable of simulating takeoffs and landings and some missions—but not traditional full-mission simulators. These are also relatively low-cost, estimated at about $1.5 million apiece.

But Mr. Eccles sees other forces at work that may win further customer acceptance of flight simulators. His company recently received a contract to supply at least six low-level flight trainers for the West German Tornado fighter, and this may be a bellwether for future procurements. Just as one of the purposes of DARPA's Simnet is to prevent tanks from tearing up farmland and causing intolerable traffic jams in West Germany, simulators for tactical aircraft in the NATO environment can be a force for better relations among NATO allies.

Looking beyond these current applications of flight simulators, Mr. Branch of GE traces the impact of size reduction made possible by new electronic components. GE's original Compu-Scene II system, introduced in 1980, consisted of twenty-six cabinets, each standing about six feet high and weighing 900 pounds. Compu-Scene V, introduced at this year's Paris Air Show, dropped that to six cabinets, and Mr. Branch says the next goal is to get an entire simulator into a single cabinet.

At 900 pounds per cabinet, the simulator could easily be installed on board an aircraft the size of a USAF C-5 transport to permit embedded training during normal flight operations. Another order of magnitude reduction, down to ninety pounds, would put that capability within reach of the ATF.

The Totally Enclosed Aircraft

Given the increasing importance of nonvisual sensor data, future derivatives of today's flight simulators might entirely replace the out-the-window view. Submarine commanders have been doing this for years. They rarely peer through periscope eyepieces anymore; the sensor data are funneled to them through a variety of mast-mounted devices and displayed in the submarine control center on television screens. This enables submarines to reduce their visibility to enemy forces.

In the case of high-performance fighters, it might be more efficient for the pilot to be in a supine position monitoring the sensor data over CCTV during periods of high G-forces. This approach could eliminate the traditional cockpit entirely, which would be valuable in reducing the aircraft's radar cross section. Pilots are already overly task-loaded with through-the-window data, and the use of sensor fusion could eliminate extraneous information. The value of sealing off the aircraft in a nuclear environment is obvious.

Taken together, these potential capabilities of CGI give this technology the edge for a variety of future applications. TV model boards put Americans on the moon and performed many other valuable functions, but today their importance has shrunk to what Mr. Eccles of E&S calls the equivalent of HO-scale railroad models. ■

John Rhea is a free-lance writer living in Woodstock, Va., who specializes in military technology issues. His most recent article for Air Force *Magazine, "Silicon's Speedier Cousins," appeared in the November '89 issue.*

Two master's degree programs prepare acquisition managers to deal with a tidal wave of new requirements.

AFIT Tackles the Software Problem

BY LT. COL. DOROTHY J. McBRIDE

WHEN it comes to producing software for critical weapon systems, the Air Force is barely treading water. That's not good enough to deal with the tidal wave of requirements now crashing around system developers.

The Air Force routinely experiences software performance problems, cost overruns, and late deliveries. Lloyd Mosemann, when he served as Air Force Deputy Assistant Secretary (Logistics), reported that software development and integration could be the problem "in seventy percent of our troubled systems." Speaking of software schedules in particular, Gen. Bernard P. Randolph, Commander of Air Force Systems Command, claims, "We've got a perfect record: . . . we've never made one on time yet."

The Air Force Institute of Technology (AFIT) is poised to play a major role in overcoming the problem. Innovative AFIT education programs will be a key component in reducing a severe shortage of acquisition managers prepared to deal with complex software issues.

Starting in May 1990, AFIT's School of Systems and Logistics will offer a master's degree program in Software Systems Management. It will be closely coordinated with a master's degree program in Software Engineering offered for the first time in May 1989 by AFIT's School of Engineering. This relationship between the schools represents a shared vision of software engineering as both a technological and a managerial discipline.

The combined discipline aims to provide systematic development and maintenance of software products that are developed, validated, and implemented within a specific period and within an estimated cost range. The programs in both schools will share a curriculum designed to introduce software engineering and management concepts. Courses have been designed to address major problems plaguing software developers.

Software systems are incredibly complicated, susceptible to change, and essentially invisible. One thinks of modern military aircraft as complex structures, and they are. The F-15 has approximately 75,000 parts, each precisely designed and all arranged to perform integrated

functions flawlessly. Software, however, makes possible the integration of all those parts.

Escalating Demand

Software complexity is dramatically increasing, too. Fewer than 100,000 instructions supported the FB-111 in 1965, but the operational flight program on the B-1 requires more than a million software instructions. Today's E-3 AWACS requires about 4,000,000 instructions. The space station will very likely need as many as 80,000,000 instructions.

Potential system users frequently demand changes throughout and beyond the development process. Changes are inevitable and necessary because military environments and missions change, but they also are very costly. Unfortunately, the impact of change orders is much more difficult to see when the change affects software than when it affects the structure of a plane or a missile.

Demand for software is escalating exponentially. "Software is the key to just about every major weapon system in DoD," says Lt. Gen. James S. Cassity, Jr., former Commander of Air Force Communications Command, now with the Joint Staff. "The Air Force spent about $4 billion on software in 1987—roughly five percent of the total Air Force budget." Mr. Mosemann suggests that, by 1995, software development and maintenance could cost $30 billion annually. Yet the national shortage of software engineers is rapidly approaching 1,000,000, and the services have a tough time competing with industry to attract and retain software managers.

The problem is multifaceted. The Air Force must identify software experts and place them where their skills provide the most leverage; they're needed primarily to support the software acquisition process. The Air Force also needs to revamp career development policies for software specialists. Acquisition procedures must be changed to take best advantage of available and evolving software development tools and methodologies.

There has been progress in each area. In particular, AFIT's innovations in graduate education are preparing Air Force men and women to respond to the challenges of software acquisition management.

For example, the most difficult part of the software development task is determining and specifying precise system requirements. Misidentified requirements could go undetected until late in the development process, resulting in ineffective software or expensive, time-consuming rework. One study has estimated that sixty percent of system errors are due to inadequate specification and design.

Traditionally, the customer has produced a requirements document before awarding a contract for software development. Experience, however, calls for customer and producer to write the requirements document jointly. The customer should expect the identification of requirements to be an iterative process. In fact, the Defense Science Board Task Force on Military Software states that "users cannot, with any amount of effort and wisdom, accurately describe the operational requirements for a substantial software system without testing by real operators in an operational environment and iteration on the specification." AFIT's software-engineering course sequence includes coverage of both traditional and joint, iterative approaches to identifying and specifying requirements.

Advanced Design

The most significant advances in techniques to support software development involve software design. Software design means producing a "blueprint" for the software system. Many methods for creating and documenting the plan have become available.

A key principle of software design is modularity—divide and conquer. The problem in its entirety is invariably too complex to tackle at once, but the various design techniques help to divide the problem systematically into manageable subproblems or modules.

Computer-aided software engineering tools have also been developed to automate the design documentation and to track changes in the design.

Despite the advances, the Defense Science Board found that the new techniques have not been generally practiced in DoD. Of course, new techniques and tools are useful only when software developers know they exist and can apply them properly, so AFIT covers modern design techniques thoroughly.

Possibly the best-known DoD innovation in software development was its definition of the Ada programming language as the standard language for new software systems. The structure of the language supports modern software principles and is closely linked to software-engineering practices. It has been successfully used in military programs. Use of Ada is prominent throughout AFIT's software systems curriculum.

When software system development falls behind schedule, the temptation is to shorten the testing phase. However, lives depend on the performance of military software, so incomplete testing is unacceptable. Testing is essential at multiple levels: to ensure that each module satisfies requirements, to ensure that combinations of modules operate together as intended, and to ensure that the whole system functions properly. Testing at all appropriate levels must be repeated when the software is changed because the modification may have introduced new errors. Appropriate testing strategies and techniques for selecting test data constitute an important part of AFIT's software sequence.

Military software plays a role significantly different from that of even advanced, complex, civilian software. Military software is critical to the safe and reliable operation of sophisticated weapon systems and is essential to intelligence, communications, command, and control.

By comparison with civilian software, military software is typically real-time. Once a "smart" weapon is launched, there's no time for preparing and analyzing reports. To ensure accurate delivery, the weapon must react instantaneously and appropriately to a continuous flow of data. Military software, particularly for command control systems, is also more communications-oriented than its civilian counterpart. Communications software must ensure reliable, secure communications.

Finally, despite its complexity, military software is more resource-

constrained than civilian software. Space and weight limitations in cockpits, for example, constrain the amount of computer memory that can be installed, mandating software that makes the best use of the available memory. AFIT graduates appreciate the distinctions between military and civilian software and understand how to apply management tools to the development of high-quality mission-critical software.

The Problem Is Management

Significant as the technical challenges are, they are not the biggest problem. The Defense Science Board charged that "today's major problems with military software development are . . . management problems." The Board particularly called for changes in the DoD software-acquisition process, as have others. In October 1988, the Software Engineering Institute held a Software Problems Workshop in which participants examined critical software problems as reported by a wide range of organizations. They concluded that past management problems have cost dearly in terms of current maintenance requirements and that management still ranks high on the list of software problems. Mr. Mosemann indicated that "the real impact of the software revolution is not the need for greater technical or mathematical proficiency, but the need for more rigorously disciplined and aggressive management."

A particularly valuable feature of AFIT's Software Systems Management program, then, is that it supplements a core of technically oriented software-engineering courses with a sequence of software-acquisition management courses. These cover cost and schedule estimation, risk assessment, quality assurance, software contract management, and configuration management.

The most obvious symptoms of software development problems are cost and schedule overruns. Many combinations of problems could be identified as the root causes for overruns in a particular program. Much of the trauma, however, might be averted if costs and schedules were more accurately predicted. Unfortunately, many software developers use cost-guessing rather than cost-estimating techniques. They also fail to account sufficiently for factors such as testing, employee turnover, skill limitations, and immaturity of hardware or software technology. AFIT will equip its software systems graduates with advanced software cost- and schedule-estimating techniques, including attention to potential risks to project completion.

Equally severe are problems with software quality. Tales abound of canceled programs or of expensive circumventions stemming from software that fails to satisfy requirements. Mr. Mosemann has cited software problems with the Peacekeeper missile-guidance system, the B-1B's defensive avionics system, and the EF-111A and F-4G Wild Weasel. Software quality assurance is a process-oriented function: Every activity and function of the process should result in a product that complies with requirements. Although some quality-assurance methods apply to many programs, each software development effort has unique features. AFIT students will learn how to tailor a software quality-assurance program to the requirements of a particular development program.

Expertise for Acquisition

Software development programs are increasingly handled by contractors because the armed services simply don't have sufficient numbers of skilled software specialists. But contracting introduces a whole new set of problems. James F. McGovern, a former Under Secretary of the Air Force, said that the DoD Inspector General's office found management problems in seventy-five percent of the software contracts it reviewed. Some of the problems could be overcome by concentrating officers with software-engineering skills in acquisition roles rather than in internal-development roles. AFIT's degree program is intended specifically to prepare Air Force officers for the acquisition role.

Solutions to some of the other contract problems, however, require changes in the government's purchasing procedures to take advantage of modern software-engineering practices. For example, purchasing practices have been biased toward building custom software rather than purchasing available software packages. Also, DoD standards make applying such modern approaches as prototyping very difficult. Finally, DoD data-rights policy does not encourage contractors to develop new software methodology and effectively discourages reuse of modules. AFIT will ensure that its graduates understand current government software purchasing policies and procedures, with all their strengths and weaknesses.

Software is evolutionary by nature. Unchecked, demands for changes could easily destroy a manager's control over the development process and threaten the integrity of a software system. The configuration management function controls change. The goal is to maintain system integrity while balancing user demands against resource constraints. AFIT students will learn to apply effective procedures for evaluating proposals for change, selecting those that contribute to meeting user requirements within established constraints and tracking implementation of approved changes.

AFIT believes that its Software Systems Management degree program will be one of a kind and will make a critical contribution to solving the Air Force's software crisis. ■

Lt. Col. Dorothy J. McBride is Director of the AFIT Graduate Information Resource Management Program, based at Wright-Patterson AFB, Ohio. This is her first article for AIR FORCE *Magazine.*

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GENERAL DYNAMICS

A Strong Company For A Strong Country

This museum preserves the airman's side of history with artifacts, memorabilia, pictures, and special exhibits.

Enlisted Heritage Hall

BY COLLEEN A. NASH, ASSOCIATE EDITOR

AMONG dozens of displays at USAF's Enlisted Heritage Hall is the overhead turret of a Consolidated Vultee B-32 Dominator, the only one in existence. It is so complete that "all we have to do is plug it in and hit it with hydraulics, and we are ready to rock and roll on twin .50-calibers," reports CMSgt. Wayne Fisk. When visitors look closer at the turret, they see that it bears serial number 1.

In 1983, CMSgt. Bobby Renfroe, the first enlisted Commandant of the Senior NCO Academy, wondered why no Air Force facility existed to discuss and preserve enlisted heritage. With SMSgt. William Allen (now retired), Chief Renfroe kicked off a drive that led to the establishment of the Hall in 1984. Today, the museum at Gunter AFB, Ala., boasts 6,000 square feet of exhibit space and nearly 100 displays.

Equipment on display provides a close-up view of combat as seen by enlisted aircrews.

There's a B-17/B-24 ball turret so tiny that it's hard to imagine how a gunner, lying on his back with his feet up in stirrups, could ever track and shoot enemy aircraft.

There's a B-52D tailgun from the Vietnam era. The compartment looks fairly roomy. But, Chief Fisk points out, many Vietnam bombing flights lasted fourteen to sixteen hours. In the 1950s, during the Cold War, flights could last up to twenty-four hours. "So," explains Chief Fisk, who was the Hall's first director, "when one thinks of the amenities inside here—the seat that folds down into a bed, the hot cup for making coffee or tea, the little portable john—it is still austere for one to be locked in here for twenty-four hours at a time."

The exhibits not only testify to the role of enlisted

Photo © Gary D. Wallace 1989

At USAF's Enlisted Heritage Hall, students from the NCO Leadership School at Maxwell AFB, Ala., visit the Order of the Sword Room, dedicated to all known recipients of this special enlisted honor.

personnel in combat but chronicle their contributions to the development of airpower as well. The tour traces USAF's lineage from the US Army to the present, from the early days of ballooning to Vietnam.

One pictorial exhibit of Civil War balloons depicts the earliest Army use of lighter-than-air craft. A photograph, taken during the Civil War Battle of Fair Oaks, portrays enlisted men holding the ropes to a balloon. Chief Fisk notes that these men are precursors of today's USAF aerospace ground equipment personnel.

There's a tribute to Pvt. Frederick Libby, the first American to down five enemy aircraft in World War I, and an almost life-size painting of Cpl. Eugene Bullard, the world's first black fighter pilot.

Corporal Bullard flew missions with the French Flying Corps. His original 1917 pilot's certificate is prominently displayed. Corporal Bullard was "a national hero of France but a forgotten son of America," says Chief Hines.

In the World War II section, enlisted and sergeant

Photo © Gary D. Wallace 1989

Heritage Hall Director CMSgt. Donald B. Hines, standing beside an almost-life-size painting of Cpl. Eugene Bullard, the world's first black fighter pilot, tells students from the NCO Leadership School of Corporal Bullard's contribution to enlisted heritage. Chief Hines has a master's degree in military history from the University of Alabama.

Another exhibit honors the progenitor of today's enlisted Air Force, Cpl. Edward Ward. He became, in 1907, the first enlisted man appointed to the Aeronautical Division of the Signal Corps.

Also present in the exhibits of this era are photos of Cpl. Vernon Burge, the Army's first enlisted pilot. Lt. Frank Lahm taught him how to fly, and Corporal Burge received his pilot certification in 1912.

The War Years

Enemy flags vividly mark transitions to different combat eras: the Bismarck flag of World War I, Nazi and Imperial Japanese flags of World War II, and North Korean and North Vietnamese flags.

"The advent of World War I revolutionized the use of both balloons and airplanes," says CMSgt. Donald B. Hines, the Hall's current director. "Tether ropes and early telephones illustrate early balloon utilization, while Jenny wicker seats, wing center struts, and personal flying gear depict the enlisted pilots' roles."

A rare photo, taken around 1918, shows a group of sergeant pilots standing beside a World War I aircraft. Nearby, there's a copy of the 1919 flying regulations. "Rule #21," notes Chief Hines, "says that aviators will not wear spurs while flying."

pilots are again recognized in a pictorial display. They flew virtually every type of aircraft in the World War II inventory. According to Chief Hines, plans exist to add many more original photos to this exhibit.

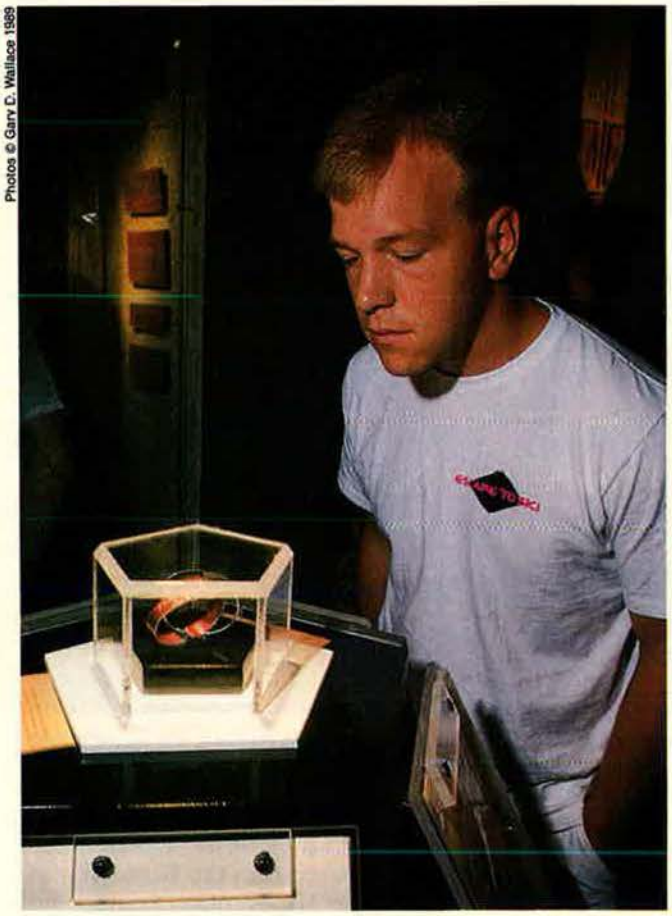
There's a tribute to enlisted crew members of the Doolittle raid and to two renowned gunners, Joseph Sarnoski and Johnny "Zero" Foley. A display case is filled with wartime artifacts such as patches, buttons, old silk maps, books, and pamphlets. A radio log tells the story of an aircraft and a radio operator's struggle to make it to Hickam Field, Hawaii, with "one motor out, other bad." There's a tribute to the Women's Army Air Corps.

Entering the section devoted to the Korean War, visitors notice that exhibits are few. "This is America's 'forgotten war,'" says Chief Hines. "At present, we have a display case containing only a few artifacts, like an old parachute and a helmet. We plan to add more photos and displays."

Ground and air uniforms and accessories depict the roles of airmen and women in Vietnam. A pararescue jumper mannequin, complete with scuba gear, parachute, and maroon beret, is on display. There's also a model of a combat controller ready to set up a drop zone. He is outfitted with a small oxygen bottle, al-

timeter, and parachute. There are mannequins of an AC-130 gunship crew member and of an Air Force woman wearing green fatigues and combat gear. Assorted memorabilia of the era include ID cards, liberty passes, a driver's license, and photos of Jolly Green Giant rescue teams.

Among the more popular exhibits is a replica of a Vietnamese prisoner of war cell. Photographs of pictures drawn by a former POW line the exterior and depict the agony that prisoners endured. Inside the cell,



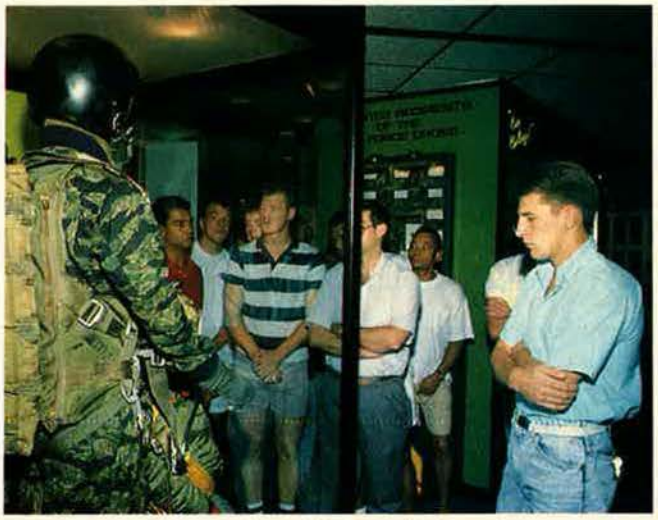
A student inspects a POW/MIA bracelet display. On the display column is a list of Air Force enlisted personnel still missing in action in Southeast Asia. Nearby are several artifacts brought back from Hanoi's POW cells.

there's a mannequin clad in a POW uniform. The outfit was donated by retired CMSgt. Gary Morgan, shot down during a Linebacker II B-52 strike on Hanoi. Many former POWs have visited this display. "We ask them to sign the walls inside the cell," says Chief Hines. More than a dozen have done so.

Next to the cell are artifacts brought back from Hanoi's cells: POW shorts, cigarettes, memos, notes, candy, and a bar of Russian lye soap so caustic that it's dissolving a razor blade resting on it. There's also a POW/MIA bracelet display and a list of all the Air Force enlisted personnel still missing in action in Southeast Asia.

Enlisted Honors and Traditions

Five original paintings, donated by the Illinois Air National Guard, depict the heroic actions of the five enlisted US Army Air Forces and USAF Medal of



In the Vietnam War section of Heritage Hall, students examine a model of a combat controller ready to set up a drop zone. The exhibit behind the students honors the nineteen enlisted recipients of the Air Force Cross.

Honor recipients. SSgt. Henry "Red" Erwin, SSgt. Archibald Mathies, Sgt. Maynard H. Smith, and TSgt. Forrest L. Vosler received the Medal of Honor for their actions in World War II. The only enlisted person to receive the Air Force Medal of Honor from the Vietnam era was A1C John L. Levitow.

Another exhibit honors the nineteen enlisted recipients of the Air Force Cross. "We have two Air Force Crosses on display—A1C William Robinson's and now CMSgt. Duane Hackney's," says Chief Hines.

Visitors are ushered through a white archway to the Chief Master Sergeants of the Air Force Room and to the Order of the Sword Room.

The first room honors the nine men who have risen to the top of the enlisted corps. Plans are under way to install a bronze statue of the first CMSAF, Paul W. Airey.

The Order of the Sword is an honor bestowed by the enlisted force on its most devoted leaders or advocates. The tradition has its roots in the thirteenth century and was revived by the Air Force in 1967. A huge broadsword, handmade by a young staff sergeant, is displayed in a showcase. Panels list the names of all known recipients. Former CMSAF Donald L. Harlow is the only enlisted person ever to receive the Order of the Sword, and his award is part of the exhibit.

The "Wall of Achievers" salutes former enlisted men and women who wore stripes and later became general officers or well-known figures. Included are singer Johnny Cash, actor Charlton Heston, test pilot Chuck Yeager, astronaut Dick Scobee, and USAF Chief of Staff Gen. Larry Welch.

About half of the items on display at the USAF Enlisted Heritage Hall were donated by individuals. Students at the Senior NCO Academy often donate artifacts, and each class passes the hat for contributions to the Hall. "We rely almost entirely on contributions and fundraisers," says Chief Hines.

The Hall is now in Phase II of a three-phase growth program. The goal of Phase III is to raise several million dollars to fund a new and permanent Heritage Hall facility, including a static display park for enlisted career field-related aircraft and equipment. ■

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The F-111 has become a mechanic's nightmare, but Lakenheath kept its mission-capable rate above command standard anyway.

Team Jaeger

BY JAMES W. CANAN, SENIOR EDITOR

AFTER a rocky start in the 1960s, the F-111 has served the Air Force well in strategic and tactical roles for more than twenty years. F-111s performed handsomely in Vietnam and carried out Operation Eldorado Canyon, the demanding long-distance raid on Libya from England in April 1986.

But the F-111 has become a mechanic's nightmare. It is "an old airplane with too many moving parts—the whole wing moves, of course, and it has lots of flaps, slats, false spoilers, and what have you. The airplane is very maintenance-intensive."

That description comes from Col. Richard L. Jaeger. He knows from experience how hard it is to keep F-111s in shape for flying and fighting, and his extraordinary success at that task is all the more impressive in view of the difficulties involved.

Colonel Jaeger won the Air Force Association's 1989 Thomas P. Gerrity Memorial Award for Logistics Management for having "led a maintenance team that achieved unprecedented levels of readiness" with its wing of F-111s at RAF Lakenheath, United Kingdom. The award was presented at AFA's forty-third national convention last September in Washington, D. C. Colonel Jaeger received AFA's highest honor in the logistics field "for his unparalleled professionalism in leadership of the largest F-111 maintenance complex in the Air Force. His mission accomplishment and logistics management have set standards for years to come."

In nominating Colonel Jaeger for the award, Gen. William L. Kirk, then Commander in Chief of US Air Forces in Europe, commended him for "achieving superior results with the hardest-to-maintain, most complex aircraft in the inventory at an overseas location where logistical support is a constant challenge."

Colonel Jaeger, now stationed at Tinker AFB, Okla., earned the Gerrity award while serving as Deputy Commander for Maintenance of the 48th Tactical Fighter Wing. The "Statue of Liberty Wing" is made up of eighty-two F-111s, including those used on the Libyan mission in 1986. Colonel Jaeger was responsible for the operations, training, and well-being of the wing's 2,300 maintenance personnel.

Never Below Seventy

He got results that were, by all accounts, hard to believe. For example, the wing's fully mission-capable (FMC) rate—the number of F-111s with all systems functioning as they should—averaged seventy-four percent for the year. This was an eye-popping twelve percent higher than the USAFE standard and a dramatic 10.6 percent improvement on the wing's previous all-time high.

The FMC rate for the 48th's F-111s was a model of consistency, too. Not once during 1988 did it drop below seventy percent. Twice, during June and July, it topped eighty percent.

In recommending Colonel Jaeger for the AFA award, USAFE noted that "it was his ability to clearly define goals, put the right people in key leadership positions, enforce strict compliance with technical-order and tool-control procedures, and insist on supply discipline that made this superb achievement possible with aircraft over twenty years old."

Colonel Jaeger augmented his leadership and managerial abilities with an inventive turn of mind. He was cited by USAFE for his "personal work with Air Force Logistics Command to solve a flux-valve problem" that had plagued his wing's F-111s. Working closely with AFLC's Sacramento Air Logistics Center, the colonel and members of his maintenance force developed "a new machine to swing flux valves more quickly and precisely."

More than twenty years old, the F-111 has become a mechanic's nightmare. Nevertheless, Col. Richard L. Jaeger, Deputy Commander for Maintenance of the 48th Tactical Fighter Wing at RAF Lakenheath, United Kingdom, kept the wing's F-111s' fully mission-capable rate twelve percent higher than the USAFE standard.

The flux-valve problem was the main reason why the partially mission-capable (PMC) rate of the wing's F-111s had been far too high. Once the problem was solved, the PMC rate came down dramatically to a level much lower, and thus much better, than the USAFE norm.

As a result, the 48th TFW's mission-capable (MC) rate, which takes into consideration both the FMC and PMC rates, climbed to "a superb 78.9 percent, far surpassing the USAFE standard of seventy-one percent," said the USAFE citation. "So high did the numbers climb that in 1989, USAFE leaders were obliged to raise standards—and not just by a little bit. 'Team Jaeger' created a new yardstick for others to measure themselves by."

The wing's extremely high readiness rates made Colonel Jaeger proud but also somewhat skeptical. He questioned their validity.

Work, Practice, and Luck

"The numbers were so good," he recalls, "that I began personally inspecting the airplanes and keeping track of things to make sure they were accurate. And they were.

"We worked for those numbers. We had good people, and we practiced a lot and we practiced hard. That's a big part of my management philosophy. It comes down to telling people what you want, giving them the resources to do it, and giving them plenty of opportunity to practice."

Colonel Jaeger, who piloted RF-4C tactical reconnaissance aircraft on 196 combat missions in Southeast Asia, says he owes his success as a maintenance commander to "a little bit of luck" as well.

"I was fortunate in having a wing commander whose style was not to micromanage, and I enjoyed very close working relationships with the [wing's] deputy commanders for operations and for resource management," the colonel says. He also notes that he received "absolutely superior support from Third Air Force, USAFE, Sacramento ALC, and British Aerospace," which runs the maintenance overhaul depot that serves RAF Lakenheath.

It seems that Colonel Jaeger gave as much support as he received. As the USAFE recommendation notes, "in the face of constant mission demands, Colonel Jaeger expertly maintained a balanced, people-oriented leadership style. He was constantly aware of and responsive to his people. . . . He created an atmosphere in which they felt free to think creatively, and his encouragement of innovation resulted in extraordinary ideas for saving time and money, many of which were adopted at the command and Air Force levels."

Demands on the maintenance team were heavy at Lakenheath. According to USAFE, the team was taxed in 1988 by such difficulties as "extremely poor weather [and] a depot call-back of twenty-two engines . . . with suspected turbine sideplate cracks." In addition, it had to cope with the effects of Air Force budget cuts and take care of large numbers of transient aircraft.

But the maintenance team's toughest challenges lay in seeing its F-111s successfully through the annual USAFE bombing competition and twenty-seven operational exercises, an average of more than two a month. It met those challenges and more, breaking USAFE records in the generation and regeneration of aircraft.

In one exercise, enough F-111s were generated to meet the wing's twelve-hour goal in less than half that time, or five hours, eighteen minutes.

"Our generation rates were astounding," Colonel Jaeger recalls, "but we worked for them. We also practiced covert generation of aircraft, because we never knew when we might have to go do the real thing. Not everyone would know about those exercises. I'd use just enough people to get the job done. I'd say to them, 'I need you to do this, but I can't tell you why.' And they always went out and did what they had to do." ■

Backed by modern automation, fewer personnel specialists can manage the force—and do a better job of it.

Personnel Moves On Line

BY FRANCINE KRASOWSKA, MANAGING EDITOR

THIRTY years ago, it took more than four US Air Force personnel specialists to handle personnel actions—recruiting, training, assignment, promotion, and separation or retirement—for every 100 servicemen. Today that ratio stands at two specialists per 100 servicemen and -women *and* civilian employees. The ratio continues to drop, and the level of efficiency continues to rise.

Two programs are largely responsible for the Air Force Military Personnel Center's success: its worldwide Personnel Data System (PDS) and its base-level civilian personnel management system (PDS/C). A third program, PC-III (for Personnel Concepts III), will extend the benefits of the PDS to the unit level—and on out to the flight line. According to Col. Bill O'Connor, Director of Personnel Data Systems at Hq. AFMPC, Randolph AFB, Tex., the ratio of personnel specialists to USAF servicemen will reach 1.8 to 100 when PC-III is fully operational.

AFMPC takes a "grow your own" approach to data management, constantly refining and tailoring its systems to the requirements of the units it supports. It also works closely with the major commands (MAJCOMs), keeping an eye on the "big picture."

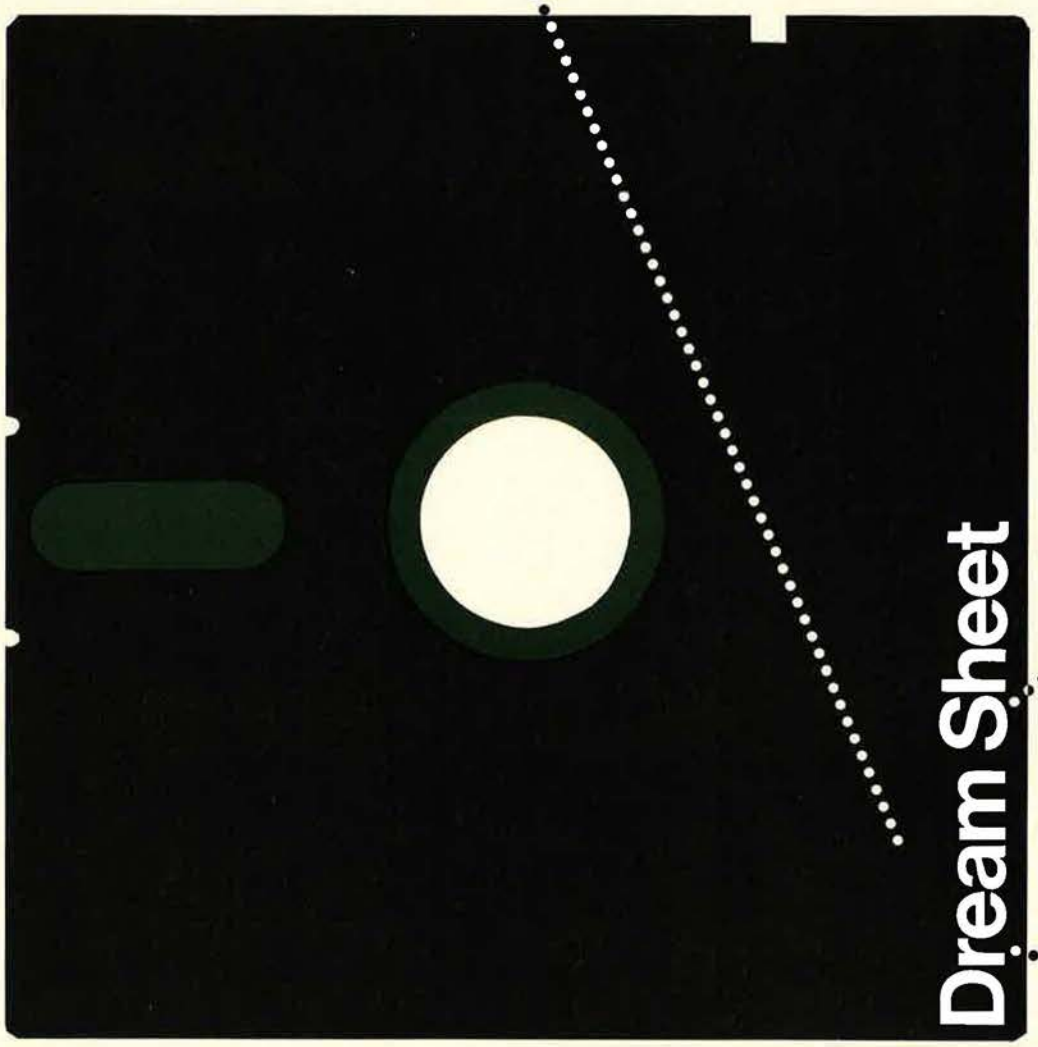
AFMPC manages personnel through a computer system whose designers were personnel specialists as well as computer technicians. They built a unique flexibility into the system. "The system is user-oriented and user-controlled," says Colonel O'Connor.

The PDS is the overall data-management architecture within which AFMPC operates. It is both an organizational structure and an approach to integrating and processing information.

Through PDS subsystems tailored to their particular requirements, the Air Staff at the Pentagon, MAJCOMs and Separate Operating Agencies (SOAs), the Guard and Reserve, bases, training centers, recruiters, and joint-service contingency planners send AFMPC a constant flow of data on such factors as manpower, flight records, personnel availability, and mobilization plans. PDS programs automatically update and correlate one another's data using this information. This allows AFMPC to spot trends, predict personnel requirements, and disseminate the necessary information to the appropriate units.

For example, if Military Airlift Command determines that a certain mission requires greater use of a particular airplane, AFMPC obtains MAC data on how many more technicians and pilots will be needed. AFMPC translates these requirements into evaluation, training, assignments, and even recruiting actions. A projected need for more maintenance technicians for a certain period can trigger a special recruiting effort with the appropriate high school graduating classes.

If a base is scheduled to close, AFMPC looks at new or expanding missions throughout the Air Force and reassigns base personnel accordingly. This action may include



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scheduling more training or assigning extra personnel workers to a receiving base to handle the influx of new manpower.

The same interactive approach is evident in AFMPC's PDS/C. The PDS/C is a version of the Base Level Personnel System (BLPS), one of the components of the PDS. Like its military counterpart, the PDS/C handles all aspects of personnel management and allows managers to monitor personnel developments that will directly affect one another.

Interaction between user and system, and among users who exchange personnel resources, is so important that Air Force personnel specialists may think, "Doesn't everyone do it this way?" The need may be apparent, but putting together a computer system that meshes all the necessary components is not so easily done.

For one thing, an agency may already rely heavily on many different—and incompatible—hardware and software systems. In addition, interdepartmental power struggles can hamper standardization even more than incompatible technology does. This is why the Army, for example, has not followed the Air Force's lead in integrating Guard and Reserve personnel management with active-duty personnel management.

The Army, the Navy, and 105 federal agencies have adopted the Air Force's PDS/C system for civilian personnel management. Most pay AFMPC in dollars or in manpower for software and training, providing their own hardware and production sites. The resulting increase in efficiency, the General Accounting Office estimates, now saves taxpayers an average of $100 million a year.

Once the flow of personnel data has been assured and coordinated, how do you extend its benefits throughout the Air Force, not just to personnel offices but also to the commanders who need that information for mission planning?

The Best of Both Worlds

The answer is PC-III. The new system has passed through testing and evaluation with flying colors and is nearly ready for deployment. When fully fielded, PC-III will eliminate 8,000,000 paper transactions a year. USAF will be able to reduce its force of personnel managers by seventeen percent while gaining in efficiency. Squadron commanders will have instant access to information that used to take days, even weeks, to obtain.

"PC-III gives us the best of both worlds," says Col. George R. Greenwood, Chief of Field Activities at AFMPC and PC-III Program Manager. It "combines the benefits of centralization with the advantages of decentralization."

For years, he explains, USAF personnel technicians were in the units. That was good for a commander, who could obtain data on his unit from the orderly room and make swift personnel decisions. It was not so good for the Air Force. "There was no standardization," says Colonel Greenwood. "You needed lots of manpower, and little information was exchanged between units."

The shortcomings of this system became painfully obvious during the Vietnam War, reports Colonel O'Connor. "Units did not always have the luxury of a permanent base from which to operate. Commanders found themselves deploying resources from temporary bases . . . or former garrisons . . . that had been closed down. Without any personnel support, with many people sent TDY [on temporary duty], with heavy reliance on SAC launches from the States, deploying commanders couldn't keep track of who they had, who they needed, and what was happening to their resources."

The evolution of AFMPC as an SOA and the development of the PDS allowed the Air Force to tackle the problem. By consolidating personnel operations into central offices, by standardizing policies and procedures, and by automating personnel data processing, AFMPC brought a high degree of organization to the Air Force's personnel actions.

The down side, explains Colonel Greenwood, was that "commanders no longer had access to their own information." If mission planners needed to know how many people were trained in certain skills or would be available at a certain time, they had to make case-by-case inquiries to the Consolidated Base Personnel Office (CBPO) and wait for the responses. Errors or miscommunications could cause more delay. Routine actions such as promotions or assignments followed a tortuous paper trail. Even with data processing, obtaining access to the processed information consumed much valuable time.

PC-III eliminates much of this inefficiency. The forms are still there—they are part of PDS standardization—but they have been put on the system. Formerly, a personnel specialist would read information written on a form, type it into the base's computer, and wait for verification or action from AFMPC. Now, the person originating the action or needing the information will type an inquiry on his or her terminal and get an instant response. The form will appear on the screen already filled out with whatever pertinent information is available, cued by the user's inquiries. Users will be able to call up personnel rosters based on security clearances or immunization records, for example, and will be able to create new rosters from the PDS database.

Users' terminals will be connected to minicomputers that will tie into their base's mainframe computer and share information with the central computers at AFMPC headquarters via the AUTODIN network.

Much of this system is already in place. Where possible, PC-III uses existing equipment. When new equipment is needed, off-the-shelf hardware will be used. The system is not dependent on the products of a particular vendor; this will give USAF more options during contract rebidding. The system has an open architecture, meaning that new components and modifications can be added as the system matures. For a hardware investment of less than $170 million, says Colonel Greenwood, USAF expects to realize productivity savings of some $1.1 billion.

PC-III is expected to reduce the cost of training. As PC-III extends to more bases, a technician who has a basic background in personnel will need less training at each new assignment, according to Colonel O'Connor.

In addition, Colonel O'Connor says, "fewer people will be needed to support different applications,

since the same software platform can be used in different ways." A personnel specialist will not have to be trained to use new software every time his or her job acquires a new function, and fewer specialists will be needed in the orderly rooms and CBPOs.

When PC-III got under way in 1984, this manpower-savings objective led some to fear that PC-III would merely shift work from CBPOs to unit orderly rooms.

An exhaustive, two-year operational test at Moody AFB, Ga., proved that this was not the case.

High Marks at Moody

"Based on what I've seen, I think PC-III will achieve its goal of increasing efficiency within the CBPOs and cutting a lot of paperwork," says Lt. Col. John Lindsey, Commander of the 347th Mission Support Squadron at Moody AFB, where testing of a PC-III prototype began in the fall of 1987.

"Some squadrons were concerned that [PC-III] was trying to transfer CBPO work out to the units," says Colonel Lindsey. "It's just a faster way of doing what we already do. Down the road, as the system matures, new applications will evolve that will make our job easier."

Colonel Greenwood supports this assessment. "The unit still is limited in what it can do—assignments, training. If a unit needs to process information, an orderly-room clerk will still fill out a form, but on a terminal instead of on paper, and the system's helps and prompts will make it easier to do it right."

After an initial concept-testing at Lackland AFB, Tex., in 1986–87, AFMPC set up its PC-III prototype system at Moody for functional validation. The plan was to get a network up and running and then see how the system affected the base—and how the base affected the system.

"There has been a lot of headshaking over this," comments Colonel Greenwood. Auditors and others within the Air Force raised questions over AFMPC's deviation from the usual method of implementing a new military tool. "The standard way of doing things," he explains, is to "develop the whole system, then test the whole system, then field the whole system."

The standard approach was too chancy for AFMPC. Programs marching doggedly along the all-or-nothing development path can fall into oblivion before they ever make it to the field. Anticipating budget and manpower tightening, AFMPC has committed PC-III to saving 1,537 authorizations in the personnel field. Colonel Greenwood defines the risk: "Once those positions are gone, they're gone. The system *has* to work. It's actually replacing those people."

The strategy used by AFMPC, says Colonel Greenwood, is "incremental development and rapid prototyping." Incremental development means working on a project a few components at a time, rather than trying to do everything at once.

"The idea is to get up and flying with what you've got," explains Colonel Greenwood. "New increments build on the lessons from earlier ones." Once a reasonable number of system components have been developed, rapid prototyping "gets it out in the field as soon as possible so you can see what works. We've gotten smart fast," says Colonel Greenwood. "The software has matured very quickly. There have been far fewer bugs and glitches than in other types of development programs."

Passing All Tests

In fact, Colonel Greenwood admits, it is highly unusual for an automated system to have come this far without major problems. PC-III has sailed over all of its formal hurdles so far.

The Air Force Management Engineering Agency validated PC-III's manpower-saving capability in August 1988. Operational Test and Evaluation (OT&E) was carried out by Air Force Communications Command in September 1989. A retrofit of the system at Moody to a new hardware configuration went smoothly this past summer. Colonel Lindsey claims that the retrofit to more powerful equipment has "vastly improved" operations, allowing Moody to "save money by reducing the number of computers."

The Office of the Secretary of Defense, which requires large automated systems to undergo three separate reviews by DoD's Major Automated Information Systems Review Council before implementation, was so impressed by the first two reviews that the third, scheduled for late November of this year, has been delegated to the Air Force.

The next step for PC-III, with its Moody-generated improvements, is two weeks each of training and installation at McConnell AFB, Kan. If McConnell comes smoothly on line, the next base is Randolph, more than twice the size of McConnell. USAF will then begin full-scale implementation at the rate of three or four bases per month. By September of 1992, under current plans, 126 bases worldwide will be part of the PC-III network.

Each MAJCOM will be responsible for installing the system and training users at its bases. AFMPC will train the MAJCOM installers and trainers, and AFMPC personnel will accompany the MAJCOM personnel to their first two bases.

AFMPC hopes that this handholding will ease the transition. "PC-III comes in many boxes; there are modems, multiplexers, comm lines, power lines, terminals. Some assembly is required," Colonel Greenwood acknowledges. "The MAJCOMs and the base project officers will realize the savings and the benefits of PC-III, so they will undertake the burden of installation."

PC-III's developers hope to extend its advantages out to the flight line. The Air Force's experience in Vietnam proved how crucial personnel data are to commanders in battle. Another AFMPC system called CPCS (Combat Personnel Control System) uses microcomputers in hardened carrying cases that can be flown to the battle area. There, the micros can tap into the PC-III network to process mobility-line TDY orders and manifests, can collect data from the bare-base units, and can feed information to computers in theater commanders' headquarters.

AFMPC's track record appears to justify the Air Force's confidence in its systems. Innovative and far-sighted management has enabled it to skirt the pitfalls of overautomation and recapture the benefits of decentralization. ■

They do have Christmas at Thule—but the trees are imported from New Jersey.

Arctic Sentinels

A PHOTO REPORT BY CHRISTOPHER GIERLICH

It sits on the barren northwest coast of Greenland, a forlorn outpost in the Arctic expanse. Here, winter storm winds rip through at 200 miles an hour. Temperatures drop to −85 degrees Fahrenheit. Nighttime darkness can last three months. Brazen Arctic foxes, known as "Archies," scavenge for food.

Thule AB, 700 miles north of the Arctic Circle, is an Air Force installation like no other. The 2,600-acre site has a Ballistic Missile Early Warning System (BMEWS) radar, some 360 Americans, 1,000 Danes, and a few low-rise buildings.

And almost nothing else.

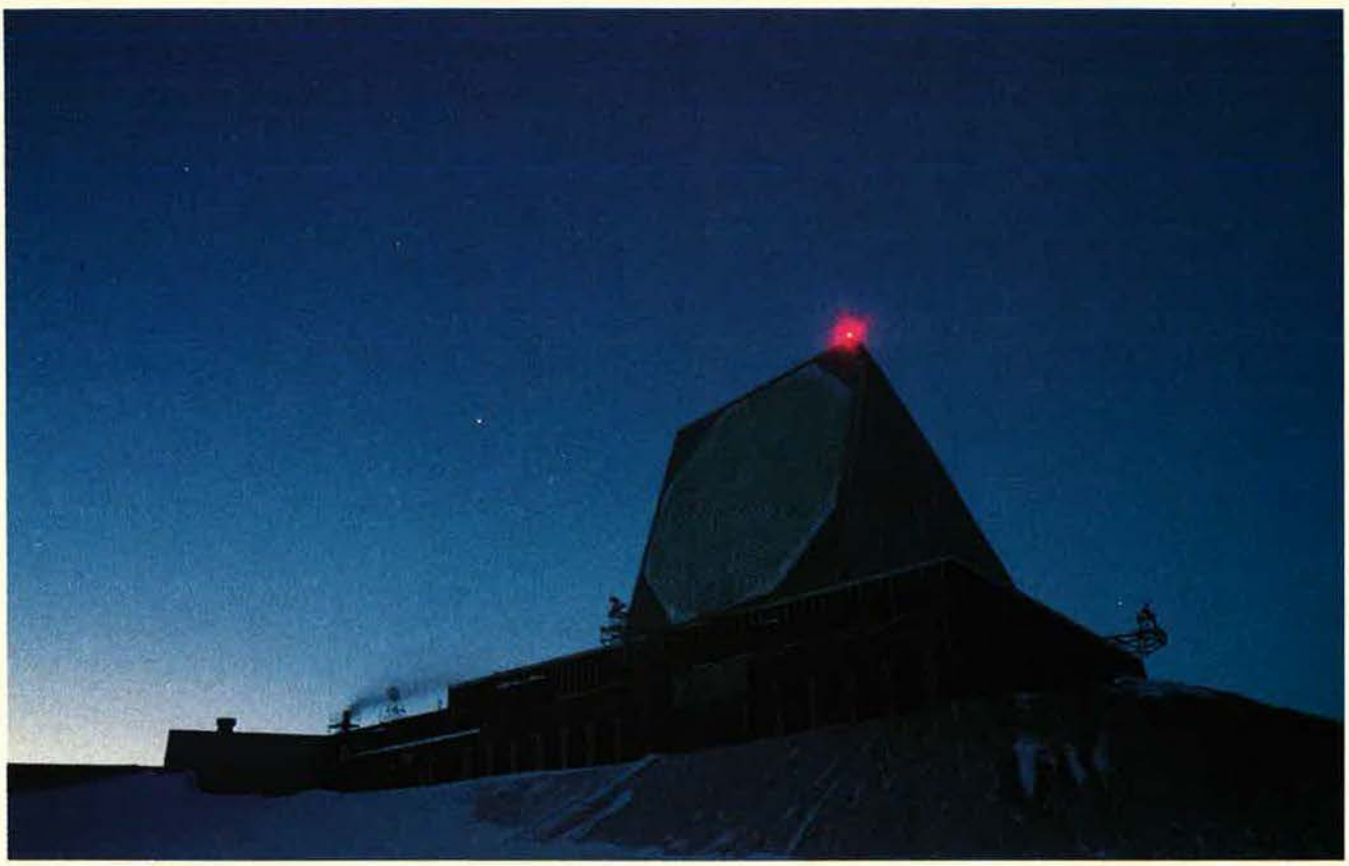
Thule is desolate, a snow-covered end of the Earth. Nothing except squat scrub bushes grows in the bitter Greenland cold. Even the base's Christmas trees must be brought in by airlift. Each December, Reserve USAF pilots donate Christmas trees and fly them from McGuire AFB, N. J., to Thule, where they quickly go up in dormitories and work sites.

As the 180 or so local USAF personnel see it, Thule is a vision of Hell frozen over. There is a 10,000-foot-long airstrip, but almost nobody comes. Once a week, C-141 resupply airplanes shuttle between Thule and McGuire. Only pilots experienced in Arctic operations are permitted to make the trip.

The C-141 flights provide a life-support system for the USAF personnel and 180 US civilian contractors, who are based in the High North to keep watch on Soviet ballistic missile launches taking place on the other side of the pole. The "eyes" of this operation are the crews who man USAF's newly upgraded BMEWS radar.

With permission from Denmark—it has sovereignty over Greenland—USAF deployed its first BMEWS ra-

Lt. Cindy Sorenson, an operational planner for the 1012th ABG Security Police Division, unloads fresh pine trees donated by Air Force Reserve pilots at McGuire AFB, N. J. McGuire flies supplies to Thule twice a week; the Christmas tree mission began in 1987.



dar to Thule in 1961. The upgraded version, which Raytheon installed at a cost of $110 million and now helps maintain, is a two-sided, electronically steered, phased-array sensor that can do a vastly better job of detecting, tracking, and assessing ICBM launches than could the three mammoth radar dishes that made up the old system.

It is also far more reliable. The older BMEWS radar was "down" an average of fourteen minutes a day; the newer one is out of action fewer than fourteen minutes a month. What's more, the new radar performs its task while using only seventy-one percent of its total sensing capacity, and power usage has been cut by eighty percent.

The two BMEWS panels send their powerful radar beams deep into the skies and space above the Soviet Union. The numerous elements of the panels make a faint popping noise as the system's sophisticated computer selects and fires them individually.

Inside the Missile Warning Operations Center, work is carried out by four crews of four. Two additional qualified radar crews are kept on standby. Occasionally, a crew will be forced to pull a twenty-hour shift because storms prevent relief from arriving.

The MWOC's computer terminals display a circular graphic showing sensors as they fire. Few fire at any given time, and the pattern seems to be random, with three or four flickering symbols appearing and disappearing every few seconds, to be replaced by another small flock. Crew members speak of "fencing in" a launched object with radar beams, with the computer determining the trajectory, arc, and impact point of the object as it breaks the "fences."

The Ballistic Missile Early Warning System's phased-array radar (above) emits faint popping sounds as its radar panels fire in the quiet of the Arctic night. The moonless night lasts for three months; unlike many Americans stationed at Thule, Lieutenant Sorenson enjoys the dark season and hopes to remain at Thule "indefinitely." Below, an inquisitive Arctic fox, or "Archie," watches as Lieutenant Sorenson delivers another Christmas tree (right). The foxes are quite numerous at Thule and not at all shy.

Thule's control tower (top) commands a view of much of the base. Few flights other than the supply flights from New Jersey arrive on Thule's 10,000-foot runway. A much busier scene is the Missile Warning Operations Center (above), where crews of the 12th Missile Warning Squadron monitor the BMEWS radar.

"We often get a 'heads up' concerning [launch of] a satellite, but not always," reports one Air Force officer. "The Russians provide the best drills for our crews when they fire an unannounced ICBM test."

A sudden, unexpected Soviet rocket launch within the Thule BMEWS "field of view" concentrates the crew's attention as they seek to verify the authenticity of information being reported by the computer. The crew is allotted one minute to determine if a threat is real.

BMEWS also receives "space watch" assignments. This entails daily tracking of some of the 19,676 cataloged objects in orbit. The computer matches a suspect object's track with a "known-object" trajectory. It is followed closely until a match is found or until the object is determined to be nonthreatening and is cataloged.

The USAF contingent at Thule AB is a part of Air Force Space Command, based at Peterson AFB, Colo. On site are the 12th Missile Warning Squadron of the 1st Space Wing; Detachment 3 of the 2d Satellite Tracking Group, 2d Space Wing; and a Host Base Support Unit of the 3d Space Support Wing.

Danish personnel living on the base perform all essential services and maintenance as contractors to the US government. The Danes treat Americans as the guests that they are and keep apart from the Americans on base. Some anti-American sentiment can be found. One large barrier to closer relations is the fact that US servicemen and -women stay only for one year. That is long enough for most Americans. ■

Christopher Gierlich, who visited Thule last winter, is a freelance photographer living in New York City.

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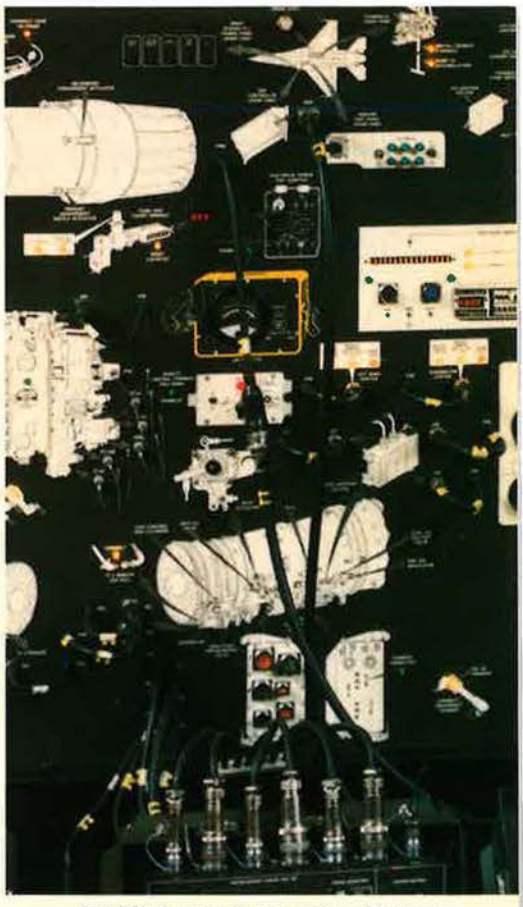

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The Post Office announcement said it was a complete success. The real story is different—and much more interesting.

The Day the Airmail Started

BY C. V. GLINES

MAY 15, 1918, was a day some wanted to forget. The story begins with Maj. Reuben H. Fleet, then Col. Henry H. "Hap" Arnold's officer in charge of training pilots at thirty-four Army Air Service fields in the United States. His primary responsibility was to make combat pilots out of carpenters and college students and get them to France. There were not enough barracks, classrooms, instructors, or airplanes. There were too many training accidents. The British-designed de Havilland DH-4 trainers were flimsy and underpowered.

Major Fleet (who one day would own his own aircraft company) had no reason to be concerned when he saw a War Department order dated May 3, 1918, that directed the young Air Service "to inaugurate an Aerial Mail Service between Washington, D. C., and New York beginning May 15th."

Major Fleet was at work in his Washington office on May 6 when he was summoned by Secretary of War Newton D. Baker. Major Fleet, the Secretary revealed, had been chosen to get the airmail started. He was to pull together airplanes and pilots and begin daily operations on a Washington-Philadelphia-New York circuit. The first flight would leave Washington at 11 a.m. on May 15. President and Mrs. Wilson would be there for the takeoff.

"I was dumbfounded," Major Fleet confessed many years later. "I didn't know how to tell this man who knew nothing about airplanes that he was giving me an almost impossible task. I said, 'Mr. Secretary, with all due respect, we don't have any airplanes that can fly from Washington to Philadelphia to New York. The best plane we have is the Curtiss JN-6H, and it will fly only an hour and twenty minutes. Its maximum range is eighty-eight miles at sixty-six mph.' "

The first "regular airmail" is loaded for delivery to Philadelphia. Despite technical problems, Maj. Reuben H. Fleet, flying a modified Curtiss JN-6H from Bustleton Field near Philadelphia to Washington, D. C., arrived as scheduled.

Major Fleet explained that the "Jenny" was only a trainer, had dual controls for student and instructor, and had no baggage compartment for mail. There was a shortage of experienced pilots, few had any cross-country experience, no maps except road maps were available, and good mechanics were extremely rare.

Secretary Baker listened to this unwelcome recitation and sent Major Fleet to repeat it to Postmaster General Albert S. Burleson. The Postmaster was not sympathet-

ic. He had already announced that Army Aerial Mail Service would begin May 15, he said, "and it's going to start, even if your pilots have to land in cow pastures every few miles."

"Leave the Front Seat Out"

Major Fleet departed and hurriedly called Col. Edwin A. Deeds, Chief of Air Service Production. He asked him to order six JN6Hs from the Curtiss Aeroplane and Motor Co. at Garden City, Long Island. "Tell them to leave the front seat out, and the front set of controls," he said. "In the front seat space, have them make a hopper or compartment up there to carry mailbags." To the fast-moving, energetic Colonel Deeds, this didn't sound impossible.

"But there's more," Major Fleet said. "I've got to have double the fuel and oil tank capacity, and we need those ships in eight days!"

When Colonel Deeds contacted the Curtiss factory, its engineers proposed doubling the fuel and oil capacity merely by hooking two nineteen-gallon gas tanks and two twelve-gallon oil tanks in tandem. Test flights proved that the modifications worked.

Major Fleet next contacted Maj. August Belmont, President of the Belmont Park Race Track on Long Island, and asked permission to use the park as the New York terminus of the mail operation. This was done to prevent interference with training of Army pilots at nearby Mineola Field.

The problem that most troubled Major Fleet was finding capable pilots. He needed six and was told to choose four from whatever source he pleased. The Post Office Department would choose the other two.

Major Fleet chose Lts. Howard P. Culver, Torrey H. Webb, Walter Miller, and Stephen Bonsal. The Post Office Department made arrangements with the War Department to have Lts. James C. Edgerton and George L. Boyle detailed to the duty.

Major Fleet soon understood why these men were chosen. Lieutenant Edgerton's father was purchasing agent for the Post Office Department. Lieutenant Boyle's prospective father-in-law was an Interstate Commerce Commissioner who "had saved the parcel post for the Post Office Department" from private express companies fighting the government in court. Both young men had just graduated from flying school at Ellington Field, Tex., and had little experience flying out of sight of their training field.

Major Fleet knew that, even if the aircraft functioned perfectly, the operation would depend on good piloting. He was furious when he learned that Lieutenant Boyle was to have the honor of flying the first mail from Washington to Philadelphia and Lieutenant Edgerton was to fly it from Philadelphia to the nation's capital.

Lt. George L. Boyle, carrying the first official load of airmail, takes off from Potomac Park in Washington, D. C., in the modified Jenny delivered by Major Fleet. Lieutenant Boyle got as far as Waldorf, Md., twenty miles southeast of Washington; another pilot flew the mail to Philadelphia the next day.

Major Fleet was told he had no choice in the matter. On May 13, he took the train to New York with five of the six pilots, having left Lieutenant Boyle in Washington. At the Curtiss factory, mechanics, engineers, and pilots worked around the clock to get the six planes into shape. By the afternoon of May 14, only two were ready. Leaving Lieutenant Webb in charge of preparing the other four planes, Major Fleet commandeered an unmodifed Jenny, knowing it didn't have enough range to make the trip to Bustleton Field outside Philadelphia.

In the late afternoon of May 14, Major Fleet left Belmont Park with Lieutenants Culver and Edgerton following closely. Major Fleet describes the flight:

"The weather was frightful; it was so foggy we pilots couldn't see each other after we left the ground. Even the masts of the boats in the New York harbor were sticking up into the clouds.

"I climbed through the fog and came out at 11,000 feet, almost the absolute ceiling of the plane. I flew south guided only by a magnetic compass and the sun until I ran out of gas and the engine quit. Since I had the Jenny without the extra gas tank, it wasn't any surprise. There was nothing I could do but ride the Jenny down and hope that I landed near a source of gas."

Flying on Tractor Gas

"I broke out of the clouds at 3,000 feet over lush farmland, so I just picked out a nice pasture and landed. A farmer sold me a five-gallon milk can of tractor gas, but I had trouble getting it in the tank without a funnel.

Perhaps three gallons got in the tank and the rest all over me, but darkness was coming, and I couldn't wait while he got more from town. I asked him to point out where Philadelphia was and took off.

"Two miles from Bustleton Field I ran out of gas again and landed in a meadow. I persuaded a farmer to drive me to Bustleton. Culver and Edgerton had just arrived, so I sent Culver with some gas to get my plane and fly it in.

"There were so many things wrong with the modified planes and their engines that we worked all night to get them in safe flying condition. One gas tank had a large hole in it, and we plugged it up with an ordinary lead pencil.

"Next morning, at 8:40 a.m., I took off for Washington, where I landed at 10:35 at the polo field in Potomac Park. The mail was due to start twenty-five minutes later."

While Major Fleet had been worrying about operational details, Army Capt. Benjamin B. Lipsner was concerned about administrative details at the Washington end. Not a pilot, he had volunteered to be the superintendent of operations when he heard the Army was going to be responsible for getting the project started.

On the morning of May 15, he was waiting nervously at Potomac Park for Major Fleet. Although he felt sure he had solved all the nonflying problems, he was worried because President and Mrs. Wilson and other VIPs had been invited to witness the historic takeoff of "the first plane in history to carry mail at an announced time to and from designated places on a regular schedule irrespective of weather," according to the Post Office press release.

The plan for the inaugural flights was uncomplicated. After Major Fleet arrived, the mail was to be loaded aboard his plane, and Lieutenant Boyle was to depart in it for Philadelphia, 133 miles away, at precisely 11 a.m. He was to pass his mail to Lieutenant Culver, who would fly it the remaining 100-plus miles to Belmont Park. At 11:30 a.m., Lieutenant Webb was to leave Belmont for Philadelphia and turn over his pouches to Lieutenant Edgerton. The other two pilots would be kept in reserve, and all pilots would share flying duties on succeeding days in order to maintain a six-day-a-week schedule until the experiment was completed.

Nothing to Worry About

The minutes ticked by, and no plane arrived. Captain Lipsner chatted nervously with Sgt. E. F. Waters, one of the mechanics assigned to service the planes at the polo field.

At 10:30, Major Fleet's plane came into sight. It circled once, then landed. "Where's Lieutenant Boyle?" he asked, as he climbed out of the cockpit. Lieutenant Boyle approached the plane with Margaret McChord, his fiancée, and introduced her.

"We haven't got much time," Major Fleet said. "The President will be here any minute." He handed a road map to Lieutenant Boyle. "Here, Boyle, I'll show you how to get to Philly," he said.

While the two pilots talked, mechanics checked the plane's fabric and wire braces. Second Assistant Postmaster General Otto Praeger pushed through the crowd and asked if everything was all right. Captain Lipsner assured him there was nothing to worry about. Just then, a line of cars chugged across the polo field. Secret Service agents were standing on the running boards. The lead car parked beside the plane. President and Mrs. Wilson stepped out to applause from the crowd. The President shook hands with the two pilots.

The mail trucks arrived. Washington Postmaster Merritt Chance held one of the mailbags open as President Wilson dropped in a letter addressed to New York Postmaster Thomas G. Patten. The President had written his name across the stamp. This historic letter was to be auctioned off in New York for the benefit of the Red Cross as part of a drive for wartime funds.

Major Fleet, who stood on the sidelines, assumed that Captain Lipsner was refueling the Jenny. He was concerned about the polo field used as the Washington terminus for the experiment. The area available was about 900 feet long and 400 feet wide. Trees at each end towered sixty feet high.

When the formalities were complete and the bags placed in the plane, Lieutenant Boyle strapped himself in and yelled, "Switch off!" Sergeant Waters twisted the propeller three times, then yelled "Contact!"

Lieutenant Boyle turned the switch on and Sergeant Waters gave the prop a mighty swing. The 150-h.p. Hispano-Suiza engine coughed once and died. Sergeant Waters tried again. And again. And again.

Major Fleet, standing nearby, quickly thought over the reasons why an engine that had worked so well would refuse to start after less than a half hour on the ground. He ordered Sergeant Waters to check the plugs. Nothing wrong there. He overheard President Wilson whisper to Mrs. Wilson, "We're losing a lot of time here."

Major Fleet then realized what the trouble was. "Sergeant, check the gas tank!"

Sergeant Waters, red-faced, dipped a stick in the tank, probably knowing what he would find. Major Fleet rushed to a nearby truck, grabbed two cans of gas, and handed them to Sergeant Waters. Sergeant Waters drained the cans into the tank, added more, and checked the level. Satisfied, he spun the prop, and the engine roared into life. Everyone, including the President, smiled in relief.

Major Fleet patted Lieutenant Boyle on the back and signaled for the chocks to be removed. Lieutenant Boyle taxied away from the crowd, turned into the wind, and lifted off smoothly. Leveling off slightly, he gained flying speed but not altitude. He was heading for the tall trees at the end of the field!

The crowd gasped. Lieutenant Boyle eased back on the stick, missed the treetops by inches, and disappeared from sight. The airmail was on its way.

The President and his party climbed back into their cars and the crowd dispersed, except a few who waited for Lieutenant Edgerton to arrive with the first inbound mail. Everything had proceeded as the Post Office press release said it would. Almost everything, that is.

Midair Confusion

Lieutenant Boyle had taken off heading north toward Philadelphia but, apparently confused by the railroad tracks leading out of Washington, had turned in the opposite direction soon after.

Captain Lipsner, who had returned to his office, had received a call telling him that Lieutenant Webb had landed at Philadelphia and turned over his pouch to Lieutenant Edgerton. Next should be a call from Lieutenant Boyle announcing his arrival in Philadelphia.

Lieutenant Boyle's call came all right—but not from Philadelphia. He was on the ground at Waldorf, Md., having landed in a field because his compass was off. The airplane had nosed over, and it would take some time to fix the propeller. The mail was on its way back by truck.

Captain Lipsner was livid, but there was nothing he could do. After nearly running out of gas, Lieutenant Boyle had landed twenty miles *southeast* of Washington. Ironically, he had landed next door to the rural home of Otto Praeger, the Postal Service official. He had become the nation's first official scheduled airmail pilot—but also the first to get lost and the first to have an accident.

Lieutenant Boyle's mailbags were sent north the next day by air. The press was too busy with war news to follow up on Lieutenant Boyle's flight, and the Post Office Department declared the airmail's first day a complete success.

Although no one else seemed to worry about Lieutenant Boyle's flying skill, Major Fleet was very concerned. He tried to get a replacement pilot, but the Post Office hierarchy asked that Lieutenant Boyle be given a second chance. Two days later, Lieutenant Boyle took off again, this time with Major Fleet flying ahead in a training Jenny to make sure Lieutenant Boyle was on course. About forty miles north of Washington, Major Fleet waved to Lieutenant Boyle and peeled off to return to Washington.

An hour later, Lieutenant Boyle, lost again, landed near the mouth of the Chesapeake Bay. He quickly obtained some tractor gas from a farmer and took off. He became disoriented again and crashed near the Philadelphia Country Club, only a few miles from his destination.

The Post Office Department requested that Lieutenant Boyle be given a third chance, but Major Fleet refused, and Secretary Baker backed him up. Lieutenant Boyle never flew the mail again.

Major Fleet (shown here upon arrival from Philadelphia, with his map still strapped to his leg) was given twelve days to get the airmail system running. Good maps, pilots, and mechanics were rare, and no plane available had the necessary range.

At Potomac Park for the historic first flight of regular scheduled airmail were (from left) Otto Praeger, Assistant Postmaster General; M. O. Chance, Postmaster of Washington, D. C.; A. S. Burleson, Postmaster General; and President Woodrow Wilson.

Lieutenant Edgerton never experienced these difficulties. He served during the entire three-month experiment without mishap.

Fifty years later, Major Fleet maintained that Lieutenant Boyle should not be criticized too severely. He said:

"There were no maps of much value to airmen in those days. Maj. E. Lester Jones, Chief of the Geodetic Survey Office, made up maps for the airmail pilots. The official state maps of New York, New Jersey, Pennsylvania, Delaware, and Maryland were all of different scales and showed only political divisions with nothing of a physical nature except cities, towns, rivers, harbors, etc. We had to fold large maps of the United States in a 'strip' in order to have everything on a uniform scale. Naturally, these contained little detail.

"In addition to poor maps, the magnetic compass in any airplane was highly inaccurate and was affected by everything metal on the airplane. Pilots had to have a sixth sense about navigating, and many didn't acquire this until they had flown a long time. Lieutenant Boyle simply didn't have enough training to do the job."

On Saturday, August 10, 1918, the airmail pilots made their final trips, and the experiment ended. The Post Office Department acquired its own planes, hired its own pilots, and continued airmail service until 1927, when private contractors took over.

Despite the snafus at the beginning, the Air Service pilots turned in a commendable record: Ninety-six percent of the flights were completed. A total of 40,500 pounds of mail was transported on 270 flights. The pilots had flown 421.5 hours and had "only" sixteen forced landings due to mechanical malfunctions. ■

C. V. Glines is a regular contributor to this magazine. A retired Air Force colonel, he is a free-lance writer, a magazine editor, and the author of numerous books. His most recent article for AIR FORCE *Magazine was "That Four-Letter Word" in the October '89 issue.*

Airman's Bookshelf

By Jeffrey P. Rhodes, AERONAUTICS EDITOR

Air Warfare and Air Base Air Defense, by John F. Kreis. Just about the time the first airplane saw combat, the first airfield came under attack. Despite this fact, little has been written about air base defense. The author notes that adequate protection of air bases has been a complex and difficult proposition; it has been greatly underrated or misunderstood, often with disastrous results. The four basic facets of air base defense—active defense (often called point defense), passive defense (such as camouflage), dispersal, and the ability to recover after an attack—are examined in a worldwide historical context in this volume. Office of Air Force History, Washington, D. C., 1988. 407 pages with maps, photos, tables, appendices, glossary, notes, bibliography, and index. $26.00.

Almanac of Airpower, by the editors of AIR FORCE Magazine. Here, updated and collected into a single volume, is the huge amount of data from our USAF and Soviet Aerospace almanac issues, aircraft galleries, systems checklists, technology forecasts, and more. Much of the material, including an eighty-five-year chronology of airpower, has not appeared in print before. Arco/Simon & Schuster, 256 pages, with illustrations and charts. $15.95.

The Berlin Raids: RAF Bomber Command, Winter 1943–44, by Martin Middlebrook. Hoping to "wreck Berlin from end to end," Sir Arthur Harris, Royal Air Force Bomber Command's chief, dispatched nineteen major raids on the city from August 1943 to March 1944. These raids were the RAF's supreme effort to end the war, as more than 10,000 sorties dropped 30,000 tons of bombs on Berlin. However, the city was not destroyed, and the RAF lost more than 600 aircraft and crews. Whether or not this campaign was successful has been debated since. Based on many RAF documents and previously unreported German documents, as well as interviews with military and civilian participants, the book gives a complete account of the nighttime Battle of Berlin. Viking Penguin, Inc., New York, N. Y., 1989. 407 pages with photos, maps, diagrams, appendices, acknowledgments, bibliography, and index. $24.95.

Journey to the Stars: Space Exploration—Tomorrow and Beyond, by Dr. Robert Jastrow. If there are intelligent beings in space, and if they are listening, they surely must be getting curious about the radio and television signals emanating from a previously unremarkable planet at one end of the Milky Way. The author, the former Chairman of NASA's Lunar Exploration Committee, gives us explanations of what is known about space, some good guesses about what is not, a fair measure of history, and an insightful discussion of what is possible. By the way, TV signals sent in 1965 took twelve years to reach the stars nearest earth that are likely to have planets with intelligent life. The response could come any day. Bantam Books, New York, N. Y., 1989. 216 pages with photos, diagrams, and index. $18.95.

Public Affairs: The Military and the Media, 1962–1968, by William M. Hammond. The popular belief that negative news media coverage was responsible for eroding public support for the war in Vietnam is simply not true. What is true, the author documents, is that the number of casualties alienated the American public during the Vietnam War. Public support fell by fifteen percentage points whenever US casualties increased by a factor of ten. The author believes that President Johnson and his advisors put too much faith in what public relations could accomplish and says that "they forgot two common-sense rules of effective propaganda—that the truth has greater ultimate power than the most pleasing of bromides and that no amount of massaging will heal either a broken limb or a fundamentally flawed strategy." US Army Center of Military History, Washington, D. C., 1988. 413 pages with maps, photos, biographical note, and index. $20.00.

Reaching for the Skies, by Ivan Rendall. The author is a television producer and writer by trade, and this book is the companion volume to the documentary series that aired on cable television this spring and was recently repeated. Based on many of the 200 or so interviews done for the series, the book presents a short but complete history of aviation seen through the eyes of the people who were there. The text doesn't go into minute detail, simply because the volume of material to be presented is so large, but the real stars of this book are the photographs and illustrations. While many of the black-and-white shots are of standards (such as the Douglas World Cruiser), many more are unique or rarely seen. The color shots are impressive not only for the quantity, but also for their subjects, many of which are unusual. Orion Books, New York, N. Y., 1989. 288 pages with index. $24.95.

Their Finest Hour: The Battle of Britain Remembered, by Richard Collier and Philip Kaplan. Next summer marks the fiftieth anniversary of the world's first great air confrontation—the Battle of Britain. What *One Last Look* did for Eighth Air Force, this book does for those momentous fifteen weeks in 1940. Every aspect of the battle is brought to life through words and pictures—the actual fighting between Hurricane, Spitfire, Me-109, and Ju-88 pilots, the pubs, the propaganda posters, how civilians fought their battle, the vernacular of the times, and even the telegrams sent to bereaved parents from King George VI. One of the many wonderful features of this work is the then-and-now pictures of buildings, airfields, and the like. This isn't just a coffee-table book filled with pretty pictures; it is an heirloom. Abbeville Press, New York, N. Y., 1989. 224 pages with photos, bibliography, technical and historical appendix, and index. $49.95.

World Encyclopaedia of Aero Engines (Fully Revised Second Edition), by Bill Gunston. This book takes an in-depth look at the powerplants that have been used since 1903 to propel an airplane from point A to point B. Arranged in alphabetical order, the book describes the history of every major engine manufacturer (including those in the Soviet Union and early builders like the Wright brothers) and discusses each of that company's more noteworthy engines. The many multinational collaborative projects are also included. Primarily a technical look at powerplants, the book also recounts some of the personal struggles behind engine development. Sterling Publishing Co., Inc., New York, N. Y., 1989. 192 pages with photos, index, and glossary. $35.00.

IN VIDEO—"The Great Planes, Volume I." The series of thirteen aircraft profiles that ran on The Discovery Channel earlier this year is now available on video. Each episode covers the developmental and operational history of one aircraft type. Many contain rare footage, such as film of an incident during which a hydraulic failure forced the crew of the prototype F-14 to eject just at the end of Grumman's runway. In addition to the Tomcat, the series includes the B-17, B-24, B-29, C-47, P-38, F-86, B-36, B-52, XB-70, F-111, AV-8A/AV-8B, and F-16. There are some minor flaws (during the C-47 tape, for instance, there is a tedious stretch without narration, and all the viewer sees is a DC-3 flying through the clouds), but each show earns high marks for overall accuracy. Approximately sixty minutes each, 1989, black and white/color. Distributed by AeroCo, Inc., Kent, Ohio. $29.95 each or $360.00 for the set. ■

Chivalry at Shemya

The RC-135 lay burning in the snow. Then there was a cry for help from the wreckage.

BY JOHN L. FRISBEE

THE RC-135 was in a holding pattern over Shemya Island on the night of March 15, 1981. Tiny Shemya, at the western end of the Aleutian chain, was below minimums in fog, blowing snow, and sleet, compounded by strong crosswinds. Aboard were twenty-two members of the Electronic Security Command's 6981st Squadron, based at Eielson AFB near Fairbanks, Alaska. TSgts. David Gerke and Tommie Wood, both sitting in the rear of the plane, had been there before. They were well aware of the hazards of flying in that area, where the warm Japan Current meets the cold waters of the Bering Sea to produce some of the worst weather in the world.

At last Shemya tower cleared the -135 to land in marginal conditions. Everyone aboard knew this would be a rough one as the big jet, wracked by turbulence, descended through the pitch-black murk. Then, over the intercom, they heard the navigator shout to the pilot that he was too low and off to the left of the runway. Too late to take it around, the pilot started a shallow right turn just as the aircraft smashed into the ground. Numbers three and four engines on the right wing exploded in a ball of flame. As the -135 careened across the runway, the aft section of the fuselage broke off, catapulting Sergeants Gerke and Wood out of the wreckage, still strapped in their seats.

Sergeant Wood's first thought as he regained consciousness was to get away from the burning wreckage as quickly as possible. Struggling painfully to his feet in the knee-deep snow, he heard a cry for help from the debris. Lt. Loren Ginter was trapped there, his clothing on fire. Sergeant Wood, with four broken ribs, a fractured left wrist, and deep cuts on his face, crawled to Lieutenant Ginter and threw snow on his burning legs. Injured as he was and on the verge of unconsciousness, Wood did not have the strength to pull the big lieutenant out of the flames.

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A few feet away, a dazed Sergeant Gerke released the safety belt holding him to his seat and started uncertainly through the waist-deep snowdrifts toward the lights of the approaching rescue vehicles. Over his shoulder, he glimpsed someone in the aft section of the fuselage. Plowing through the snow, he found Sergeant Wood and the trapped lieutenant.

Sergeant Gerke knew that in their condition, neither he nor Sergeant Wood alone could get Lieutenant Ginter out of the wreckage. He told Sergeant Wood to take Lieutenant Ginter's shoulders while he worked to free the lieutenant's legs. With the lieutenant almost free, a second explosion hit Seregant Gerke full in the face, inflicting second- and third-degree burns and blowing him out of the torn fuselage.

Momentarily oblivious to the pain in his face and neck, Sergeant Gerke made his way back to the crash scene and succeeded in freeing Lieutenant Ginter's legs. He and Sergeant Wood somehow managed to drag the 200-pound lieutenant away from the fire. While Sergeant Wood remained with the critically injured man, Sergeant Gerke fought his way through the heavy, wet snow toward the oncoming rescue vehicles.

When he was sure the rescue crews knew where to find Sergeant Wood and Lieutenant Ginter, Sergeant Gerke allowed himself to be taken to the base dispensary. Medical technicians did what they could to care for Sergeant Gerke's burns, which threatened to cut off his breathing, and for Sergeant Wood's and Lieutenant Ginter's injuries.

The following day the weather improved enough for Air Force doctors to be flown in and for the two men to be evacuated to Elmendorf AFB at Anchorage. Sergeant Wood was able to return to duty in a month, but Sergeant Gerke spent weeks at the burn clinic of Letterman Army Medical Center in San Francisco before he was released. Sadly, Lieutenant Ginter, for whom they had risked their lives, succumbed to burns and smoke inhalation, the sixth to die in that crash.

Both Tommie Wood and David Gerke were awarded the Airman's Medal. The following year, they were honored as recipients of the Cheney Award, presented annually for "an act of valor, extreme fortitude, or self-sacrifice in a humanitarian interest performed in connection with aircraft."

Sergeants Gerke and Wood demonstrated again that valor is as much a part of the Air Force tradition in time of peace as it is in war. At the award of his Airman's Medal, Sergeant Gerke put it in a nutshell: "I'd like to think that I've never flown with anyone who wouldn't have done the same for me." ■

Viewpoint

Two Celebrations in Germany

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

East Germany was created forty years ago, a week after the Berlin Airlift ended. A new feeling marked anniversary observances on both sides of the border.

This past September 29 marked the fortieth anniversary of the conclusion of the Berlin Airlift. A week later, the East Germans celebrated the fortieth anniversary of the establishment of the German Democratic Republic (*Deutsche Demokratische Republik,* or DDR). The proximity of the two dates is no coincidence. Allied resistance to the siege of Berlin through the improbable use of airlift backed by the implied threat of a nuclear strike not only gave an immense lift to West German morale, but also ended Stalin's scheme for the bloodless conquest of western Europe. If the Allies had capitulated over Berlin, the rest of Europe would have been lost. That, at least, was the judgment of Ernest Bevin, then Britain's Foreign Secretary.

Our side celebrated the anniversary of the Berlin Airlift's conclusion with a number of ceremonies, mainly nostalgic and low-key. The DDR put on a grand show in East Berlin. *Unter den Linden* was decked out as it hadn't been since Hitler's day, and Mikhail Gorbachev was the guest of honor and the intended symbol of Communist solidarity. The parade came off well enough, but the symbolism fizzled. Mr. Gorbachev is the hero of the hour in East (and West) Germany, because he appears to stand for relaxed tensions, disarmament, and a less threatening world. His obvious lack of support for East German Secretary-General Erich Honecker ensured the early retirement of that rigid Stalinist.

The torrent of East Germans pouring through Hungary's leaky border and huge demonstrations in Leipzig and East Berlin are clear signs that the DDR, once considered Moscow's most reliable satellite, is now, together with Hungary and Poland, a questionable Soviet ally. Demonstrations aside, there are other small signs that times have changed.

In a leisurely drive around East Berlin, we fell in behind a truck full of DDR soldiers. When they spotted the US license plate, there was great excitement, followed, inexplicably, by a few "V for Victory" signals. Even the East Berlin police seemed more cordial, and there was no sign of the time-wasting harassment at Checkpoint Charlie so often seen in the past.

The changes have revived a feeling of unity in West Germany. The escapees from the East are received, not as immigrants, but as fellow Germans who are entitled to rights and privileges of citizenship in the Federal Republic. They will probably be given credit for their military service in the DDR. If they wish to return to East Germany, as a few have done because of homesickness and other reasons, they are free to do so. The Bonn government is making it clear in a variety of ways, including extensive financial assistance, that it feels close to the people of East Germany, if not to their repressive government.

German unification is a long way off, given the opposing ideologies and Moscow's interest in the DDR as a buffer state. *Glasnost* and *perestroika* notwithstanding, there are still 550,000 Soviet troops in East Germany. Nevertheless, great changes are under way in Europe that will affect NATO and the United States defense outlay.

For the first time in the forty years of NATO's existence, responsible people are considering substantial reductions in its forces, matched, of course, by comparable cuts in those of the Warsaw Pact. A US negotiator in Vienna has described the progress in conventional arms reductions as "breathtaking" (not necessarily, to some of us, a reassuring adjective).

The German political left has begun to question the need for NATO itself. Gerhard Kiesling, a retired German general and former Deputy SACEUR, has published an article in which he advocates a neutral Germany, one outside both NATO and the Warsaw Pact, with a Swiss-style approach to its defense. That sort of thinking gives rise to alarm in other European countries, for removing Germany from the common defense of Western Europe leaves a gaping hole in that defense. Beyond that, it conjures up old memories of a Germany nonaligned and powerful.

Meanwhile, with the European Community looking forward to 1992 and the beginnings of European federalism, the United States, as an outsider, must make decisions about its future role in Europe's defense. Force reductions, if sensibly made, need not affect the credibility of the Alliance. The exercise is much easier to do on paper, however, than when dealing with an alliance of equals in which national pride and economics have had more to do with force structure than the common need has.

A more dangerous threat to the Alliance than force reductions is indifference—the feeling that all this military activity is irrelevant in today's world. It is the prevalent attitude among a growing number of West Germans who have never experienced war and see no prospect of it.

The more realistic element knows the continuing importance of NATO, although at a reduced size and, while this is not yet openly discussed, without reliance on short-range nuclear weapons. East Germany can no longer be postulated to West Germany as the enemy—if it ever could be. ■

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Intercom

By John R. "Doc" McCauslin, CHIEF, FIELD ORGANIZATION SUPPORT GROUP

Chapter News

The **Eglin (Fla.) Chapter** held its Scholarship Awards Night at the Eglin AFB Officers' Beach Club with Maj. Gen. John E. Jaquish, Director of Tactical Programs in the Office of the Assistant Secretary of the Air Force (Acquisition), as the guest speaker. His talk centered on USAF budget constraints and their impact on acquisition programs. Scholarships worth $13,000 were awarded during the evening to AFJROTC cadets from area schools. Niceville High School Cadet Michael Nygard received a $2,000 scholarship, a plaque, and a watch. Cadet Noralynn Mills from Choctawhatchee High School and Cadet Stephen Hodge of Fort Walton Beach were awarded $1,500 scholarships. Paul Messerli of the Eglin CAP Squadron, Lisa Kelly of Fort Walton Beach, Pam Martin of Niceville, and Kevin Coggins of Pensacola each received $1,000 scholarships. Dignitaries in attendance included Lt. Gen. John Burns, USAF (Ret.); Lt. Gen. James Light, USAF (Ret.); Maj. Gen. Benny Putnam, USAF (Ret.); Maj. Gen. Leo Lewis, USAF (Ret.); Maj. Gen. Paul Thompson, USAF (Ret.); and Brig. Gen. Gerry Barnes, USAF (Ret.).

Col. Jack Broughton, USAF (Ret.), author of *Thud Ridge* and *Going Downtown*, spoke at a recent meeting of the **Antelope Valley (Calif.) Chapter.** He gave an excellent talk, "Rolling Thunder from the Cockpit," augmented by videotape and slides, describing his experiences as an F-105 pilot leading strikes against Hanoi during the Vietnam War. His appreciative audience included Chapter President Sam Kilanowski and President of the Red River Valley Fighter Pilots Association Bob Ettinger.

Aviation Hall of Famer and sound-barrier conqueror Brig. Gen. Chuck Yeager, USAF (Ret.), delighted a crowd of 1,600 at a **Klamath Basin (Ore.) Chapter** meeting with tales of his experiences as a fighter pilot and test pilot. At the same meeting, the Oregon Institute of Technology gave an informative presentation. On hand were Oregon AFA State President Barbara Brooks; ANG Maj. Gen. Raymond F. Rees, Adjutant General of the Oregon ANG; ANG Maj. Gen. Charles A. Sams, Commander of the Oregon ANG; and Klamath Basin Chapter President Richard P. Norton.

The **Scott Memorial (Ill.) Chapter** and the **Spirit of St. Louis (Mo.) Chapter** cosponsored the eighth annual Air Force Ball of Mid-America at the Adam's Mark Hotel in St. Louis, Mo. More than 400 people turned out to hear Gen. Merrill A. McPeak, Commander in Chief of Pacific Air Forces, give a briefing on communications in his far-flung command. Other speakers included Gen. Duane H. Cassidy, Commander in Chief of Military Airlift Command (MAC) and Commander in Chief of US Transportation Command, who has since retired; Lt. Gen. James S. Cassity, Jr., Director of C³ for the Joint Chiefs of Staff; Lt. Gen. Robert P. McCoy, Vice Commander of Air Force Logistics Command; Maj. Gen. William E. Overacker, Chief of Staff of MAC; Brig. Gen. Phillip E. Bracher, Deputy Director of Defense Communications Systems for the Defense Communications Agency; and Brig. Gen. Dennis C. Beasley, Director of C³ for US Transportation Command. More than 550 people took part in the ball held in conjunction with the briefings. Scott Memorial Chapter President Paul Cleary and Spirit of St. Louis Chapter President Paul Whelan announced that $4,000 had been raised at the Ball for the Aerospace Education Foundation.

Rep. Charles Hatcher (D-Ga.) addressed a recent chapter-membership meeting of the **South Georgia (Ga.) Chapter.** His theme was the national budget process and its effect on defense spending and veterans' benefits. Several local AFA industrial associates were recognized during the program, including First State Bank and Trust Co., Georgia Power Co., Delta Petroleum, and Langdale Ford. Former National Vice President (Southeast Region) James E. "Red" Smith and Georgia State President Homer N. Childs were among the

Capt. Daniel J. Bisanti, USAF (left), receives the Wilmington (Del.) Chapter's Premiere Salute Award for distinguished service to the nation's youth. Presenting the award to Captain Bisanti are (from left) Wilmington Chapter President Lt. Col. Richard E. Kyle, USAF (Ret.), Delaware State President Robert Berglund, and past Delaware State President Horace W. Cook.

AFA National Vice President (Southwest Region) Oliver R. Crawford escorted the NATO Air Chiefs on a recent tour of Sheppard AFB, Tex. From left are Lt. Gen. Rolf Thieman, Commander, 4th Allied Tactical Air Force; Air Chief Marshal Sir Anthony Skingsley, Deputy Commander in Chief, Allied Forces, Central Europe; Mr. Crawford; Air Marshal Roger Palin, Commander, 2d Allied Tactical Air Force; Gen. Eberhard Eimler, Deputy Supreme Allied Commander, Europe; and an unidentified NATO aide.

honored guests. Chapter President Charles Price welcomed renewed interest in AFA in the Moody AFB/Valdosta, Ga., area.

In California, more than 300 golfers participated in the twenty-second annual Bob Hope Charity Golf Tournament at Norton and March AFBs, sponsored by the **San Bernardino (Calif.) Chapter.** At the evening banquet, almost 700 AFA members and their guests dined and danced to music provided by the 15th Air Force Band of the Golden West from March AFB. Prizes were donated by 120 sponsors, and forty-some AFA volunteers worked hard to make this fundraiser a success. Chapter President Jon E. Boursaw reported that $18,000 had been raised for the Aerospace Education Foundation (AEF) and local Air Force charities.

AFA State Conventions

The **Delaware State Convention** was held at Dover AFB in August. The Wilmington Chapter presented Capt. Daniel J. Bisanti, USAF, its Premiere Salute Award for his distinguished service to the youth of the nation. Captain Bisanti is a leading Air Force recruiter and the AFROTC Assistant Professor of Aerospace Studies at the University of Delaware. Wilmington Chapter President Lt. Col. Richard E. Kyle, USAF (Ret.), served as master of ceremonies and made the presentation.

The **Louisiana State Convention** was held at the Barksdale AFB Officers' Club with AEF President Lt. Gen. James M. Keck, USAF (Ret.), as the guest speaker. General Keck has since become AEF's Chairman of the Board. The Ark-La-Tex Chapter presented four scholarships totaling $1,000 during the convention. AFJROTC Cadet Col. Brian J. Fow of Bossier High School, Cadet Lt. Col.

Carl J. Long, Sr., 1909–1989

AIR FORCE Magazine is saddened to report the death of longtime AFA stalwart Carl J. Long, Sr., of Pittsburgh, Pa. An engineer by profession, Mr. Long had held national office in the Illuminating Engineering Society and was instrumental in the development of USAAF's first jet aircraft procured in quantity, the P-80. Mr. Long was a charter member of AFA who fit comfortably into the role of elder statesman during his later years. Unfortunately, his illness prevented him from attending this year's AFA Convention, where his son delivered the keynote address. It was the first Convention he had missed since 1948. AFA's Man of the Year for 1959, Mr. Long was an outstanding Permanent National Director for many years and helped establish AFA chapters throughout Pennsylvania. He will be missed by many, not least by his colleagues in AFA.

At a recent Hawaii Chapter luncheon meeting, Col. Richard S. "Steve" Ritchie, USAFR, a Vietnam War Air Force ace, was guest speaker. From left are Col. Charles Tucker, USAF, Hq. PACAF; Colonel Ritchie, holding a painting made shortly after he downed his fifth enemy aircraft in Vietnam; and Tom Keeney, Hawaii Chapter President.

Sandra Bickel of Parkway High School, and Cadet Col. Skyler Vanzandt and Cadet Lt. Col. James Lee Herriage, both of Haughton High School, received the scholarships. Col. Jack Welde, Commander of the 23d Tactical Fighter Wing, England AFB, La.; Col. Joseph F. Mudd, Commander of the 2d Bomb Wing, Barksdale AFB; Dr. Everett E. Stevenson, AFA National Vice President (South Central Region); Paul Johnston, Louisiana AFA State President; H. R. "Bobby" Case, Alabama AFA State President; and Bernard Walters, Arkansas AFA State President, attended the convention.

Have AFA News?

Contributions to "Intercom" should be sent to J. R. "Doc" McCauslin, AFA National Headquarters, 1501 Lee Highway, Arlington, Va. 22209-1198. ■

Bulletin Board

Information on the whereabouts of **Lt. John J. O. Andersen,** former B-24 navigator and a member of 36th Bomb Squadron, 8th Air Force, stationed at Alconbury, England, during World War II. **Contact:** Harry Soderstrom, 7840 40th Ave., Kenosha, Wis. 53142.

Information—tech manuals, anecdotes, maps, photos, slides, insignia—on the Air Force's **Johnston Island antisatellite system** (Program 437), operational with Thor missiles from 1964 to 1975. Also seeking contact with contractor and l0th Aerospace Defense Squadron personnel who served on Johnston. **Contact:** Michael S. Binder, 6107 Palo Pinto Ave., Dallas, Tex. 75214-3615.

Information on the whereabouts of **Lester J. Roser,** who was an air traffic controller in the Pacific theater during World War II and was with MATS in Spain and England during the early 1960s. Recently retired from FAA. **Contact:** Fred Babcock, 24793 Verdant Square, Farmington Hills, Mich. 48331.

Information on the whereabouts of Signal Corps **Lt. Owen Albert "Al" Knorr,** who served in an Air Warning company in Tampa, Fla., in 1943. Also seeking contact with B-24 crew members of the 343d Bomb Squadron, 98th Bomb Group, who served in Italy in 1944 and 1945. **Contact:** Lee Huddleston, 6940 Belinder, Mission Hills, Kan. 66208.

Seeking information about and contact with civilian and military personnel involved in the investigation of **German jet and other high-technology aircraft** from 1944 to 1954. **Contact:** Bill Yenne, Room 1410, 111 Pine St., San Francisco, Calif. 94111.

Information on the whereabouts of **Capt. Vernon L. Bonn** or other personnel of the 406th Bomb Squadron during the Aleutian campaign from June 1942 to October 1943. **Contact:** Col. Doug Courtney, USAF (Ret.), 5841 Winding Ridge Dr., San Antonio, Tex. 78239-2015.

Information on **Lt. Richard L. Williams,** a B-17 pilot who served with the 351st Bomb Group, Polebrook, England, during World War II. His last known address was Alton, Ill., in 1951. **Contact:** W. Eugene Smith, 1876 Choctaw Court, Fayetteville, Ark. 72701.

Information on the whereabouts of **Capt. John Ordway,** engineering officer of the 61st Fighter Squadron in England during World War II. **Contact:** Norman Malayney, 519 Semple St., Pittsburgh, Pa. 15213-4315.

Seeking USAF Reserves ID, USAF Retired ID, and US Merchant Marine ID to complete **ID card** collection. Will pay cost and postage. **Contact:** M. W. Morabito, 295 Main St., 2D, Belleville, N. J. 07109.

If you need information on an individual, unit, or aircraft, or if you want to collect, donate, or trade USAF-related items, write to "Bulletin Board," AIR FORCE Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Letters should be brief and typewritten. We cannot acknowledge receipt of letters to "Bulletin Board." We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Photographs cannot be used or returned.—THE EDITORS

Information on the whereabouts of **2d Lt. E. D. Sellers,** who was in Class 58-H, Squadron 5, stationed at Lackland AFB, Tex., in the 1950s. **Contact:** Mary Johnson, Rte. 2, Box 150, Conroe, Tex. 77303.

Seeking USAF **patches or decals** from all eras to add to collection. **Contact:** Bram Kusuma, Flat 2, 158 Walm Lane, London NW2, United Kingdom.

Seeking to correspond with graduates of the **USAFE NCO Academy, Class 57-D. Contact:** MSgt. Thomas W. Young, Sr., USAF (Ret.), 830 W. Amsden St., Denison, Tex. 75020-0007.

Information on **MSgt. Frank O'Conwell,** friend of **MSgt. Robert Levi,** who died in the crash of a B-17 piloted by 1st Lt. Arthur J. Reynolds, near Brome (near Eye), Suffolk, England, on November 10, 1943. Both men were probably assigned to 813th Bomb Squadron, 482d Bomb Group, and earlier to 325th Bomb Squadron, 92d Bomb Group. **Contact:** Lt. Col. John R. Reynolds, USAF (Ret.), 1128 291st St. S., Roy, Wash. 98580.

Seeking information on the whereabouts of **Lt. Allan Harvey Todd** (or Tod), who was in the OSS, attached to the British 1st Airborne Division for the battle for the Arnhem Bridge, the Netherlands, in 1944. He was captured and held in Oflag 64 in north Germany. The 1945 address of his wife was in Marion, Ill. **Contact:** Roger King, 46 Bury Lane, Datchworth, Knebworth, Hertfordshire SG3 6ST, England.

Seeking information on the whereabouts of the following members of **Kelly Field Aviation Cadet Class of 42-H:** Pete Ballases, Lester Barnand, John Bentley, Billie Blunton, and William Britt. **Contact:** Allan F. Beck, 4905 Casa del Oso NE, Albuquerque, N. M. 87111.

Seeking information on the whereabouts of **Lieutenant Ep,** the pilot or copilot of a bomber

shot down over Bulgaria on February 8, 1943. Lieutenant Ep and four crew members of the bomber were rescued by a partisan named "Zlantan." Lieutenant Ep gave his .45-caliber pistol with shoulder holster to Zlantan, whose real name is Gen. Kiril Markov. General Markov would like to invite Lieutenant Ep to take part in a ceremony with the pistol at a museum in Sofia, Bulgaria. **Contact:** MSgt. William E. Krilling, USA (Ret.), 6622 Trapper Way, Midland, Ga. 38120.

Seeking information on the whereabouts of **Sgt. Bill Welch,** USAF, from Shreveport, La., who was based at Alconbury, Cambridgeshire, England, during the late 1950s. **Contact:** L. R. Wakley, 4 Millview, Coldharbour, Uffculme, Devon EX15 3EE, United Kingdom.

Caterpillar Club Patches are available, embroidered in eight colors. For pictures and price, send self-addressed, stamped envelope. **Contact:** William J. Brinkman, P. O. Box 627, Lakehills, Tex. 78063.

Seeking information, photos, or clippings on the **Northrop F-89J,** serial number 52-1868, which last served with the 3565th Navigator Training Wing at Connally AFB, Tex., before being retired and put on display. All items will be returned. **Contact:** Steve Tobey, Southwest Aerospace Museum, P. O. Box 5462, Fort Worth, Tex. 76108.

Seeking information, pictures, records, and artifacts from former members of **KB-50 units or the 427th Air Refueling Squadron** for the Museum of Aviation at Robins AFB, Ga. **Contact:** MSgt. Gilbert R. Switzer USAF (Ret.), 101 Oliver Dr., Warner Robins, Ga. 31088.

Seeking information on and photos of **nose art,** low-intensity air wars from 1950 to the present, and World War II fighter combat in Europe and the Mediterranean, for use in books on these subjects. All material will be returned. **Contact:** Jeffrey L. Ethell, Rte. 1., Box 3154, Front Royal, Va., 22630.

Seeking **photos** of the following aircraft: Air Force Thunderbird, F-84, G7-F100C and D, model F-105, F-4E, and T-38. Also seeking photos or slides of support aircraft, including C-54, C-119, and C-123. **Contact:** Craig Porter, c/o G. Willett, 8500 Tyspring St., #142, Vienna, Va., 22182.

Author seeks to contact **C-47 (DC-3) flight crews** who were on active duty out of any RAF bases during the first eighteen months of World War II. **Contact:** Susan Holland Tolles, 7708 Wolford Way, Lorton, Va., 22079.

Seeking World War II **memorabilia of the Philippines,** including letters, documents, and maps, regardless of nationality. Will pay for material. Also seeking **autographs** of key World War II personnel. **Contact:** Edward F. Lawton, PSC 4, Box 17051, APO San Francisco, 96408.

I have a **1942 Pacific Airways Manual** and a **North Atlantic Airways Manual,** showing radio and navigation procedures necessary to fly in these areas, as well as detailed diagrams of many airfields. If you would like a copy of any part of these, send a self-addressed, stamped envelope and your area of interest, and I'll send you a copy for the cost of copying and handling. **Contact:** Lt. Col. R. E. Daniels, USAF (Ret.), 5428 S. 116th St., Hales Corners, Wis. 53130.

Seeking information on **"Suzie Q," a B-17** that went on bond tours after combat duty in World War II. Also have good **photos of modern aircraft** suitable for publication in aviation magazines. **Contact:** Bill Reid, 1600 Prairie, Essexville, Mich. 48732.

Seeking USAF **posters and patches. Contact:** Butch Bailey, 703 Canyon Bend, Pflugerville, Tex. 78660.

Collector seeks to trade air force **patches** from throughout the world. **Contact:** Dennis Cooper, 2504 Linda Lane, Del City, Okla. 73115.

Seeking contact with members of **5th and 55th Bomb Wings of 15th Air Force** who were in Italy in the summer and fall of 1944, for a history of these wings. **Contact:** Stuart Erdheim, 77 W. 15th St., #4F, New York, N. Y. 10011.

Unit Reunions

Air Weather Ass'n
Veterans of the Air Weather Service will hold a reunion May 23–27, 1990, in San Antonio, Tex. **Contact:** Maj. Gen. John W. Collens, USAF (Ret.), 5301 Reservation Rd., Placerville, Calif. 95667.

Cannon AFB
Personnel who were stationed at Cannon AFB, N. M., will hold a reunion June 15–17, 1990. **Contact:** Bertha Wells, 312 W. Yucca, Clovis, N. M. 88101. Phone: (505) 763-3198.

Caterpillar Ass'n
The Caterpillar Association of the US will hold a reunion July 27–28, 1990, at the Embassy Suites Hotel in Green Bay, Wis. **Contact:** Lt. Col. Johnny Brown, P. O. Box 1321, Kenosha, Wis. 53141. Phone: (414) 658-1559.

Santa Ana AAB
Personnel from the Santa Ana Army Air Base Wing (SAAAB) will hold a reunion March 24, 1990, at Orange Coast College in Costa Mesa, Calif. **Contact:** Alvin E. "Bud" Anderson, P. O.

Coming Events

February 1–2, **TAC Symposium,** Orlando, Fla.; February 22–24, **AFA Board of Directors Meeting,** San Antonio, Tex.; April 7, **Iron Gate Salute,** New York, N. Y.; May 11–13, **New York State AFA Convention,** Rome, N. Y.; May 25–27, **AFA Board of Directors Meeting,** Colorado Springs, Colo.; July 13–15, **Pennsylvania State AFA Convention,** Philadelphia, Pa.; July 13–14, **Texas State AFA Convention,** Fort Worth, Tex.; September 6–7, **Colorado State Convention,** Colorado Springs, Colo.; September 17–19, **AFA National Convention and Aerospace Development Briefings and Displays,** Washington, D. C.

Box 1764, Costa Mesa, Calif. 92628. Phone: (714) 631-5918.

U-2/TR-1
U-2/TR-1 pilots and squadron navigators are planning to hold a reunion September 28–30, 1990, in Tucson, Ariz. **Contact:** U-2 Reunion Committee, P. O. Box 60312, Tucson, Ariz. 85751.

20th Tactical Recon Squadron
The 20th Tactical Reconnaissance Squadron will hold a reunion May 17–19, 1990, in Destin, Fla. **Contact:** Stanley A. Gawlik, 661 Woodland Dr., Tallmadge, Ohio 44278. Phone: (216) 633-5750.

85th Bomb Squadron
The 85th Bomb Squadron (Sculthorpe, England) will hold a reunion July 1–4, 1990, in Greenwood, Ind. **Contacts:** Tom Leeper, 913 E. Minnesota, Indianapolis, Ind. 46203. Phone: (317) 635-3975. Richard L. McCormick, 307 S. Meridian, Greenwood, Ind. 46143. Phone: (317) 881-6585.

307th Air Refueling Squadron
Members of the 307th Air Refueling Squadron (Lincoln/Selfridge) will hold a reunion April 20–22, 1990, at the Marriott Perimeter Center Hotel in Atlanta, Ga. **Contact:** Allen Osborn, 2628 Amberly Dr., Atlanta, Ga. 30360. Phone: (404) 458-3821.

314th Bomb Wing
Members of the 28th Bomb Squadron, 19th Bomb Group, 314th Bomb Wing, 20th Air Force, who served on Guam during World War II (Crew 39), will hold a reunion October 1–6, 1990, in Albuquerque, N. M. **Contact:** Ian N. "Ike" Boggs, 7705 Spring Ave. N. E., Albuquerque, N. M. 87110. Phone: (505) 265-2230.

344th Service Squadron
The 344th Service Squadron will hold a reunion September 13–15, 1990, at the Patterson Inn in Fairborn, Ohio. **Contact:** Jerome G. Peppers, Jr., 438 Coronado Dr., Fairborn, Ohio 45324-5711. Phone: (513) 878-7068.

390th Bomb Squadron
Members of the 390th Bomb Squadron, 42d Bomb Group, will hold a reunion June 28–July 1, 1990, at the Embassy Suites Hotel in Lompoc, Calif. **Contact:** Lt. Col. Lorin N. Trubschenck, USAF (Ret.), 442 St. Andrews Way, Lompoc, Calif. 93436. Phone: (805) 733-2765.

446th Bomb Group
Members of the 446th Bomb Group (World War II) will hold a reunion October 19–22, 1990, in Tucson, Ariz. **Contact:** Col. Marvin J. Anderson, USAF (Ret.), 8411 E. Albion Pl., Tucson, Ariz. 85715.

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.

464th Bomb Group
The 464th Bomb Group will hold a reunion May 3–5, 1990, in San Antonio, Tex. **Contact:** Robert L. Weinberg, 2229 Rock Creek Dr., Kerrville, Tex. 78028. Phone: (512) 257-4643.

SAC Airborne Command Control
SAC Airborne Command Control Squadrons (2d, 3d, and 4th) are planning to hold a joint reunion in the spring of 1991 at Offutt AFB, Neb., for former squadron members.
Please contact any of the addresses below.
Jack Suggs
7645 Oak Leaf Dr.
Santa Rosa, Calif. 95409
or
Don Wilson
Rte. 1, Box 574A
Tupelo, Miss. 38801
or
Lt. Col. Ray Watts, USAF
P. O. Box 1633
Bellevue, Neb. 68005
Phone: (707) 538-3192 (Jack Suggs)
(601) 844-0110 (Don Wilson)
(402) 556-2346 (Ray Watts)

Class 52-G
Members of Class 52-G from all bases are trying to locate former members for the purpose of planning a reunion.
Please contact the address below.
Jack Gilliland
1232 Redwood Lane
Gulf Breeze, Fla. 32561
Phone: (904) 932-5472

In conjunction with AFA's 1990 Tactical Air Warfare Symposium, the Central Florida Chapter is proud to offer other opportunities to enjoy the many sights and sounds of Central Florida.

AFA's SIXTH ANNUAL TACTICAL AIR WARFARE SYMPOSIUM

February 1 - 2, 1990

THE BUENA VISTA PALACE HOTEL
ORLANDO, FLORIDA

A "must" on your agenda:

AFA's 1990 Tactical Air Warfare Symposium: In conjunction with the Tactical Air Command, we are sponsoring our sixth annual Symposium on tactical air warfare requirements and related topics — from R&D and hardware to doctrine and the evolving Soviet threat.

In addition to a keynote address by TAC Commander Gen. Robert D. Russ and a presentation by Gen. Michael J. Dugan, CINCUSAFE, top leaders from the Defense Department, the Air Force, and other services will probe the status and prospects of the role of airpower in conventional and theater warfare. For more information, call Jim McDonnell or Dottie Flanagan at (703) 247-5800.

GOLF TOURNAMENT

Wednesday, January 31, 1990
12:00 noon
On one of Walt Disney World's Famous Courses. . .

$85 per person, which includes golf, green fees, golf cart, and reception following the tournament. ($35 for reception only.)
Contact: Tommy Harrison
(407) 886-1922

TACTICAL FORCES GALA

On Friday, February 2, 1990, the Central Florida Chapter will sponsor its sixth annual black-tie Gala. This year's theme is "Hail to the Chiefs—the Chiefs of Staff and CMSAF Present and Former." Proceeds will benefit AFA's Aerospace Education Foundation as well as ROTC, scholarships, and other aerospace education activities. For more information, contact Marty Harris (407) 356-4810 or Tom Churan (407) 356-8430.

EXHIBITS AND DISPLAYS

For each Gala table purchased, companies will be allowed 100 square feet of display space. Exhibits will be on display during the two-day Symposium and Gala. For more information on exhibits, contact Carol Watson (407) 356-3812.

Registration Form
A 1990 Air Force National Symposium

"Tactical Air Warfare—
Status and Prospects"

The Buena Vista Palace Hotel
Lake Buena Vista, Florida
1-800-327-2990

February 1—2, 1990

Advance registration closes Monday, January 22, 1990

No refunds can be made for cancellations after that date. MAIL THIS FORM TO:
Air Force Association
ATTN: Miss Flanagan
1501 Lee Highway
Arlington, Va. 22209-1198
(703) 247-5805

NAME (Print) _____

TITLE _____

AFFILIATION _____

ADDRESS _____

CITY, STATE, ZIP _____

TELEPHONE: (AREA CODE) _____ (NO.) _____

My check covering the Symposium fee of $300 for AFA individual or Industrial Associate member, payable to the Air Force Association, is enclosed. The fee includes one (1) Reception/Buffet ticket and (1) Exhibit Hall lunch ticket.

(Note: Fee for non-member is $325.)

☐ Mark here if an extra guest Reception/Buffet ticket is desired. Enclosed is $115 for the additional ticket.

Bob Stevens'

"There I was..."

STORIES LIKE THIS ONE ARE NOT UNCOMMON - IN PEACE OR WAR (I HAD A SIMILAR EXPERIENCE IN WWII). WHAT MAKES THIS ONE UNUSUAL IS THE FACT THAT THE WSO BROKE ALL EXISTING RECORDS FOR THE 100-YARD DASH IN FULL COMBAT GEAR.

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On land, you'll find variants of the unmatched Low Altitude Air Defense System (LAADS). With high sub-clutter visibility, this pulse doppler radar gives air defense commanders the eyes to deny fighters and helicopters the safety of low altitude operation.

And in the air no one can match Sanders' countermeasures technology, in both passive and active electronic warfare systems. The Sanders ALQ-144 protects helicopters around the world. The ALQ-126B is in operation shielding fighter aircraft for the United States and Canada with a suit of electronic armor and has also been chosen by Australia, Spain and Kuwait.

No other company can match our military electronics experience – in any environment.

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TO HERE...

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Beechcraft, with its tradition of aviation excellence, brings the Beechjet, the industry's newest and most advanced light commercial jet. The aircraft with the greatest similarity in cockpit and handling characteristics to Air Force tankers and transports.

Quintron Corporation, selected for its aircrew training device technical and support expertise, rounds out the team that will produce the best overall value for TTTS. The team the Air Force needs to provide a smooth transition into Specialized Undergraduate Pilot Training.

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