JUNE 1989/$2

AIR FORCE MAGAZINE

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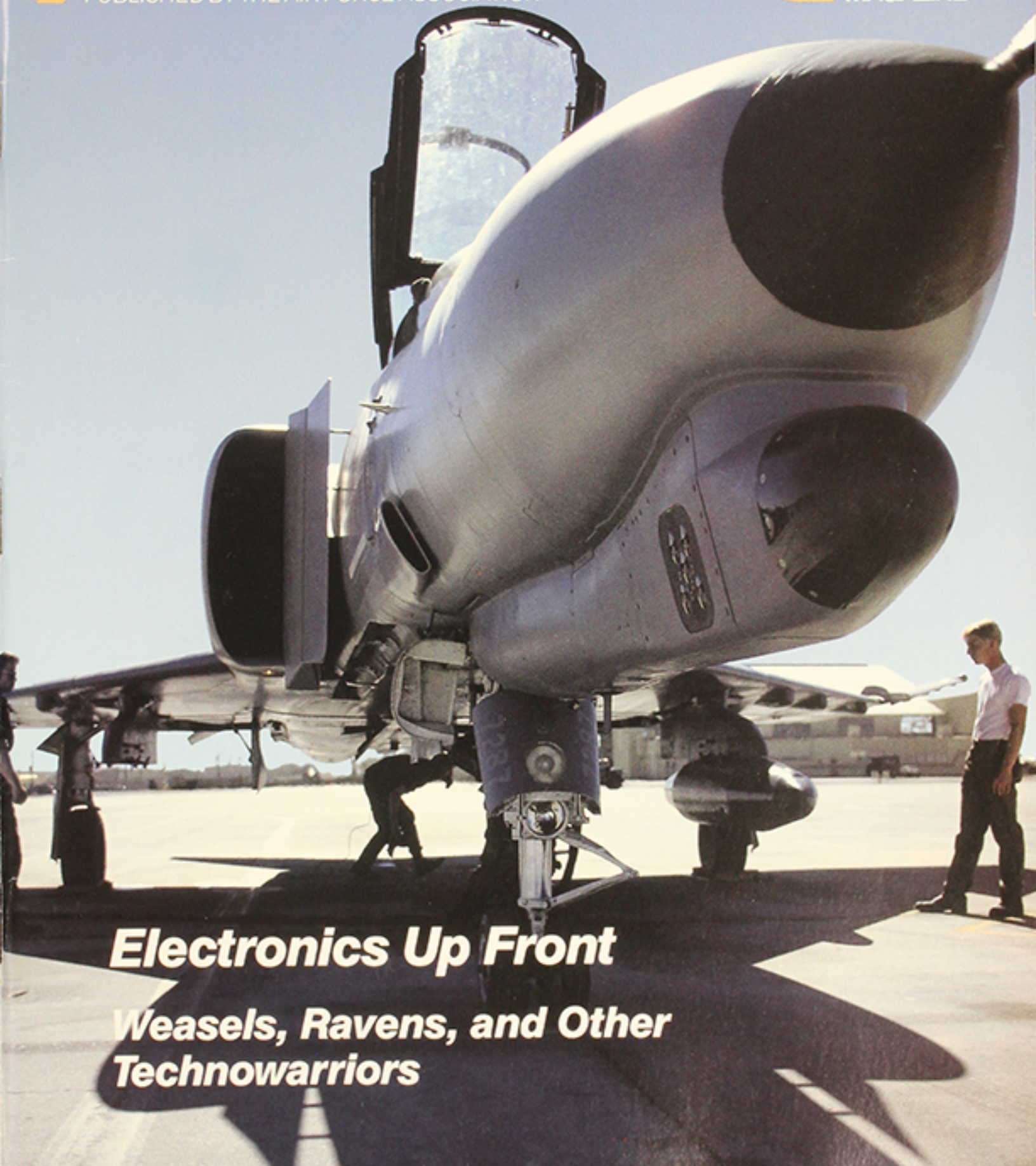

Electronics Up Front

Weasels, Ravens, and Other Technowarriors

THE B-2. WE TAKI

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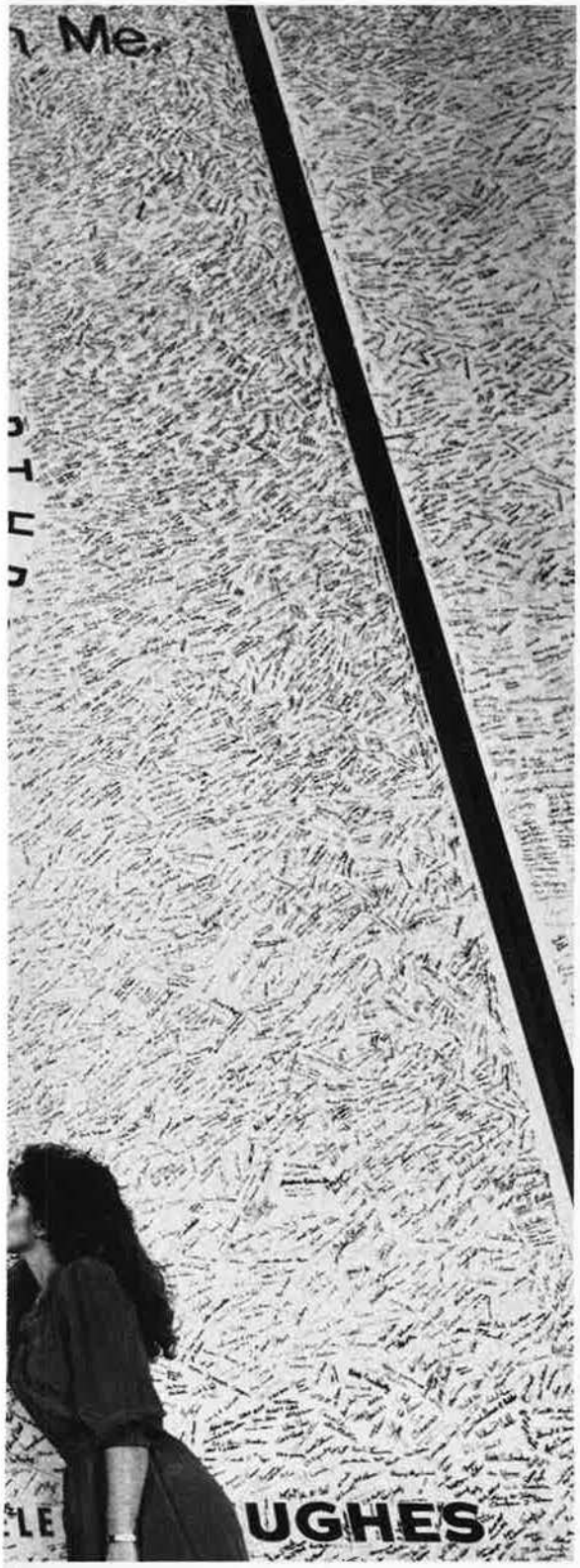

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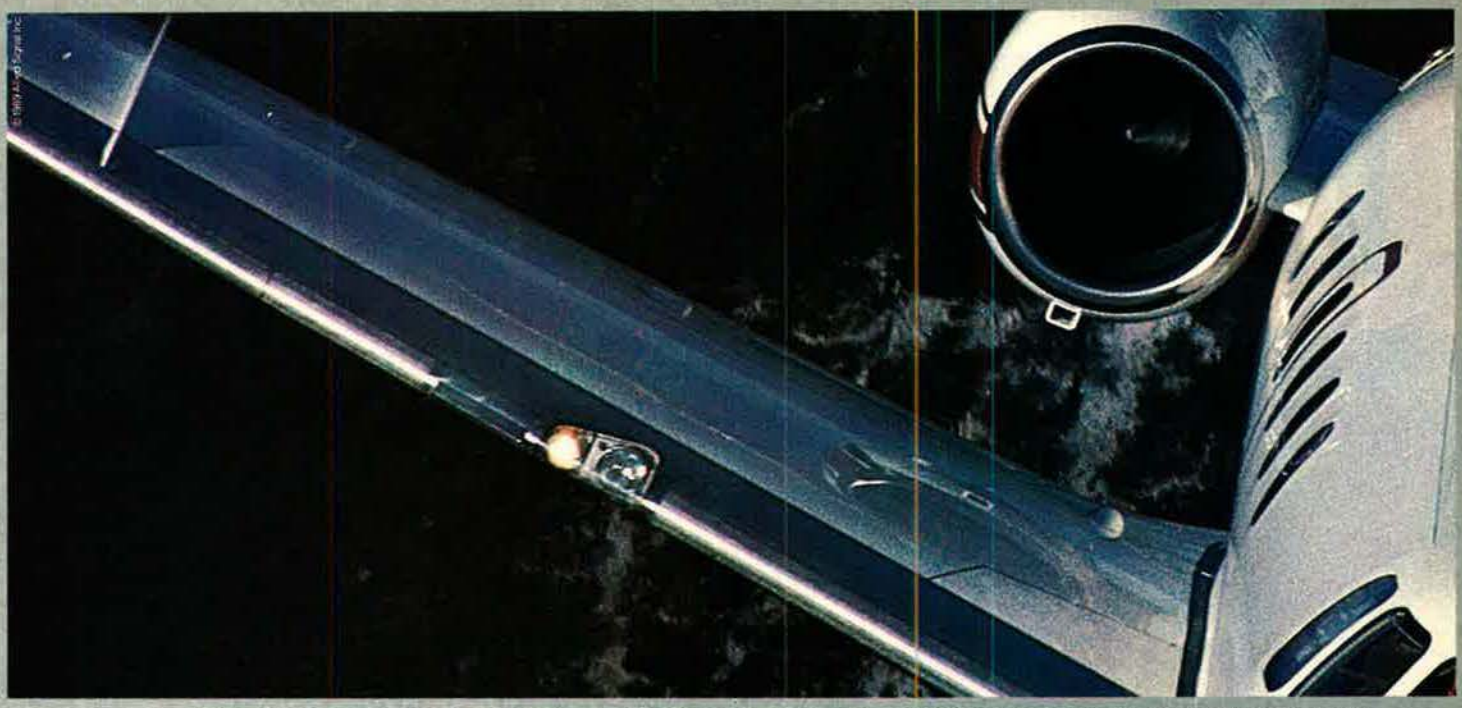

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JUNE 1989
VOLUME 72, NUMBER 6

AIR FORCE MAGAZINE

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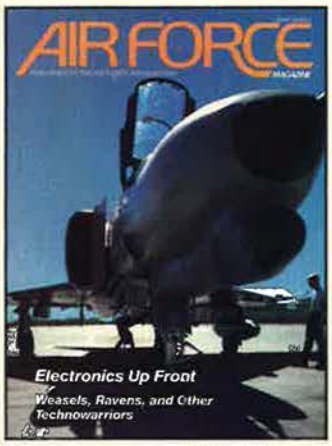

About the cover: A Wild Weasel F-4G from the 37th Tactical Fighter Wing blocks in at George AFB, Calif. A special section on Electronics and Technology begins on p. 42. (Staff photo by Guy Aceto)

Special Section: Electronics and Technology

Features

Departments

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An Editorial

Maybe We Need a Sputnik

By John T. Correll, EDITOR IN CHIEF

WHEN the Soviet Union put Sputnik I, the first artificial earth satellite, into orbit in 1957, Americans were initially shocked, then scared, and finally stirred to action. Passing overhead, Sputnik served notice that oceans and geographic isolation would no longer provide us the security they did before.

There was another aspect to the alarm, though. The United States took great pride in its technology. Now the Russians were first in space. How could we have fallen so far behind?

In fact, we were not nearly so far behind as we imagined, but the perception was a powerful stimulant. Government programs shifted to a faster gait. Stung by criticism, schools began to emphasize math and science. Research and development flourished.

Within the decade, a well-run space program, proceeding alongside a revolution in microelectronics, led to a golden age for US technology. The commercial spinoffs that followed became fundamental to economic growth and trade.

From World War II until sometime in the 1970s, American technology was dominant in the world. It was our strongest suit—a national signature, almost—in both military and economic affairs. That dominance now appears to be in decline. As the President's Commission on Long-Term Strategy said in its 1988 report, "American technology today is less superior than it used to be."

Last year, *Research and Development* Magazine surveyed 125 industrial CEOs and 500 scientists, asking their opinion about the US position in world technology. Both groups said that we are losing ground. A third of the CEOs said that the US has been overtaken already, and 48.2 percent think we will fall behind by the year 2000. The scientists, who are closer to the problem, saw a worse situation. Only half of them believe the United States is the undisputed leader today, and sixty-two percent predict that the US will not be leading at the turn of the century.

There is abundant evidence of a decline. High-technology products from abroad proliferate in our markets. Almost half of the new US patents issued are to residents of other countries. The armed forces are increasingly dependent on foreign components for their most advanced weapon systems. Our margin of quality over Soviet weapons is diminishing.

The change has come upon us gradually, unlike in 1957 when Sputnik painted a warning across the sky. Ironically, the gradual decline may be of more consequence than Sputnik ever was.

Americans are displeased by the trend, but demonstrate little concern except when jobs or businesses are threatened by foreign competition. There is an unfortunate inclination to blame our deteriorating position on special advantages and unfair practices on the part of other nations. In some instances, we can and should pursue changes in the conduct of international trade, but that is a weak plan of action. We will not achieve much by legislating protectionism or by battering apart Japanese products with sledgehammers on television. We can find equally deserving candidates for correction at home.

When properly supported, American technology still leads the league in innovation. One of our worst problems is that we are not very good at producing the things we invent. We do not have the efficient factories, the modern equipment, or the manufacturing ability to take our technology to market at competitive prices.

In both government and industry, the priority for research and development is too low, and the funding for it is insufficient. Our educational system does not teach enough math and science. It does not produce enough scientists, engineers, or technicians. Achievement tests find American students below the international average on technical subjects. Overshadowing it all is a preoccupation with short-term results.

Technology is inherently a long-range proposition. The Wright brothers did not spontaneously climb Kill Devil Hill, crank up, and take off on December 17, 1903. From the 1890s on, they scoured libraries for anything they could read on aeronautics. They conducted experiments and exchanged letters with other experimenters. Three years before Kitty Hawk, they tested their designs in a crude wind tunnel. We do not remember them for their quarterly dividend at the bicycle shop.

Our government today is fixated on the budget deficit for 1990, not on the technology we will need in 1999. An industry that concentrates on long-term growth rather than short-term profits may see its stock drop and corporate raiders gathering for the kill.

We cannot know what will not be invented or what opportunities will be missed when we fail to pursue technological growth. We can say only that throughout history, research and development has been a good investment and that technological leadership will surely be of benefit in the future.

Without the advantage of superior technology, the effectiveness of US military forces and their ability to protect our interests will be reduced, perhaps to a dangerous extent. Economic prosperity depends on technology, too. We must have something to export besides rock music and designer jeans.

We do not need gimmicks or crash programs. We must get out of this problem the same way we got into it: gradually and across a broad front. Given a steady national commitment and a reasonable allocation of resources, the recovery will follow naturally.

Resources, however, may be the easier part of that solution, even in this era of tight budgets. Money alone will not solve the problem so long as our society remains indifferent to the underlying causes. Maybe it requires another surprise like Sputnik to shock us, scare us, and motivate us to action. ■

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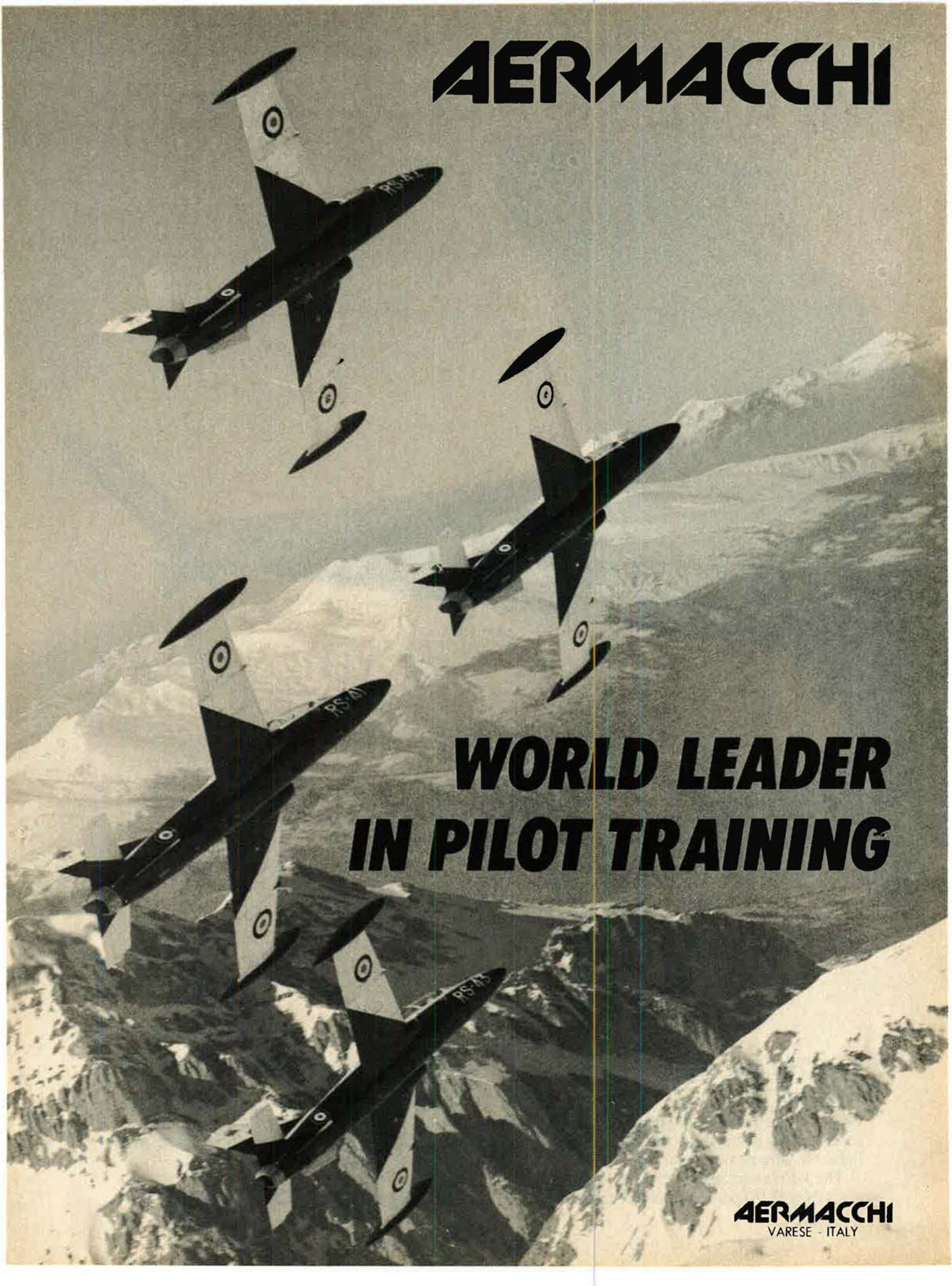
GENERAL DYNAMICS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Airmail

AirLand Fighter Debate

In addressing the Harrier option for a close air support aircraft *[see "What's Bogging Down the AirLand Fighter?" April '89 issue, p. 40]*, General Dugan was quoted as stating that "the typical problem is to get from where the runway is to wherever the fight is." I would respectfully add that besides buying aircraft with longer range to solve the problem, we should also consider the advantages of buying aircraft that make it easier to quickly build runways closer to the fight. That ability could be especially useful if General Milton is right about fixed, permanent bases rarely being where the trouble is. *[See "Forces for the Lesser Wars," April '89 issue, p. 92.]* It could also prove valuable should a future war be characterized by significant movement, as the Army's AirLand Battle (and Soviet) doctrine assumes.

During World War II, quickly building runways closer to the fight was a high priority for Generals Kenney, Spaatz, Brereton, and Vandenberg when they planned the air portion of a campaign. One of the reasons they were able to build runways quickly was the ability of their aircraft to operate from rough, short runways that were built with materials like Marston mat *[April '89 issue, p. 84]*. Another was the large number of engineers (Ninth Air Force had 25,000) available for building runways and keeping them operable.

Lt. Col. Price T. Bingham, USAF
Airpower Research Institute
Maxwell AFB, Ala.

John Correll's article on the USAF's close air support aircraft selection process reveals the growing frustration over this issue. Unfortunately, it also highlights the manner in which the available data on one candidate, the AV-8B, has been misused. It concerns me to see this data distorted and manipulated to demonstrate that "no matter how you slice it, the data says 'A-16.'"

Mr. Correll nicely summarizes the points made against the AV-8B throughout this protracted effort, but perhaps unconsciously proves the very lack of objectivity that has led Congress and DoD to demand further studies. Why not use the AV-8B? Because of "costs for special support and logistics infrastructure." One paragraph later in Mr. Correll's article, we are told [by General Dugan] that the AV-8B can't get to the fight. "If that's a couple of hundred miles away, no matter what size runway the AV-8B gets off, it doesn't quite get there with enough punch."

These are the two crucial arguments used against the AV-8B, but consider them carefully. The first says that the AV-8B *must* carry a special logistics burden because it is operated from forward bases; the second says that the AV-8B *must* operate from rear bases for the purposes of calculating mission radius.

This analysis is fundamentally flawed. Since the AV-8B is *capable* of operating from a forward base, it was *required* to do so when this led to higher logistics costs. But when target-killing effectiveness was the criterion, the AV-8B was *denied* the benefits of forward basing and was shown to be operating from a main base. The aircraft will be operating in one mode or the other, and there are compensating advantages and disadvantages for each. The Marine Corps intends to forward-base AV-8Bs to the extent necessary to provide responsive, flexible close air support to the ground combat element of the Marine Air Ground Task Force (MAGTF). Many studies to date have been carefully orchestrated to base the AV-8B wherever it incurs the largest penalties in whatever parameter is being considered at the time.

The Marine Corps has opted for the AV-8B because we don't intend for the fight in which our MAGTF is involved to be "a couple hundred miles away." Runways are not invulnerable, and increased sortie rates by virtue of forward basing justify solving demanding logistics requirements.

The USAF should be allowed to [select] an AirLand aircraft to support the Army requirement. If the A-16 best meets the requirement, it should be selected. But any study should refrain from bolstering a case by manipulating data. Those of us who operate the AV-8B know that its good characteristics have been consistently minimized and its penalties maximized in CAS studies to date.

Lt. Col. Joseph T. Anderson, USMC
Washington, D. C.

Charter members of [the Mudfighter Faction], which [championed] the FX (F-15) and LWF (F-16), recall that both of those crusades were opposed by USAF factions intent on creating an Advanced Tactical Fighter that (in the early 1960s) was to be an all-weather deep strike aircraft. Because of that experience, I am neither confused nor chagrined by the Chief [of Staff's] mandate relative to A-10 replacement; it reflects a deep-seated view of the best use of tactical airpower.

One answer to your question, "What's Bogging Down the AirLand Fighter [A-16]?" is that it is a transparent effort by the USAF to transfer limited tacair resources from a mission that many feel is an exercise in futility (CAS) to the mission that Commanders of Air Forces believe is the only real deterrence to the Soviet threat in Europe, namely, tactical nuclear strike. Support for this view is reflected in a statement by General Galvin (*Armed Forces Journal*, March '88): "I can guarantee only two weeks against an all-out Pact attack—then we will have to use nuclear weapons."

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

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Later he talks about augmenting those nuclear arms that are not likely to be traded away in the accord process. Perhaps he shares the hope that tactical strike fighters will be immune.

Back to the issue of how best to relieve the infantry's problem of being intimidated and trampled by Hinds and tanks when their organic firepower fails. DoD has two choices: a combination of FAADS/LHX with a planned acquisition cost of $60 billion or a possibly more effective, less manpower-intensive, and logistically less burdensome force of Mudfighters for $20 billion. Mudfighters are not slow, and they outfight all known fighters and helicopters at low altitude. They kill tanks, require only one pilot, and are not very vulnerable to .50-caliber fire. Neither are they nightfighters, because National Training Center experience confirms that night belongs to infantry and helicopters.

The Chief was correct when he said that the USAF-procured studies (performed by ATF aspirants) say A-16, not Mudfighter. He just hasn't gotten around to asking the right question—one which neither Army, Air Force, nor many industry leaders would like to have addressed at this time.

Chuck Myers
Gordonsville, Va.

The Air Force is finally right in its preference for the A-16. Not that the A-16 is the ideal close air support plane. It's more in the better-than-nothing category. Unfortunately, the Air Force is down to that option.

We are in a budgetary climate where the B-2 and ATF programs are being stretched and readiness is being reduced. There really is no room left to develop a new CAS plane in this century. Nor would we want to further sacrifice the B-2, ATF, and readiness just to warm over the A-7 and A-10.

The AV-8B is another matter. It loses any cost-per-plane comparison with the A-16. The AV-8B is also operationally inferior when forced to operate from A-16 bases. However, it beats the A-16 at cost per pound on target, on time, on demand, if the AV-8B is permitted mobile remote forward basing while A-16's fixed established bases are under persistent SSM and Su-24 attack. Of course, once you add on the cost of each remote base's officers' club, BX, theater, family housing, etc., the AV-8B loses again. There's no way an Air Force officer is willing to live like a Marine. Besides, Marine AV-8B pilots only have to do it in combat, whereas USAFE AV-8B pilots would have to do it for decades.

The AV-8B requires more proficiency than any other combat aircraft. As a result, an AV-8B pilot is stuck for his career. It's a prestige job for a Marine. For a USAFE/TAC pilot, it requires the greatest skill and hardship for the least potential recognition and glory.

The A-16 is the only practical choice for the Air Force. But it's not the nation's only choice. The Army already intends to operate its combat helicopters from the boonies. Army warrant officers would drool at the opportunity to pilot AV-8Bs. Therefore, there is one last comparative study that would make sense. Ask the Army what it could do with the AV-8B using the acquisition, O&M, personnel, and construction funds that the Air Force would spend on the A-16.

Paul Madden
Seattle, Wash.

The Welcome "Mat"

I enjoyed the story about Marston mat by Richard K. Smith in the April '89 issue, p. 84. Our B-24 crew lifted off of Marston mat from Darwin, Australia, to Okinawa, with many stops along the way. Only now, forty-four years later, do I learn why all those forward island runways were 5,000 feet long.

The capacity of the lower hold of No. 3 hatch of a Liberty ship wouldn't hold any more than 5,000 feet of mat. It was OK for A-20s and P-38s, but a damn short runway for a loaded B-24. With all its attributes, the steel mat had one significant drawback for the "heavies." Friction!

I would estimate that in 5,000 feet of mat runway a B-24 was robbed of two miles per hour indicated airspeed (IAS). Important? You bet, when 5,000 feet was all there was. Routinely, takeoff procedure was: one, stand on the brakes; two, pull RPMs and manifold pressure to red lines; three, Go! A 66,000-pound B-24 needed 130 miles per hour IAS to fly. At the end of 5,000 feet of steel mat, 128 miles per hour was dicey. With the combined supplication of everyone within earshot of this early-morning struggle, we made it. Some didn't.

We finally scrounged another 1,000 feet of mat to extend the length of Murtha Strip on the island of Mindoro, P. I.

Terry Geer
Solvang, Calif.

I read with great interest Richard K. Smith's article on Marston mat. It was

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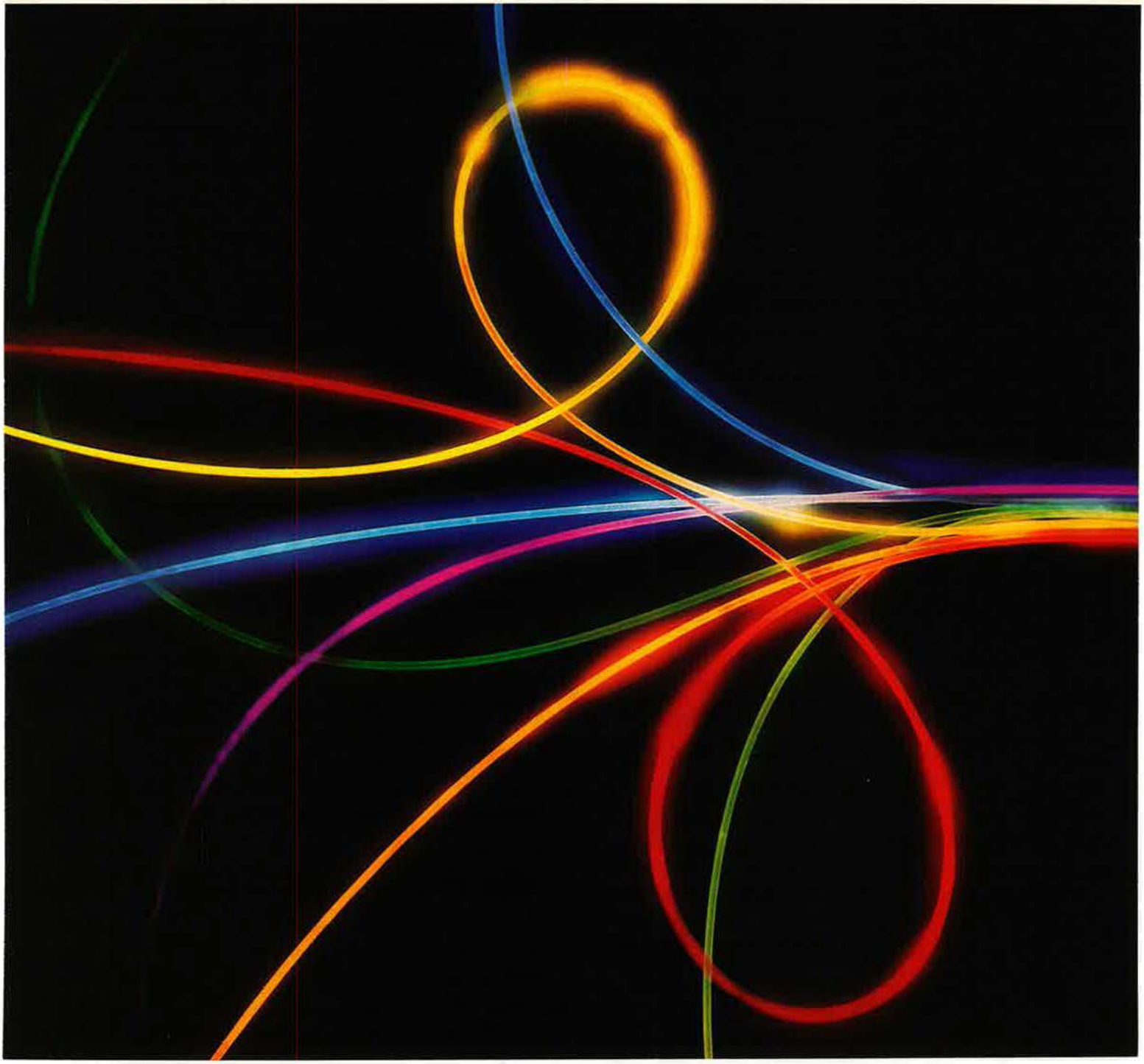

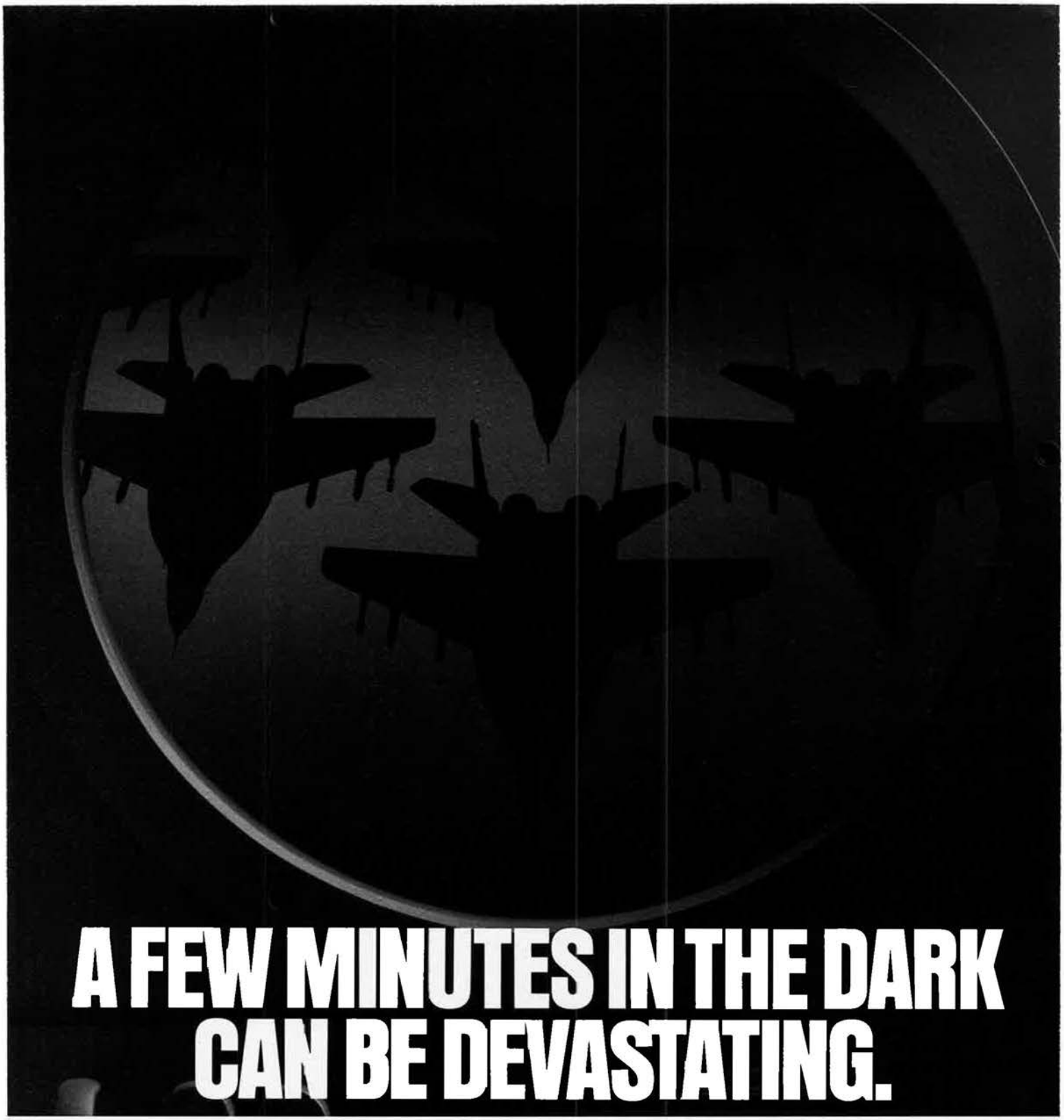

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most informative and offered a history of this material that is, I'm sure, unknown even to those veterans who worked with it.

I was particularly struck by the author's comment, on the last page of the article, that Marston mat is not included among the exhibits at any aviation museum. While it may not have the crowd appeal of a P-51 Mustang, it should still warrant at least a little recognition.

I do not wish to take issue with Mr. Smith's statement, but were he to visit the Heritage in Flight Museum, Logan County Airport, in Lincoln, Ill., he would be able to see examples of Marston mat on prominent display. Until now, the museum did not have a background history on this engineering tool. But thanks to Mr. Smith's article, the museum display can add some factual data that will be both interesting and informative, not only to veterans of World War II, but also to schoolchildren who visit the museum.

As a member of Heritage in Flight Museum, I wish to extend my personal thanks to Mr. Smith for his article, and I'll look forward to his future contributions to AIR FORCE Magazine.

Kenneth Sommerfield
Princeton, Ill.

I was delighted to see Richard K. Smith's article on Marston mat (PSP) in the April '89 issue, but I need to correct one point. There *is* an aviation museum at which this matting is displayed—the US Air Force Museum near Dayton, Ohio.

Our P-39 is painted and marked as one of the Airacobras assigned to the 57th Fighter Squadron based in the Aleutians in 1942. It's displayed in a habitat setting, complete with ground crew member outfitted in winter gear and a World War II utility heater positioned beside the aircraft. The aircraft is parked on Marston matting, and the holes are filled with sand from Shemya Island in the Aleutians to add greater authenticity to the exhibit. A display sign highlights the role the Marston mat played in creating the AAF's "footprint of global airpower" in World War II.

Charles G. Worman
Wright-Patterson AFB, Ohio

• *Our readers have been quick to point out these and other museums where samples of Marston mat are on prominent display. We regret the error.*—THE EDITORS

Maximizing Retention

I conclude from the April '89 issue letters of former blue-suiters, now airline pilots, that they perceived their roles in the Air Force to be strictly vocational-school graduates. Where is the responsibility to be officers or to apply initiative and experience to improve the Air Force of the present and future?

Additional duties, socials, etc., make meaningful contributions to the experience base of the Air Force careerist. There isn't a bad job in our service, and members who accept varied challenges help us to cross-fertilize, ensuring strength throughout.

Count me in for looking for accessions who take a long-range view; count me out on elitist notions that one faction should set more favorable work rules than another. Retention maximization lies in promoting kinship to the organization, not to a single job.

Lt. Col. George A. Solli, USAF
Washington, D. C.

Leadership by Example

General Milton's "The Commitment Gap" comes hot on the tail of similar remarks by the Air Force Chief of Staff and MAC Commander *[see "Tough Choices for Hard Times," February '89 issue]* questioning the dedication of young pilots.

I am an Air Force Academy graduate and spent the last few years prior to retirement in Air Training Command, where I had continuous daily contact with those fine officers that Generals Welch, Cassidy, and Milton accuse of not being "team players." Let me reassure you that the aviators going through pilot training today are just as enthusiastic and motivated as those who graced the flight rooms twenty or thirty years ago.

What has changed is the qualification and motivation of many of the leaders who run flying units today. We used to find at the top the crusty aviator who could outfly anyone in the unit and who had a library of war stories to tell. It was leadership by example. Experience reigned supreme.

A large segment of today's commanders are staff-oriented, lack the operational experience necessary to understand what makes their flying organizations tick, and cannot muster the fire and zeal necessary to motivate young troops. What is worse, this growing segment of flying commanders—from squadron commander on up—has as its number-one objective personal career progression. Instead of having leaders, we have a bunch of

puppy dogs with their heads on swivels, always "checking six," hoping they have not offended the next colonel or general in their chain of command.

No, General Milton, I am afraid you are after the wrong horse this time. Commitment is a two-way street. Our young folks start out very committed, but then they look at their role models and soon learn that the warrior-commander willing to sacrifice his own career for his troops is a thing of the past and that there is no future for them in the active force. So they vote with their feet and head off to a Guard or Reserve unit, where the fighting man—and not the politician—still gets some respect.

Lt. Col. James V. Kelso III, USAF (Ret.)
Griffin, Ga.

The Valor of POWs

The reading of "Valor en Masse," February 1989, brought on a swell of emotion and feelings that I haven't felt in many, many years.

I was a USAF F-84 pilot, shot down on January 5, 1953, in Korea, the "Forgotten War," the "police action." Maybe I was a naïve twenty-four-year-old, but, as the months wore on, I couldn't believe what I was experiencing. It was nothing like I had heard about from World War II, and no training prior to combat prepared me for what was to come. I was held in solitary confinement—no roommate, no camps, no one who spoke English except the Chinese interrogators, for the entire length of my internment. Not a friendly face for eight months.

I was very much "out of it" when I was turned over to friendlies at Freedom Village. What I do remember was the biggest Marine I'd ever seen. He wrapped one arm around me and carried me out of there like I weighed less than a sack of groceries. [He was] the most welcome and glorious sight of my entire life to that point.

I don't even remember the exact date, except that it was the last day that anyone was released in September 1953. I was told on the way home that Colonel Schwable, Colonel Evans, and Colonel Mahurin were in the same group.

POW treatment in Vietnam closely paralleled that in Korea. I believe that those who were responsible for the "care and treatment" of Vietnam POWs were trained using a syllabus developed in Korea. I also believe that our experiences as POWs in Korea were the catalyst that resulted in the formation of the USAF Survival Schools and the Escape and Evasion Schools. How true it is that "forewarned is forearmed."

It is my greatest hope that those who were POWs in Vietnam were better prepared than we were. Or do we have another case of failing to use past experiences to advantage? I feel an emotional bond with each of [the Vietnam POWs], and I heartily concur with John Frisbee that "they should be publicly commemorated as a symbol of patriotism and of the unconquerable spirit that inspires the best in free men."

Roger Warren
Reynoldsburg, Ohio

A Mission or a Place?

This letter is in reference to Senior Editor James W. Canan's article "Space Comes Into Its Own," in the March '89 issue *[see "Washington Watch," p. 20]*.

While I agree with his assessment of current Air Force attitudes toward space, I fear that Editor Canan may have left readers with a misconception of space's role "as a place or a mission." The distinction might appear to be one of semantics, but it does have a bearing on the development of military space doctrine (as contrasted with aerospace doctrine), space force structures, and concepts of operations. Neither the Department of Defense space policy of March 1987 nor the recently released Air Force space policy refers to space as a mission. Rather, space is viewed as "a medium within which the conduct of military operations in support of our national security can take place, just as on land, at sea, and in the atmosphere. . . ."

It is one thing to put space operations on an equal footing with air operations in USAF planning, programming, and budgeting, but it is another to make it a *mission* in the traditional definition of the term. According to JCS Pub. 1 (April 1, 1984 edition), "mission" is defined as "the task, together with the purpose, that clearly indicates the action to be taken and the reason therefor." Space per se does not fit this definition, but, for example, aerospace surveillance and reconnaissance, *i.e.*, strategic and tactical surveillance of objects in space or on the earth, is considered a mission in this context without implying the use of only air-based or only space-based systems for this purpose.

Advanced technologies and the more routine use of space as an alternative environment for military operations are leading us to consider more active roles for space-based systems. If space is viewed as the "high ground," space operations will continue to be viewed in force enhancement and space support roles. Alternatively, if one considers space as a separate theater of operations, based on its distinct environmental and operational differences, then military space operations can envision space control and force application roles.

Both philosophies have fundamental implications for the direction of military space doctrine, force structures, and operational concepts, the former being more conservative than the latter. Implementing the "space as a separate theater" philosophy could, for example, result in a separate "space force" for the conduct of offensive and defensive operations against threats to US national interests in space. Such a "space force"—which may or may not be the Air Force—would face severe organizational and budgetary obstacles in its competition with the other services for scarce resources. Obviously this concept is premature in light of today's political, arms-control, and budgetary concerns. However, if circumstances were to change sometime in the future (*e.g.*, a change in the national perception of the threat posed by the Soviet Union), a "space force" could become a reality. This is why the distinction between space as a place and as a mission is important.

It is heartening to hear of the steps initiated by former Secretary Aldridge and General Welch to integrate space operations into Air Force thinking. However, only time will tell as to whether space has truly "come into its own."

Dana J. Johnson
Santa Monica, Calif.

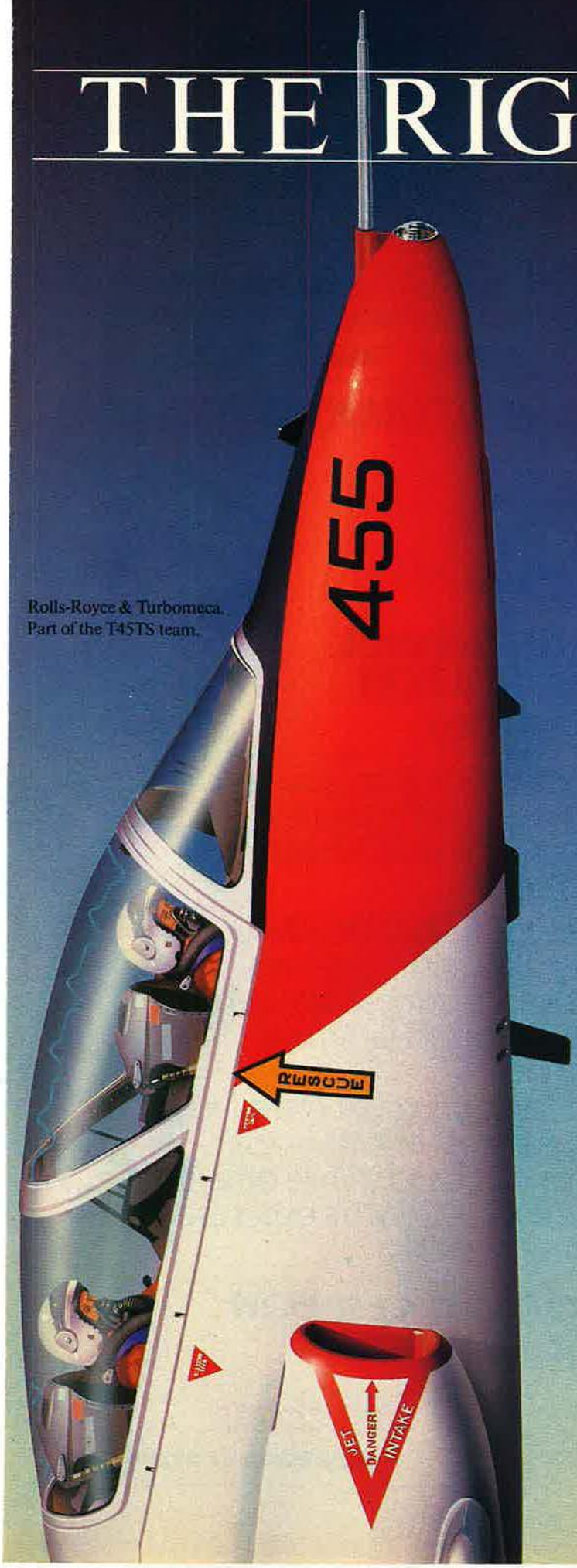
The B-2's Cost

After reading numerous articles concerning the B-2 (including those in AIR FORCE Magazine), I have decided that some people are really serious about spending $5 billion on one airplane. Years ago, [the person] who said, "Why can't we buy them one airplane and let them take turns flying it?" was kidding! It seems that someone has taken it seriously.

I can only think of two reasons to spend that kind of money for an unarmed, subsonic, large, black airplane that, on a clear day, can be run down and gunned to death by a twenty-five-year-old MiG-21.

1. The entire Air Force staff has taken leave of its senses.

THE RIGHT STUFF



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Col. Bud Hall, USAF (Ret.)
Tijeras, N. M.

Collectors' Corner

Serious collector wants unusual USAF aircraft patches, unit patches, and competition patches donated. Thank you.

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Capt. Jaime Rojo
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Nurses Remembered

On p. 28, April '89 issue, [an item in "Aerospace World" claimed] that an award was presented in the name of "Dolly" Vinsant as "the only American flight nurse killed in the line of duty during World War II."

Sorry to refute that, but Lt. Ruth Gardner, flight nurse, died in the crash of an evacuation flight en route to Attu, Alaska, in the summer of 1943. In fact, I understand Gardner General Hospital, Chicago, was named in her honor.

Another example of the "Forgotten War"—Alaska?

W. W. Westcott
Torrance, Calif.

[With regard to the] April '89 issue, p. 28, I should like to correct the item honoring the evacuation nurse. It states " . . . in honor of Wilma 'Dolly' Vinsant, the only American flight nurse killed in the line of duty during World War II."

The omission is as follows:

Gerda Mulak, RN, from Newburgh, N. Y., a flight nurse assigned to the 804th Air Evacuation Squadron in New Guinea during World War II, was killed in a C-47 troop carrier evacuation plane piloted by 1st Lt. John S. Hutcheson, (Class 43-A) of the 65th Troop Carrier Squadron, 433d T. C. Group, after a takeoff in bad weather from Finschhafen, New Guinea, on March 6, 1944. . . .

Thank you for correcting the record. I'm sure Gerda's family will appreciate it. I hope the Confederate Air Force will take similar steps to correct its records.

Richard A. Grant
Victor, Mont.

Designation Mixup

In the caption in the March '89 issue on p. 37, the USS *Kennedy* was identified as "CF-67." "CV" is the carrier prefix. These Naval designations are bewildering, so this [does not reflect on] Mr. Rhodes's competence.

Laurence H. Cummings
Philadelphia, Pa.

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Operating cost savings also would compound at an even faster rate because of the increased fuel efficiency of its new Rolls-Royce Tay engines; the design improvements and reduced maintenance requirements of its many new aircraft systems; and the significant commonalities it has with the C-20 Gulfstream in maintenance procedures, spares supply and support programs.

The way we see it, the Air Force took a big step forward when it began operating its present C-20 Gulfstreams.

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After the Squeeze

By James W. Canan, SENIOR EDITOR

The 1990 budget reductions make the Air Force narrow its options and put more of its chips on stealth. On balance, the damage could have been worse.

Washington, D. C. All things considered, the Air Force fared relatively well in the Bush Administration's downsized defense budget for Fiscal Year 1990. USAF's force structure has been trimmed only slightly, and all its major systems survived, for the time being at least.

At first glance, the budget's big news for the Air Force seems to center on strategic weapons. The document charts new headings for programs involving ICBMs, the Strategic Defense Initiative (SDI), and the B-2 bomber, which is looking less and less like a sure thing.

But the budget says just as much, if less obviously and emphatically, about the changing look of the tactical Air Force. The document makes it more evident than ever that USAF is now betting its future on stealth as the saving grace of its air-superiority and deep-attack fighters.

As to big-ticket strategic weapons, the budget provides funds for the Air Force to begin redeploying its fifty Peacekeeper ICBMs from silos to railways to make them much more survivable. USAF also is given the wherewithal to continue developing the so-called Midgetman road-mobile ICBM, a weapon that is almost certain to remain politically, financially, and strategically controversial within the Administration and in Congress.

Full production of F-16 fighters for many years to come is foreshadowed in the new budget. The budget also sets the stage for USAF to remodel 225 A-10s and 146 F-16s to perform the increasingly demanding close air support (CAS) mission for the Army.

As the Air Force itself had proposed, there is no money in the budget for development of a burlier F-16 called Agile Falcon, a state-of-the-art fighter that is seen by some officials as a possible threat to USAF's more highly prized—but farther-term and higher-priced—Advanced Tactical Fighter (ATF).

Agile Falcon will not go away, though. It has staying power in Pentagon and congressional circles, where it is fondly regarded as a future winning entry for the US in overseas aircraft markets. Its resurrection cannot be ruled out.

Fears that the budget crunch would cause the Air Force to shift two tactical fighter wings from the active force to the reserves proved unfounded. As Chairman of the Joint Chiefs of Staff Adm. William J. Crowe, Jr., told Congress, "The Air Force will enter the 1990s with thirty-five tactical fighter wings."

Tactical Air Command can live with that number, even though it is a far cry from the forty-four such wings that TAC regards as optimum—and from the forty wings to which TAC more realistically aspired.

The Air Force can find much to like in the new defense budget. Thanks to "operational pull" from the Commanders in Chief of the warfighting operational commands, the C-17 airlifter program, a big favorite of the CINCs, not only stays alive but thrives at the threshold of production.

The budget also enables several other high-priority Air Force systems to hold their own, most notably the Advanced Cruise Missile (ACM), the Advanced Medium-Range Air-to-Air Missile (AMRAAM), and the Joint Surveillance Target Attack Radar System (Joint STARS) *(see page 42).*

Admiral Crowe underscored the importance of the ACM, AMRAAM, and Joint STARS in the "US Military Posture" statement that he presented to Congress at budget-submission time. He called them "instrumental to the future robustness of the Air Force."

But there is a hint of trouble, or at least of mounting uncertainty, in what the revised defense budget reveals about some other top-drawer USAF programs that are every bit as important to USAF's future capability.

These programs have to do with combat aircraft, the very stuff of the Air Force. In the programmatic decisions and priorities it reflects, the budget is evidence of the Air Force's irreversible commitment to stealth as the overarching attribute of its future fighters and bombers.

Indeed, it is fair to say that the Air Force is betting its future on stealth. Its leaders insist that they would never make stealth the only criterion, or even necessarily the overriding one, in planning for aircraft and other systems. They acknowledge, though, that stealth has become a highly persuasive factor in such planning. The emergence and continuing enrichment of low-observable technologies and techniques through the past fifteen years or so has greatly broadened their options for warfighting plans, systems, and tactics.

For all that, the revised defense budget can hardly be interpreted as a wholehearted show of confidence—whether by the Air Force or the Office of the Secretary of Defense—in the progress of individual programs for developing and producing stealth-type aircraft.

Concerning such aircraft, the Pentagon postulates schedule slippages of at least one year for the Air Force's B-2 bomber and of unspecified, although likely shorter, duration for its Advanced Tactical Fighter (ATF) and the Navy's A-12 Advanced Tactical Aircraft.

Admiral Crowe summed up the situation thusly: "The pace of developing an Advanced Tactical Fighter and fielding an Advanced Tactical Aircraft will be slower than previously planned."

The Navy ATA, or A-12, comes into play in the Air Force scenario because USAF intends to develop, produce, and deploy variants of that stealthy,

subsonic attack aircraft for deep-interdiction missions now assigned to F-111s and F-15Es.

None of the stealth aircraft programs seems to be in life-threatening difficulty, although Secretary of Defense Richard Cheney, in his budget message to Congress, acknowledged "technical problems" and troubling uncertainties in the B-2 program. He went so far as to testify that he was "raising a red flag" about the B-2 program.

There are no such flags flying over the ATF and A-12 programs. It seems that they can simply use a tad more breathing room, nothing direr, and if stretching them a bit saves a little money in the short run, so much the better.

Now comes a contradiction. Even as the ATF and ATA programs are being slowed, the Air Force, in the name of dollar savings over the longer term, has been forced to do something that "hurts like the devil," as one senior Air Force official admitted. USAF has foreshortened the production run of its esteemed F-15E fighter, the latest, top-of-the-line Eagle that the Air Force holds dear for its dual prowess in the air-superiority moce and in the conventional or nuclear deep-interdiction role.

In air combat, the F-15E, newly in production, and the exclusively air-to-air F-15C/D variants, no longer in production, are the closest that the Air Force will be able to come to the ATF until the ATF itself comes along. As to deep interdiction, the F-15Es lack the range and maybe the full-up air-to-ground firepower of the doughty and highly regarded F-111s. But their modernity, exemplified by their highly advanced avionics and cockpit display technologies along with other superior characteristics, puts the dual-role Eagles in a class by themselves among current fighters.

If all goes well, the Air Force variant of the Navy A-12 is slated to supplant the F-111 and then the F-15E. The replacement process is scheduled to begin sometime in the latter half of the coming decade and to carry forward well into the first part of the twenty-first century.

But the transition from today's fighters to tomorrow's is beginning to look a little less smooth than the Air Force once planned. In presaging the premature ending of F-15E production and a slowdown of A-12 and ATF development, the new defense budget exposes a time gap that USAF had been trying to avoid by keeping F-15Es coming off the line until the other two fighters were ready. Meanwhile, the F-111s, although inarguably effective, will not be getting any younger.

It is highly unlikely that the Air Force will be able to begin buying A-12s and ATFs until the latter half of the 1990s. John J. Welch, Under Secretary of the Air Force for Acquisition, points out that "this means we'll have only one fighter [the F-16] in production for some years" after the F-15E line falls idle. The Air Force has not found itself in such a single-fighter state of affairs in recent memory.

It also means that the Air Force will have to forgo six years of F-15E production in which 192 of the fighters were to have been built and that the service will have to make do with only 200 of the versatile aircraft that TAC Commander Gen. Robert D. Russ describes as "absolutely superb."

There will be enough F-15Es to fill out and replenish only two wings, rather than the four wings that TAC had once deemed necessary and had counted on getting.

That's not the whole story. TAC is now fated to come up short—by one wing—of the three F-15E wings that it had set as the "absolute minimum" needed to accommodate concurrent deployment of the dual-role fighter in Europe, in the Pacific, and Stateside. Clearly, something will have to give in F-15E deployment plans.

The revised defense budget also signals the untimely end of production of USAF's LANTIRN. This infrared navigation and targeting system has been a high priority with USAF for a long time, because it takes the night away from the enemy. It enables ground-attack fighters to operate in darkness and beneath overcasts with the confidence and precision now possible only in daytime, clear-weather conditions.

LANTIRN pods will go out of production, along with F-15Es, at the end of Fiscal Year 1991. But enough LANTIRN sets, each made up of a targeting pod and a navigation pod, will have been produced to outfit all 200 F-15Es and about 350 F-16C/Ds as well.

The bad news about the F-15E comes just as the fighter is poised to become fully operational and as its "flyaway cost" seems to have steadied at about $31 million. But the F-15E program came awfully close to not even making it this far.

Early last year, the program analysis and evaluation (PAE) shop within the Office of the Secretary of Defense (OSD) proposed aborting the F-15E

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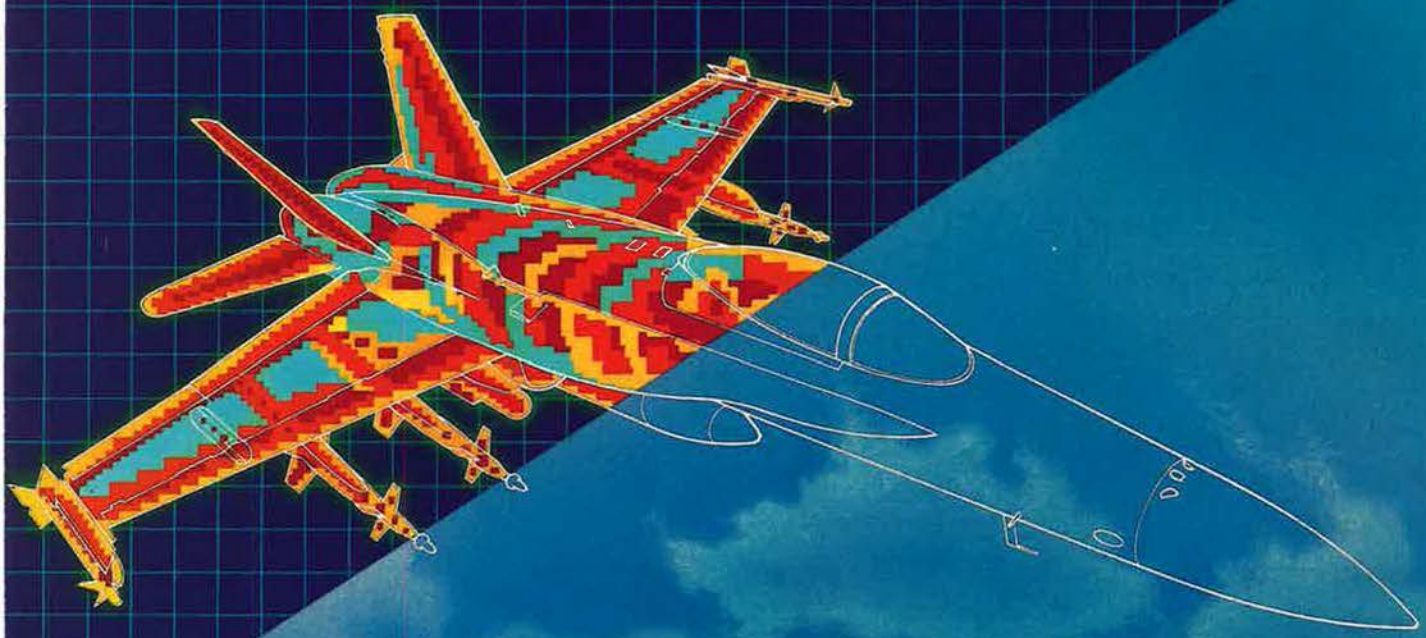

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production program at its outset and banking the big money thus saved against the day that ATFs and ATAs would begin coming along.

The Air Force leadership managed to save the program by a last-ditch appeal to then-Secretary of Defense Frank C. Carlucci. Not long afterward, General Russ retrospectively described the PAE proposal as "a bankrupt idea."

General Russ declared, "Trading our 'now' capability and docking ourselves for a number of years would not have been a good thing to do."

Now that the F-15E has become a case of here today and gone tomorrow, Air Force leaders see no further point in fighting to prolong its production. They also say that they have no intention of mounting—or joining—any end runs for the F-15E on Capitol Hill. They prefer to take the positive approach that 200 of the fighters are better than none.

Air Force officials also acknowledge that the F-15E, lacking stealth properties and going up against ever-tougher air defenses, "probably won't be able to do the job any more some day," as one of them put it. But this official undoubtedly spoke for the leadership at large in also saying:

"It will hurt to let the [F-15E] line go down in 1991. It's a great multircle fighter. We hate to let an aircraft like that go out of production. We'll be holding our breath for some years afterward."

TAC has insisted all along that the F-15E became all the more important to US military capability once the Intermediate-range Nuclear Forces (INF) Treaty took effect in Europe last year. That agreement had the effect of shifting emphasis away from NATO and Warsaw Pact medium-range nuclear missiles and putting it squarely on air and ground forces instead. Accordingly, TAC began pushing to step up F-15E production rates, but to no avail.

Now those air and ground forces have replaced medium-range missiles at center stage in the European theater arms-control drama, Act Two. Soviet General Secretary Mikhail Gorbachev has announced—but not yet made—unilateral cuts of conventional forces and seems earnest about negotiating a NATO-Warsaw Pact treaty to make symmetrical reductions of both sides' conventional forces in Europe (CFE).

With all this in the air, some Air Force sources acknowledge that the possibility, if not yet the likelihood, of "threat degradation" in Europe made it easier for the service to give in to OSD's pressure against the F-15E.

US military leaders believe a CFE treaty is by no means out of the question. But they warn of the so-called "aircraft problem." It is a major one that could well undo the whole CFE endeavor.

Admiral Crowe made this clear in recent testimony before Congress. Referring to CFE negotiations tentatively under way, the JCS Chairman declared: "There will be some tough sessions in Vienna on the subject of land-based aircraft."

Right off the bat, Warsaw Pact negotiators set as their goal a treaty that would ban all ground-attack aircraft in Europe and that would permit "only fighters" to be deployed, solely in air-to-air roles, Admiral Crowe explained.

"In fact," the Chairman declared, "they have said that phase three of CFE should eliminate all systems with an offensive potential." He added, however, that the Pact is "on weak ground" in attempting to constrain NATO tactical aircraft, for the following reasons:

- The Warsaw Pact has a big advantage in numbers of Soviet air-superi-

ority fighters, which the Pact proposes to exempt from CFE reductions.

• The Pact would also exclude tactical ground-attack aircraft based east of the Urals, even though NATO officials make the case that those aircraft could quickly be moved to alternate bases in eastern Europe within easy striking distance of Western armies.

• Conventional or nuclear strikes against NATO forces could also be carried out by medium-range bombers based in the Soviet Union. The Soviets have "an asymmetrically large inventory" of such aircraft, including Backfires, which are allowed by the SALT II Treaty and the putative START Treaty, Admiral Crowe explained.

He lumped all these points under what he dubbed "the aircraft problem," and continued: "It reminds us that CFE [negotiations] will not produce a perfect military balance or solve all of the military problems of Europe."

Admiral Crowe sized up CFE prospects as part of his testimony before the Senate Armed Services Committee on "the global security environment." He told the lawmakers that the US has "managed to maintain a reasonable balance among our various global responsibilities" despite the steady decline of defense purchasing power in real terms over the past four years.

Then the JCS Chairman delivered the warning, "Today, however, our combatant forces are tightly stretched. They cannot be strong everywhere at once in peace, crisis, or war.

"The military risks associated with a forward defense of Europe and Asia are higher than the Joint Chiefs of Staff would prefer. Yet we are challenged as well to maintain a credible nuclear deterrent, a secure position in space, a healthy maritime environment, and strategically mobile forces capable of dealing with crises or contingencies in the Third World."

The JCS Chairman reemphasized these themes in his subsequent military posture statement to Congress. In it, he seemed blunter than ever before in imparting his message that enough is enough in military spending cuts and that time may be running out on US military strength.

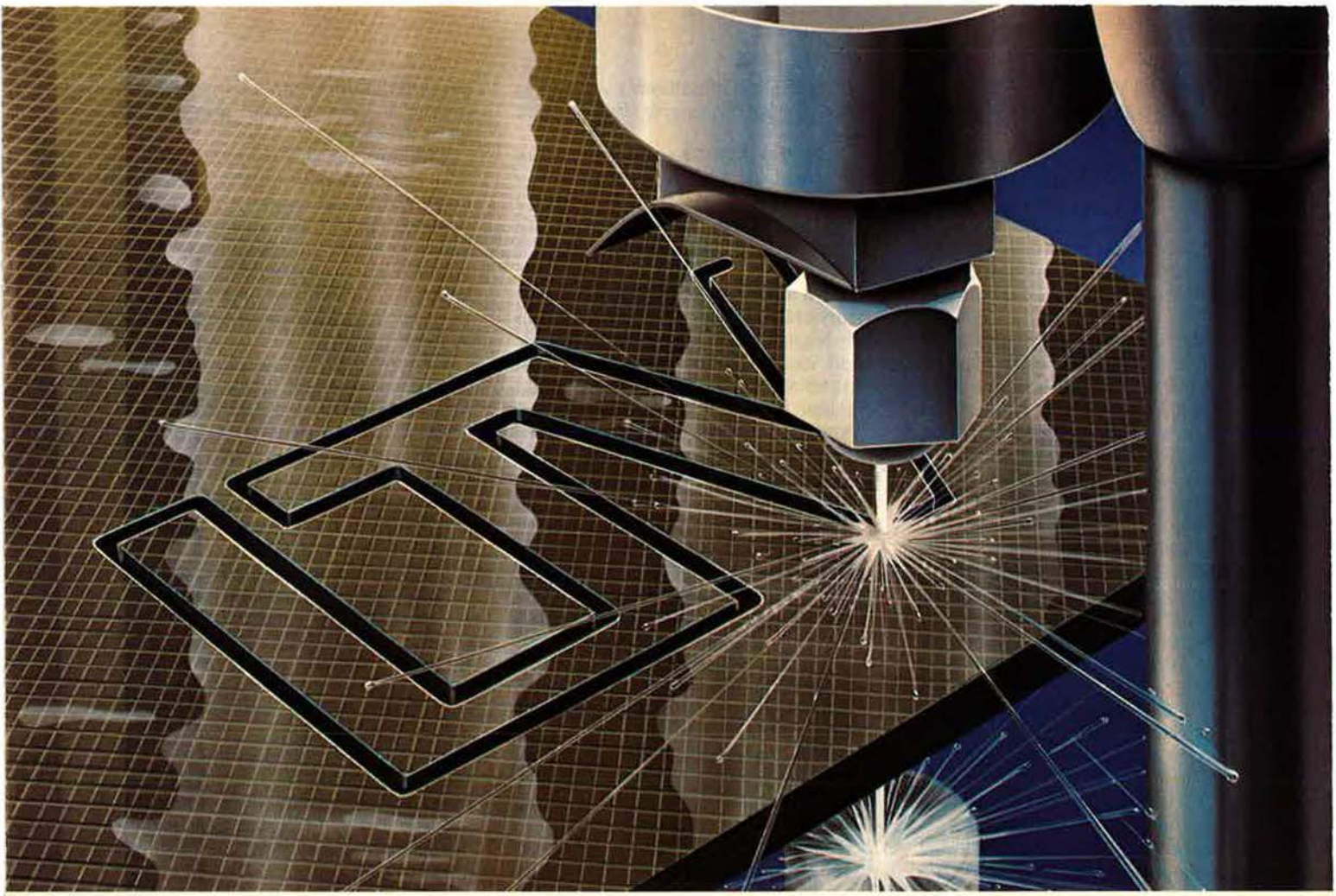
Admiral Crowe called the European theater "the biggest problem we have" and declared: "The most glaring weakness in our global posture is our inability to adequately defend western Europe conventionally."

He asserted, "We cannot get more defense for less money. . . . This budget is very tight when it comes to protecting a force of high quality." He cited examples:

• Military pay will fall short of inflation rates, investments in weapons and equipment modernization will decline, spare parts inventories will dwindle, more and more depot maintenance will be deferred, and military bases and facilities will not be kept up as conscientiously as they have been in recent years.

• Force structures will take hits across the services. Compared to the Army and the Navy, the Air Force gets off easy. It will have to deactivate only its hurricane-monitoring WC-130 units and restructure its TR-1 tactical reconnaissance force. USAF will also strike 3,200 uniformed personnel from active-duty payrolls.

On Capitol Hill, defense budget in hand, Admiral Crowe was clearly unhappy about the whole affair. He asserted, "I would vastly prefer a dollar figure that would permit us to keep our current force structure, without sacrificing quality, until we have a clearer understanding of where the Soviet Union is going, of the arms reduction calculus, and of the international climate. In my judgment, there are too many uncertainties on the horizon at this time to justify force cuts." ■



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The Chart Page

Edited by Colleen A. Nash, STAFF EDITOR

The Twenty-Two Most Critical Technologies

Technology	Objective
1. Microelectronics Circuits and Their Fabrication	The production of ultrasmall integrated electronic devices for high-speed computers, sensitive receivers, automatic control, etc.
2. Preparation of Gallium Arsenide (GaAs) and Other Compound Semiconductors	The preparation of high-purity GaAs and other compound semiconductor substrates and thin films for microelectronic substrates.
3. Software Producibility	The generation of affordable and reliable software in timely fashion.
4. Parallel Computer Architectures	Ultrahigh-speed computing by simultaneous use of all processing capabilities in the next generation of computers.
5. Machine Intelligence/Robotics	Incorporation of human "intelligence" and actions into mechanical devices.
6. Simulation and Modeling	Testing of concepts and designs without building physical replicas.
7. Integrated Optics	Optical memories and optical signal and data processing.
8. Fiber Optics	Ultralow-loss fibers and optical components such as switches, couplers, and multiplexers for communications, navigation, etc.
9. Sensitive Radars	Radar sensors capable of detecting low-observable targets and/or capable of noncooperative target classification, recognition, and/or identification.
10. Passive Sensors	Sensors not needing to emit signals (hence passive) to detect targets, monitor the environment, or determine the status or condition of equipment.
11. Automatic Target Recognition	Combination of computer architecture, algorithms, and signal processing for near-real-time automation of detection, classification, and tracking of targets.
12. Phased Arrays	Formation of spatial beams by controlling the phase and amplitude of RF signals at individual sensor elements distributed along an array (radar, underwater acoustic, or other).
13. Data Fusion	The machine integration and/or interpretation of data and its presentation in convenient form to the human operator.
14. Signature Control	The ability to control the target signature (radar, optical, acoustic, or other) and thereby enhance the survivability of vehicles and weapon systems.
15. Computational Fluid Dynamics	The modeling of complex fluid flow to make dependable predictions by computing, thus saving time and money previously required for expensive facilities and experiments.
16. Air-Breathing Propulsion	Lightweight, fuel-efficient engines using atmospheric oxygen to support combustion.
17. High-Power Microwaves	Microwave radiation at high power levels for weapon applications to temporarily or permanently disable sensors or to do structural damage.
18. Pulsed Power	The generation of power in the field with relatively lightweight, low-volume devices.
19. Hypervelocity Projectiles	The generation and use of hypervelocity projectiles to (1) penetrate hardened targets and (2) increase the weapon's effective range.
20. High-Temperature/High-Strength/ Lightweight Composite Materials	Materials possessing high strength and low weight and/or able to withstand high temperatures for aerospace and other applications.
21. Superconductivity	The fabrication and exploitation of superconducting materials.
22. Biotechnology Materials and Processing	The systematic application of biology for end use in military engineering or medicine.

On March 15, the Department of Defense identified for Congress these twenty-two technologies as the ones most essential to "the long-term qualitative superiority of US weapon systems."

Source: *The Department of Defense Critical Technologies Plan*


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Capitol Hill

By Brian Green, CONGRESSIONAL EDITOR

Washington, D. C.

FY '90 Budget—Finally

President Bush submitted to Congress a detailed FY '90 defense budget consistent with an agreement among White House and House and Senate Budget Committee negotiators. The spending package provides $305.5 billion in budget authority (BA—the amount that DoD and other defense agencies can legally obligate to be spent) and $299.2 billion in outlays (the amount that will actually be spent in FY '90). The agreement cuts the defense budget by about $10 billion compared to the final Reagan Administration request, about $3.5 billion compared to President Bush's own February defense proposal, and about one and a half percent compared to FY '89. The Bush Administration had been seeking an inflation-adjusted freeze for defense. If these figures hold up, defense funding will decline for the fifth consecutive year. About $65 billion will be cut from the January five-year defense plan.

The Air Force budget request for FY '90 winds up at $97.7 billion, down nearly seventeen percent from the Air Force budget peak in FY '85, and almost three percent from the January budget submission. If the request is approved, the Air Force budget will rise over the FY '89 level just about enough to cover inflation.

Two major programs—the Navy F-14D and the Navy/Marine vertical-takeoff V-22 Osprey—were canceled outright. The Air Force was slated to procure fifty-five Ospreys to support special operations forces. The Osprey has substantial support in Congress.

Other major program actions submitted for congressional review and approval:

- Cancellation of the RF-16, the reconnaissance version of the F-16.
- Termination of the F-15E Eagle after FY '91 procurement. Only 200 of the original program of 392 F-15Es will be bought unless Congress reverses this decision.
- Termination of the Agile Falcon program. The Agile Falcon program would enhance F-16 performance through wing and engine upgrades and technical advances from the Advanced Tactical Fighter.
- Delay of the B-2 Stealth bomber by an additional year. Secretary of Defense Richard Cheney, in congressional testimony, said he was "raising a red flag" on the B-2 and was as yet unconvinced of its technical merits.
- Reduction in the SDI request from $5.6 billion to $4.6 billion. SDI requests will be cut $7 billion over five years.

Other major programs—including the C-17 airlifter, AMRAAM (Advanced Medium-Range Air-to-Air Missile), and ATF—survived the budget scrub with little or no damage. The budget retains the 3.6 percent military and two percent civilian pay raise originally proposed.

Rocky Road to ICBM Bargain

The Bush budget funds both Peacekeeper rail-garrison basing and the Small ICBM but not the additional fifty deployed Peacekeepers that the Air Force has long sought. In the Administration plan, the fifty Peacekeeper ICBMs already deployed in silos would be redeployed to trains based on existing military facilities. Initial operating capability (IOC) is slated for 1992. The Small ICBM would be funded at relatively low levels—about $100 million in FY '90—in preparation for larger expenditures in the mid-1990s and an IOC of 1997.

The movement toward compromise on the contentious issue of ICBM deployment has been tenuous and difficult. Congressional Democrats pounced on Chairman of the House Armed Services Committee (HASC) Rep. Les Aspin (D-Wis.) for failing to consult them. Secretary Cheney, in a move widely seen as an attempt to establish his authority but also as unjustified on its merits, strongly criticized Air Force Chief of Staff Gen. Larry Welch for "free-lancing" when General Welch canvassed members of Congress concerning an ICBM compromise. Defense Secretary Cheney then recommended that the Small ICBM be canceled due to fiscal constraints—the same position previously supported by the Air Force. President Bush then overruled the Secretary. Rep. Bill Dickinson of Alabama, the senior HASC Republican, originally opposed funding the SICBM unless the defense budget was increased, but now says he can live with the compromise so long as the Administration "hangs tough."

Bases to Close

The House of Representatives, by a vote of 381 to 43, defeated a bill that would have blocked the base actions recommended by the Commission on Base Realignment and Closure. The House vote means that five major Air Force bases—Chanute AFB, Norton AFB, George AFB, Mather AFB, and Pease AFB—will close. Closure would have been blocked if both the House and Senate rejected the Commission's recommendations.

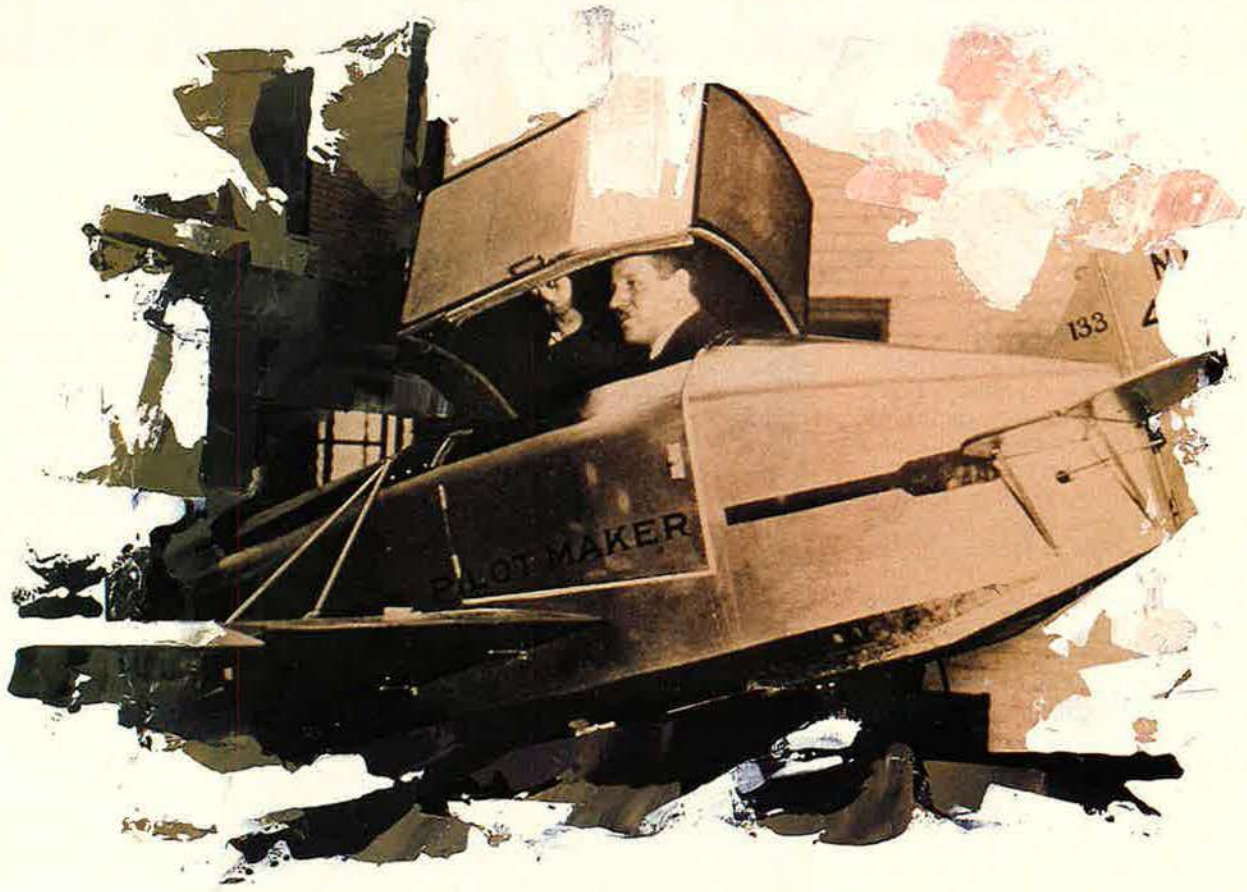
President Nixes Medicare Fix

President Bush has nixed a move to cut the special Medicare catastrophic illness "supplemental" premium. The Medicare Catastrophic Coverage Act of 1988 imposes an annual tax surcharge, up to a maximum of $1,050 per person in 1993, to finance federal insurance for the costs of catastrophic illness. The measure is unpopular among retired military people, who will pay the maximum surcharge. New figures show that the surtax will generate about $5 billion in excess reserve funds because the number of senior citizens who fall in the affected income brackets was underestimated.

President Bush, in a letter to Chairman of the House Ways and Means Committee Rep. Dan Rostenkowski (D-Ill.), said that it would be "imprudent to tinker with Medicare catastrophic insurance." While money in the account is available only for Medicare, the $5 billion surplus reserve has the effect of reducing the overall deficit.

Representative Rostenkowski supports the President's view. Sen. Lloyd Bentsen (D-Tex.), Chairman of the Senate Finance Committee, supports a reduction of the premiums. ■

The Best Deserve The Best



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Aerospace World

By Jeffrey P. Rhodes, AERONAUTICS EDITOR

Washington, D. C.

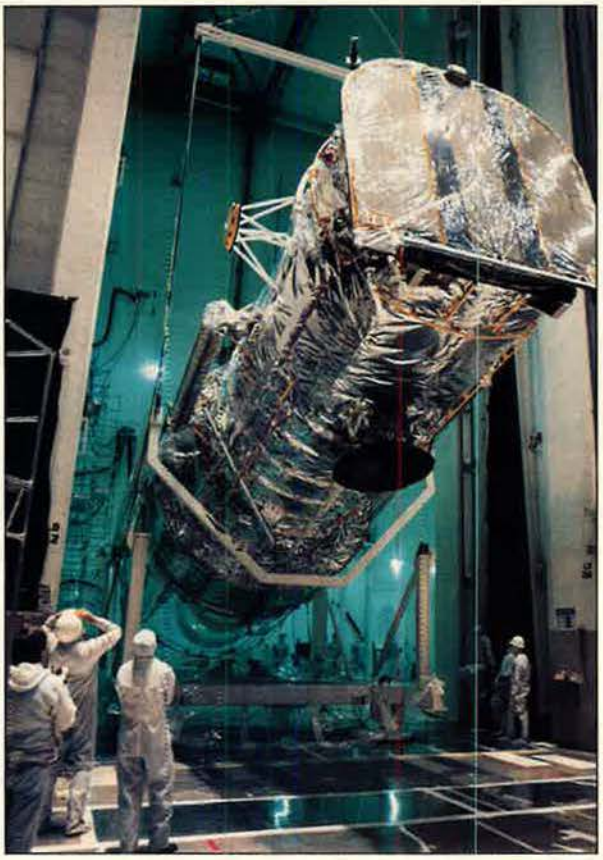
★ This year will be the National Aeronautics and Space Administration's biggest year of planetary exploration since the 1960s. The Magellan probe will map Venus, Galileo will orbit Jupiter, and—the crowning achievement—the Hubble Space Telescope (HST) may be able to look out to the beginning of time.

The heart of the HST is its 94.5-inch primary mirror and 12.2-inch secondary mirror. These will allow the telescope to see fourteen billion light-years into space. (Scientists believe the universe began eighteen billion years ago.) As a contrast, the human eye can see stars that are only six million light-years away, and ground telescopes can see stars two billion light-years away. The largest imperfection in the HST's mirrors is five microns. Perkin-Elmer Corp. in Danbury, Conn., made the telescope assembly.

The HST is now in final checkout at the Lockheed Missiles & Space Co. facility in Sunnyvale, Calif. The 43.5-foot-long, 25,200-pound telescope is scheduled to be launched this December. Originally scheduled for launch in October 1986, it was grounded along with the shuttle fleet in the wake of the *Challenger* disaster. The delay actually may have helped, as some of the electronics in the telescope have accumulated 10,000 to 15,000 hours of "burn-in" time, which should make them more reliable once in space.

The HST also carries five scientific instruments that are replaceable and serviceable in orbit. Four of the instruments—the Faint Object Camera, the Faint Object Spectrograph, the High-Resolution Spectrograph, and the High-Speed Photometer—receive light directly from the mirrors and are as big as telephone booths. The Wide Field/Planetary Camera mounted on the outer rim of the telescope will provide pictures of Saturn from a 320-nautical-mile earth orbit with resolution ten times greater than that beamed from Voyager-2, which flew by the planet.

The HST has only one multimission module. Everything else is operated by unique modules, so the loss of one system will degrade the effectiveness of the entire telescope only slightly. The HST is designed to have a five-year maintenance cycle and is to remain in orbit for fifteen years. The cost for the total Hubble Space Telescope program is around $1.7 billion.



Lockheed technicians lower the Hubble Space Telescope during a recent check at the company's Sunnyvale, Calif., plant. The large arch-shaped door at the end of the telescope will automatically close to protect sensitive instruments from too much direct light.

Lockheed has two major tests left to conduct on the telescope. The first is an optical throughput test to check the flow of light through the assembly. The second is an end-to-end test that will link the telescope, the Tracking and Data Relay Satellite System satellites now in orbit, and NASA's Goddard Spaceflight Center in Maryland. The HST will be shipped to the Kennedy Space Center in Florida in August via a modified Air Force C-5A. It will be put in the shuttle *Atlantis*'s payload bay only a week before the scheduled December 11 liftoff of STS-31.

★ The Strategic Defense Initiative Organization (SDIO), in cooperation with the Air Force, launched its third on-orbit experiment on March 24. The Delta Star payload was launched on a McDonnell Douglas Delta I booster (Delta 183) from Launch Complex 17 at Cape Canaveral AFS, Fla. This was Air Force Space Command's first launch for SDIO.

The $140 million Delta Star spacecraft will collect multispectral imagery of rocket plumes and of the near-earth and space environments. The 6,000-pound orbiting payload includes a laser radar ("ladar"), seven imaging sensors in the infrared, visible, and ultraviolet spectra, and a materials exposure experiment.

The spacecraft, designed by the Johns Hopkins University Applied Physics Laboratory, is expected to operate for up to nine months and will measure the booster plume charac-

teristics of a number of sounding rockets, space shuttle missions, Navy UGM-133A Trident II missiles, and Delta II, Titan 34D, and Titan IV boosters. The Delta Star spacecraft will also gather data on the aurora borealis.

The spacecraft missed observations of a de-orbit burn of the second stage of its Delta I launch vehicle because a protective cover on one of the sensors failed to open soon enough. Apart from that, the spacecraft is working well and is in a 270-nautical-mile circular orbit.

The first Delta series experiment, Delta 180, was launched in September 1986, conducted a series of critical space observations, and performed a space intercept. Delta 181 (February 1988) used sensing instruments to characterize test objects against a variety of space and earth backgrounds.

★ A thirty-four-year-old Lockheed U-2C ended its career on a high note on April 17 and 18 as two company pilots provisionally set sixteen time-to-climb and altitude records at the Dryden Flight Research Facility at Edwards AFB, Calif. The aircraft will now be retired to a museum at Robins AFB, Ga.

The aircraft (USAF serial number 56-6682) has been on loan to NASA since 1971. Based at NASA's Ames Research Center at NAS Moffett Field, Calif., the aircraft was used to gather atmospheric samples the day after Mt. St. Helens erupted in 1980 and to provide information for a damage assessment after the fires in Yellowstone National Park last summer. The aircraft accumulated a total of 8,680 hours of flight time, 5,300 hours at the hands of NASA pilots.

Pilot Jerry Hoyt set one unclaimed Class C-1.F record (jet aircraft weighing between 13,227 pounds and 19,841 pounds) and broke seven other marks in the same class previously held by a Learjet 28 pilot. The records set were: altitude without payload—73,700 feet; altitude in horizontal flight—73,700 feet; and time-to-climb records to 3,000 meters—0:52 minutes; 6,000 meters—1:46 minutes; 9,000 meters—2:48 minutes; 12,000 meters—4:14 minutes; 15,000 meters—6:15 minutes; and 20,000 meters—12:13 minutes. The last record was previously unclaimed.

Pilot Ron Williams broke seven Class C-1.G records (jet aircraft weighing between 19,841 pounds and 26,455 pounds) previously held by a Canadair Challenger crew (four records) and Falcon 900 crew (the remaining three marks). Mr. Williams also set an unclaimed record. The records set are: altitude without payload—72,720 feet; altitude in horizontal flight—72,720 feet; and time-to-climb records to 3,000 meters—1:10 minutes; 6,000 meters—2:14 minutes; 9,000 meters—3:31 minutes; 12,000 meters—5:11 minutes; 15,000 meters—8:10 minutes; and 20,000 meters—19:41 minutes. The last mark was previously unclaimed.

All of the records will have to be certified by the National Aeronautic Association (NAA), the official sanctioning body for record attempts in the US. The Paris-based Fédération Aéronautique Internationale (FAI), of which the US is a member, will certify the records as world marks.

Lockheed pilots Jerry Hoyt and Ron Williams set sixteen world records over Edwards AFB, Calif., in this thirty-four-year-old Lockheed U-2C. The aircraft, lent by USAF to NASA in 1971, is about to retire to a museum. Its NASA successor is an upgraded U-2 called an ER-1.

★ **APPOINTED—Dr. Donald B. Rice,** the chief executive officer of the Rand Corp., was nominated to be the seventeenth full-time **Secretary of the Air Force** on April 3. Dr. Rice previously served as a cost analyst at the Pentagon and at the White House Office of Management and Budget. He has also served as an advisor to the Office of Technical Assessment and a member of the Defense Science Board. Dr. Rice earned his bachelor's degree in chemical engineering from Notre Dame University in 1961 and his doctorate in economics from Purdue University in 1965. He will be fifty on June 4.

Rear Adm. Richard H. Truly, currently NASA's Deputy Administrator for Spaceflight, was nominated to **head the space agency** on April 12. Admiral Truly joined NASA in 1969. He served as pilot on STS-2 in 1981 and commander of STS-8 in 1983. He is credited with returning the space shuttle program to working order after the *Challenger* accident. Admiral Truly, fifty-two, will have to resign his commission and defer his pension until his tenure with NASA is over.

Another person who will have to resign his commission is **Adm. James B. Busey IV,** who has been nominated to be the **new head of the Federal Aviation Administration.** Admiral Busey, who holds the Navy Cross, is currently Commander in Chief of US Naval Forces in Europe. He is a past Vice Chief of Naval Operations and also past director of Naval Air Systems Command. He is fifty-six.

William H. Taft IV, Deputy Secretary of Defense from 1984 until early April, has been nominated as the **new US Ambassador to NATO.** He served as acting secretary of defense until Secretary Dick Cheney was confirmed earlier this year. Mr. Taft held a number of positions in government prior to coming to the Department of Defense. Mr. Taft, forty-four, is a 1969 graduate of Harvard Law School.

★ **HONORS**—The **Harmon Trophy,** awarded more or less yearly for outstanding international achievements

in aeronautics, was presented to six people in ceremonies on April 3. Astronaut **Vance Brand** was cited for commanding the first operational space shuttle mission (STS-5) in 1982, while astronaut **Paul Weitz** was recognized for setting a spaceship on-time performance record during STS-6, the maiden voyage of *Challenger* in 1983. **Stephanie Shinn** and **John Petrehn** were cited for setting records in balloons. Ms. Shinn was thirteen at the time of her flight. **Donald Taylor** and **Brooke Knapp** were recognized for their accomplishments as pilots.

Maj. Antonia M. Scialdo, clinical branch chief of ambulatory services at the Thirteenth Air Force Medical Center at Clark AB, the Philippines, has been selected as **Air Force nurse of the year** for 1988. Major Scialdo supervises the outpatient clinics and also teaches patients about better health care. The fourteen-year Air Force veteran made nearly 3,600 house calls last year.

Capt. Paul D. Huling recently received one of the most prestigious space awards—**the Silver Snoopy.** Given by the astronauts themselves, the Silver Snoopy has been awarded to a small number of individuals who have made outstanding contributions to the success of manned spaceflight. Captain Huling, Fighter Engine and NASA Program Manager at the Air Force Plant Representative Office at Pratt & Whitney's facility in West Palm Beach, Fla., was cited for his work on the space shuttle main engine alternate turbopump development program.

The maintenance complex of the **363d Tactical Fighter Wing** at Shaw AFB, S. C., has been named the **Daedalian Maintenance Award winner for 1988.** The award recognizes the outstanding Air Force maintenance organization for the previous fiscal year. The award has been presented since 1974 by the Order of the Daedalians, an organization founded by World War I pilots.

Time marches on. On April 3, Mr. Air Force himself, **Col. Steve Canyon,** the cartoon character created by the late Milton Caniff, **was "retired"** in a ceremony at the Milton Caniff Research Room of Ohio State's Library for Communications and Graphic Arts. A group at McGuire AFB, N. J., spent five months creating retired ID cards, updating flight and personal records for Colonel Canyon, and even completing his Servicemen's Group Life Insurance forms. These memorabilia were then presented to the library at OSU, Mr. Caniff's alma mater. Records after 1984 were incomplete, so the McGuire group assigned Colonel Canyon to the wing's 18th Military Airlift Squadron as a C-141 instructor pilot. The Air Force donated Mr. Caniff's papers and many original comic strips to the library.

Using a three-dimensional electronic database, Northrop has eliminated "soft" (preproduction) tooling for the B-2 strategic bomber and is building the aircraft on "hard" or production tooling at Air Force Plant 42 in Palmdale, Calif. The mats and plastic wrap protect the B-2's composite skin during production.

★ **PURCHASES**—On April 21, NASA selected the team of **Lockheed and Aerojet to develop and produce the Advanced Solid-Rocket Motor** (ASRM) for the space shuttle. ASRMs will replace the redesigned solid rocket boosters now used. The ASRMs will allow NASA to add 12,000 pounds of payload per flight, thus achieving the shuttle goal of 65,000 pounds to orbit. The overall cost of design and development, including the cost of motors for six shuttle flights, is estimated at just under $1 billion. Facility costs are estimated to be another $200 million to $300 million. The ASRMs will be built at a new plant at Yellow Creek, Miss. Lockheed is the prime contractor, and Aerojet is the production subcontractor.

Hughes will build fifty-nine percent of the Air Force's **FY '89 buy of** AGM-65D and G **Maverick** air-to-ground tactical **missiles.** Hughes received $170.9 million for 2,304 missiles, broken down into 1,692 for the Air Force and 612 for Foreign Military Sales (FMS) customers. **Raytheon,** the second-source manufacturer, **received $134.8 million for 1,601 missiles**—1,176 for the Air Force and 425 for FMS. This was the third annual competitive Maverick buy.

The Army Tank Automotive Command awarded a **$12.5 million letter contract to General Dynamics** on April 5 **for manufacturing technical assistance to Egypt for M1A1 tank coproduction.** The Egyptians, who plan to buy more than 500 of the Abrams tanks, will start out building M1A1s from parts and will eventually manufacture components and assemblies that contain no classified technologies. The US Army will not buy any Egyptian-made tanks, and Egyptian M1 sales to third parties will be restricted unless the US approves the sale.

★ **DELIVERIES**—The **fiftieth and last Lockheed C-5B Galaxy was delivered to the Air Force** in ceremonies at the company's plant in Marietta, Ga., on April 17. Gen. Duane Cassidy, Commander in Chief of US Transportation Command and Military Airlift Command, accepted the aircraft and flew it to Dover AFB, Del., home of the 436th Military Airlift Wing. As a result of a lower inflation rate and a renegotiation of the cost of the last twenty-one aircraft, the C-5B fleet cost $6.7 billion, a $1.1 billion savings over the original contract price. Deliv-

eries began in 1986, and since then the C-5B fleet has logged more than 46,000 flying hours.

The first **six** of fifteen Soviet **Sukhoi Su-24D fighters were delivered to Libya** in March. The all-weather "Fencer-Ds" have provisions for air refueling and have a range of 805 miles. Therefore, with drop tanks or aerial tankers (which Libya doesn't have yet), the fighters could hold at risk targets in Israel, Chad, or Italy (home of the US Sixth Fleet). The Soviets say the deal was made in 1986, before they decided to curtail involvement in regional conflicts.

Fairchild delivered the first of ten **C-26A** operational support turboprop aircraft **to the Air National Guard** on March 30. The C-26As, a military version of the eighteen-passenger Metro III commuter airliner, will replace C-131s currently used as support aircraft. The remaining C-26s, which can be configured for carrying cargo or litters, are to be delivered by November. The C-26As were acquired under a $33.7 million contract that includes contractor logistics support and an option for three additional aircraft. The first C-26A will be assigned to the 147th Fighter Interceptor Group at Ellington ANGB, Tex.

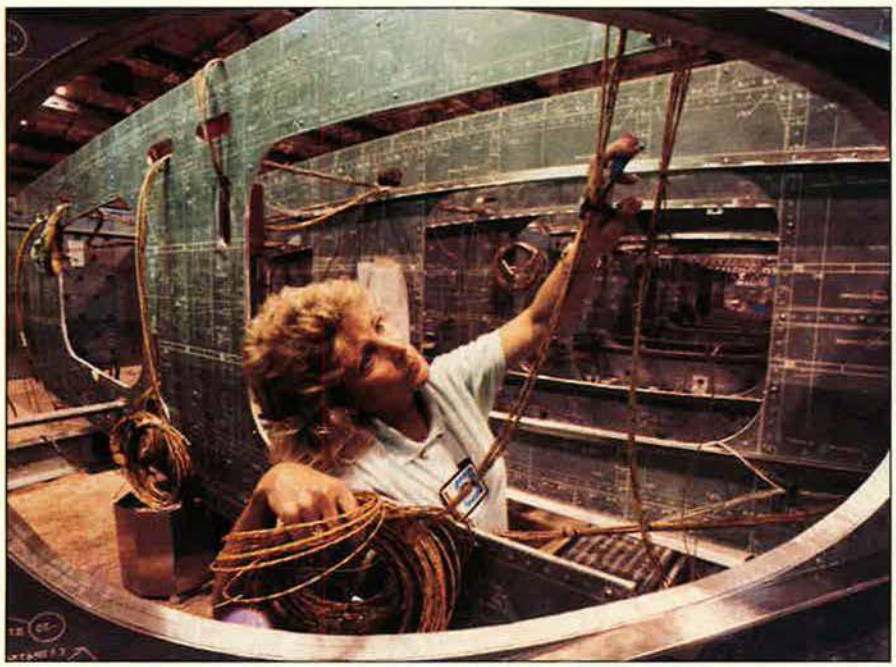
The Smithsonian's **National Air and Space Museum recently received a historic Lockheed C-130A and a commitment for a supersonic Concorde.** The C-130A (serial number 57-0460) was used to airlift 350 Vietnamese civilians (nearly four times the plane's rated capacity) from Da Nang to Saigon during the last days of the Republic of South Vietnam. The aircraft was the 167th C-130 built and has served with the US and South Vietnamese Air Forces, an Air National Guard unit, and an Air Force Reserve unit. On April 16, Air France announced that it would give the Museum a British/French Concorde, the only supersonic commercial transport flying, in the late 1990s when the 100-passenger aircraft is retired. The delay works out well, as the Museum has no place now to store or display the aircraft.

The last of fifty Lockheed C-5B Galaxy transports was delivered to the Air Force on April 17. The new C-5s have been averaging thirty maintenance man-hours per flight hour, well below the specified forty. Program responsibility for the C-5B has shifted from AFSC's Aeronautical Systems Division to AFLC.

★ **MILESTONES**—A Rockwell **B-1B bomber** on a March 23 training flight became the **first** of its type **to pass the 1,000-flight-hour plateau.** The aircraft (serial number 85-0072) is assigned to the 96th Bomb Wing at Dyess AFB, Tex. In 1986, the aircraft became the first B-1B to fly over the North Pole (after which it was nicknamed *Polarized*) and was later the first B-1B to perform navigation tests over the Pacific.

NASA completed flight tests of the Mission Adaptive Wing (MAW) on March 21. For the MAW program, the Advanced Fighter Technology Integration (AFTI) F-111's right wing was modified so that the curvature of the leading and trailing edges could be varied in flight. Reductions in air drag from eight percent to twenty percent were recorded, the airplane's handling qualities improved, and there was a significant delay in the onset of buffet around the wing. The MAW had no failures during 144.9 flight hours on fifty-nine flights. During the final phase of testing, the wing was operated in the automatic mode. The aircraft is now in flyable storage at NASA's Dryden Flight Research Facility at Edwards AFB, Calif.

The **Air Force carried out the eighteenth consecutive successful test flight of** the LGM-118A **Peacekeeper** intercontinental ballistic missile on March 19. The missile was launched from Vandenberg AFB, Calif., on command from an Airborne Launch Control Center, and it flew the 4,100 miles to the Army's Kwajalein Missile Test



A worker at LTV's plant in Dallas, Tex., installs wire routing on the McDonnell Douglas C-17 airlifter's vertical stabilizer development fixture. The horizontal and vertical stabilizer development fixtures aid in routing all plumbing and wiring for hydraulic, electrical, and flight controls.

June Anniversaries

- *June 28, 1914:* Archduke Franz Ferdinand of Austria-Hungary is assassinated in Sarajevo, Bosnia (now Yugoslavia), providing the catalyst for World War I.
- *June 14–15, 1919:* Royal Air Force Capt. John Alcock and Lt. Arthur Whitten Brown make the first nonstop crossing of the Atlantic, going from St. John's, Newfoundland, to Clifden, Ireland, in a Vickers Vimy. The 1,960-mile trip takes sixteen hours and twelve minutes.
- *June 4, 1924:* The three Douglas World Cruiser crews *(see April and May Anniversaries)* reach Shanghai, China. Not knowing how much room the pontoon-equipped World Cruisers will need to land, the Shanghai harbormaster clears several miles of waterway of all fishing boats.
- *June 18, 1934:* Boeing begins company-funded design work on the Model 299, which would become the B-17.
- *June 20, 1939:* The German Heinkel He-176, the world's first aircraft to have a throttle-controlled liquid-fuel rocket engine, makes its first flight at Peenemünde with Erich Warsitz at the controls.
- *June 6, 1944:* Allied aircraft fly approximately 15,000 sorties in support of Operation Overlord, the D-Day landings at Normandy beaches. Later in the month (date uncertain), the Army Air Forces reaches a peak of 78,757 aircraft.
- *June 2, 1949:* Gen. H. H. "Hap" Arnold is given the permanent rank of General of the Air Force by a special act of Congress.
- *June 22, 1954:* The Douglas A4D (A-4) Skyhawk makes its first flight from Edwards AFB, Calif., with company pilot Robert Rahn at the controls. (Thirty-five years and 2,960 aircraft later, "Scooters" are still flying with the Navy as training aircraft and with several foreign countries as front-line equipment.)
- *June 3, 1959:* The first class of 207 cadets graduates from the Air Force Academy.
- *June 8, 1959:* After several tries, North American Aviation pilot Scott Crossfield makes the first nonpowered flight in the X-15. Also on this date, mail is carried by missile for the first time as 3,000 letters are delivered to NAS Mayport, Fla., in a Vought RGM-6 Regulus I launched from a submarine.
- *June 4, 1969:* The Air Force Air Demonstration Squadron, the Thunderbirds, fly their first show in their new McDonnell Douglas F-4E Phantom IIs.
- *June 12, 1979:* Pilot/cyclist Bryan Allen makes the first human-powered flight across the English Channel in the transparent *Gossamer Albatross.*

At the end of the latest test, four unarmed LGM-118A Peacekeeper ICBM Mk. 21 reentry vehicles streak down to a target area in the Army's Kwajalein Missile Test Range in the Pacific. The missile also carried three other inert warheads that came down in another target zone.

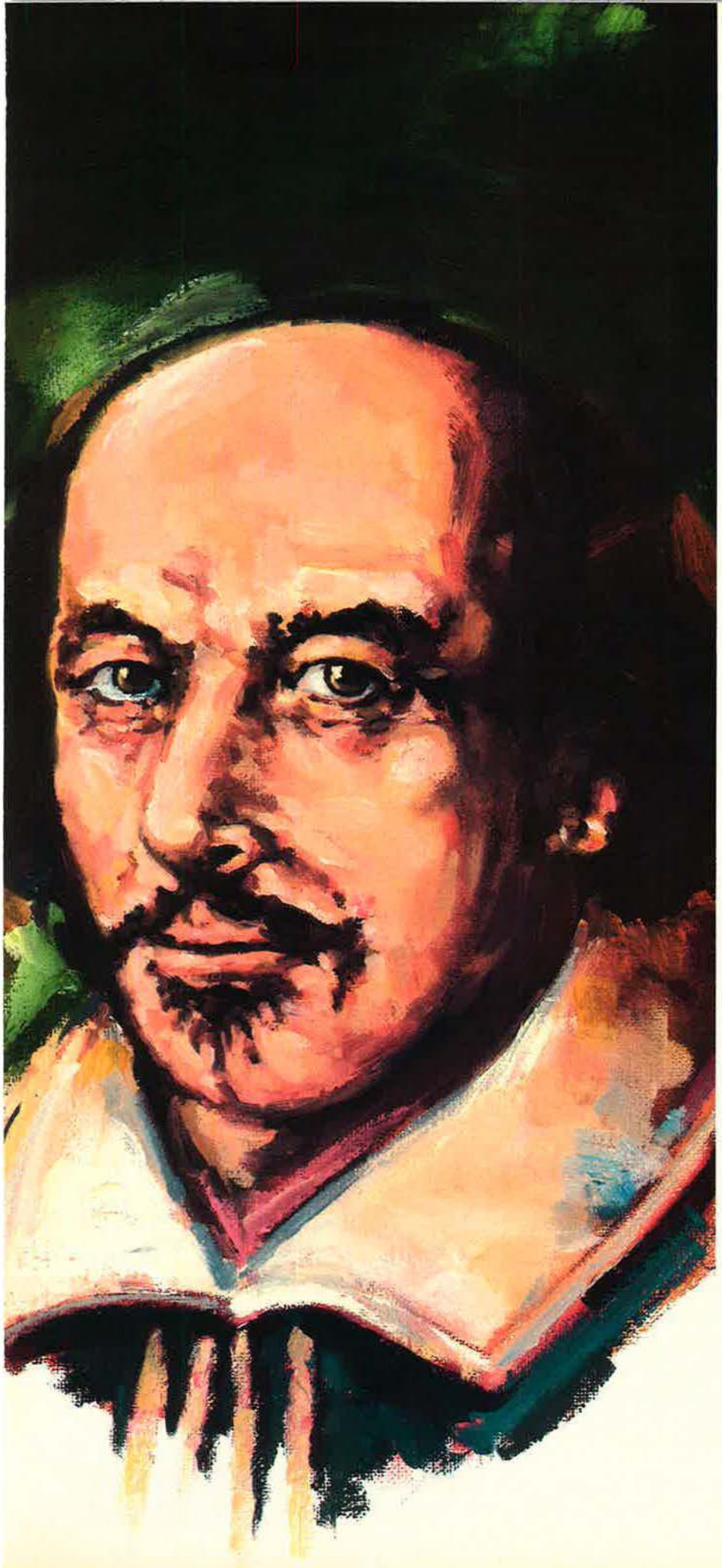
Range in the Pacific in about thirty minutes. The missile carried seven unarmed Mk. 21 reentry vehicles to two target areas. In other news, the fiftieth and last LGM-118 was placed in a modified Minuteman III silo at F. E. Warren AFB, Wyo., earlier this year.

Military Airlift Command's fleet of 266 Lockheed **C-141B StarLifters recently passed the 8,000,000-flight-hour mark.** This total flight time is equivalent to more than 8,000 C-141B round trips to the moon, or about four billion miles. MAC began operations with the C-141A in April 1965, and the aircraft were modified to the B-model standard between 1979 and 1982. Four C-141As are used by Air Force Systems Command's Aeronautical Systems Division at Wright-Patterson AFB, Ohio, as test aircraft.

The Strategic Defense Initiative Organization **(SDIO) successfully carried out the first test of the Alpha Laser** in a laboratory at TRW's facility in San Juan Capistrano, Calif., on April 10. The laser runs on a combination of hydrogen and fluorine and has a 2.7 micron wavelength. It was not brought up to full power (exact figures are classified) during the one-fifth-of-a-second test. The test came fifteen months later than expected because of technical problems and a fire in the laboratory. The Alpha Laser is a key element of the Zenith Star experiment that SDIO is planning to conduct around 1994.

On March 9, **five** of the Royal Air Force's six **Avro Shackleton AEW Mk. 2 aircraft flew to their birthplace,** the British Aerospace factory at Woodford, **to mark the fortieth anniversary of the Shackleton prototype's first flight.** Relatives of the World War II Lancaster bomber, the Shackletons are flown by No. 8 Squadron in the airborne early warning role. The flight leader's aircraft has 14,960 hours on it, and the youngest aircraft has 13,676 hours. The "Shacks" will be flown by No. 8 Squadron until 1991, when they will be replaced by seven Boeing Sentry Mk. 1 (E-3D) aircraft.

★ **NEWS NOTES**—The Bell-Boeing **V-22 Osprey prototype completed the first phase of its 4,000-hour test program much more quickly than had been anticipated.** The original schedule was to have been completed in four hours, but the prototype tilt-rotor completed it in just 2.3 hours on nine flights as of April 20. The prototype is now in a six-week scheduled downtime to completely inspect the prop-rotor gear box drive system and to calibrate test equipment. The next



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■ EXCELLENCE IN ELECTRONICS

phase of the flight-test program will include the first conversion from helicopter to airplane mode. This phase will last twenty-four weeks.

The results of a recent Department of Defense survey show that **heavy alcohol and drug use have continued to decline in the military.** Figures for both drug and alcohol use are now the lowest they've been since the survey series began in 1980. The portion of military personnel using any drug declined from 27.6 percent in 1980 to 4.8 percent in 1988. Marijuana use declined from 6.5 percent in 1980 to 2.9 percent in 1988. Cigarette smoking and use of other tobacco products dropped from 51.0 percent in 1980 to 40.9 percent in 1988. The most recent survey shows that 47.7 percent of enlisted personnel smoke while only eighteen percent of officers smoke. Twenty-four percent of military personnel smoke cigars or pipes, and 17.3 percent use smokeless tobacco. The percentage of pipe and cigar smokers remained relatively stable from 1980 to 1988, but smokeless tobacco use has fallen from 1985 to 1988.

A Lockheed **SR-71A** reconnaissance aircraft on a classified mission **crashed into the South China Sea** off Luzon island in the Philippines on April 20. Both crewmen ejected safely and were taken to Clark AB, the Philippines. The crew, assigned to the 9th Strategic Reconnaissance Wing at Beale AFB, Calif., on rotational duty to Kadena AB, Japan, experienced engine failure shortly after takeoff. The wreckage had been located but not yet recovered as of this writing. This was reportedly the first SR-71 to be lost in seventeen years. The SR-71 fleet is scheduled to be retired this fall.

US Southern Command headquarters, now at Howard AFB, Panama, announced on April 22 that it **will be moving to the continental US** well before the expiration of the Panama Canal Treaty on December 31, 1999. Seven bases—Fort Polk, England AFB, and NAS New Orleans in Louisiana; Patrick and MacDill AFBs in Florida; and Brooks AFB and Fort Sam Houston in Texas—have been proposed as relocation sites for the command headquarters. The relocation is part of a phased military withdrawal from Panama.

The **full-scale development program for** the Hughes/Raytheon AIM-120A Advanced Medium-Range Air-to-Air Missile **(AMRAAM) was completed** earlier this year. Here are the final numbers: ninety-five missiles were launched, sixty-eight from Air Force F-15s and F-16s and twenty-seven from Navy F-14s and F/A-18s. Seventy-five AMRAAMs were launched for score, and fifty-eight were successful for an average of 77.3 percent. Nineteen of the shots were direct hits. This fall, the 33d Tactical Fighter Wing at Eglin AFB, Fla., will be the first operational unit to receive the twelve-foot-long missiles. The Navy will receive its first AMRAAMs, which have a range of about thirty miles, in 1992.

In another missile note, the Rockwell **AGM-130A rocket-powered**

Senior Staff Changes

PROMOTION: To be **Lieutenant General:** James S. **Cassity,** Jr.

RETIREMENTS: B/G Rufus M. **DeHart,** Jr.; M/G William L. **Doyle,** Jr.; M/G Ralph E. **Spraker.**

CHANGES: M/G Joseph W. Ashy, from Cmdr., USAFTFWC, TAC, Nellis AFB, Nev., to DCS/Ops., and Dep. Dir., Ops., TACOS, Hq. TAC, Langley AFB, Va., replacing M/G William K. James . . . **M/G George L. Butler,** from Vice Dir., Strat. P&P, J-5, OJCS, Washington, D. C., to Dir., Strat. P&P, J-5, OJCS, Washington, D. C. . . . **M/G (L/G selectee) James S. Cassity, Jr.,** from Cmdr., Hq. AFCC, Scott AFB, Ill., to Dir., C^3 systems, J-6, OJCS, Washington, D. C. . . . **M/G James R. Clapper, Jr.,** from Dir., Intel., J-2, Hq. PACOM, Camp Smith, Hawaii, to DCS/Intel., Hq. SAC, Offutt AFB, Neb., replacing retired M/G William L. Doyle, Jr. . . . **Col. (B/G selectee) Roscoe M. Cougill,** from Dep. ACS/C^3 and Computer Systems, Hq. USAF, Washington, D. C., to Dir., C^3, J-6, Hq. USCENTCOM, MacDill AFB, Fla., replacing B/G Albert J. Edmonds . . . **Col. (B/G selectee) William B. Davitte,** from Exec. Officer to CINC, Hq. SAC, Offutt AFB, Neb., to Spec. Ass't to Ass't Sec'y of the Air Force for Acq., for Strat. Modernization, Hq. USAF, Washington, D. C. . . . **Col. (B/G selectee) William M. Douglass,** from Cmdr., 48th TFW, USAFE, RAF Lakenheath, UK, to Vice Cmdr., Warner Robins ALC, AFLC, Robins AFB, Ga., replacing B/G Richard C. Milnes II . . . **B/G Albert J. Edmonds,** from Dir., C^3, J-6, Hq. USCENTCOM, MacDill AFB, Fla., to ACS/C^3 and Computer Systems, Hq. USAF, Washington, D. C., replacing M/G Robert H. Ludwig.

M/G Eugene H. Fischer, from Dep. CINC, Hq. USSOUTHCOM, Howard AFB, Panama, to Ass't DCS/P&R, Hq. USAF, Washington, D. C., replacing M/G David M. Goodrich . . . **M/G David M. Goodrich,** from Ass't DCS/P&R, Hq. USAF, Washington, D. C., to Cmdt., Ind. College of the Armed Forces, Ft. McNair, Washington, D. C. . . . **Col. (B/G selectee) Ronald D. Gray,** from Cmdr., 1st Space Wg., Hq. AFSPACECOM, Peterson AFB, Colo., to DCS/Ops., Hq. AFSPACECOM, Peterson AFB, Colo., replacing B/G Jay W. Kelley . . . **Col. (B/G selectee) Thomas R. Griffith,** from Chief, Joint Ops. Div., J-3, OJCS, Washington, D. C., to Dep. Dir., Ops., NMCC, J-3, OJCS, Washington, D. C., replacing B/G Antonio Maldonado . . . **Col. (B/G selectee) Patricia A. Hinneburg,** from Dir., Maintenance, Warner Robins ALC, AFLC, Robins AFB, Ga., to DCS/Maintenance, Hq. AFLC, Wright-Patterson AFB, Ohio, replacing B/G (M/G selectee) John M. Nowak . . . **B/G Grover E. Jackson,** from Vice Dir., Joint Spec. Studies Gp., NSA, Ft. Meade, Md., to Dir., Intel., J-2, Hq. PACOM, Camp Smith, Hawaii, replacing M/G James R. Clapper, Jr. . . . **M/G William K. James,** from DCS/Ops., and Dep. Dir., TACOS, Hq. TAC, Langley AFB, Va., to Dep. CINC, Hq. USSOUTHCOM, Howard AFB, Panama, replacing M/G Eugene H. Fischer . . . **B/G Jay W. Kelley,** from DCS/Ops., Hq. AFSPACECOM, Peterson AFB, Colo., to DCS/Plans, Hq. AFSPACECOM, Peterson AFB, Colo., replacing M/G Gaylord W. Clark.

M/G Robert H. Ludwig, from ACS/C^3 and Computer Systems, Hq. USAF, Washington, D. C., to Cmdr., Hq. AFCC, Scott AFB, Ill., replacing M/G (L/G selectee) James S. Cassity, Jr. . . . **B/G Antonio Maldonado,** from Dep. Dir., Ops., NMCC, J-3, OJCS, Washington, D. C., to Chief, JUSMG/MAAG, Madrid, Spain . . . **B/G (M/G selectee) Billy G. McCoy,** from DCS/Ops., 2d ATAF, AFCENT, Rheindahlen, Germany, to Cmdr., USAFTFWC, TAC, Nellis AFB, Nev., replacing M/G Joseph W. Ashy . . . **M/G Gary H. Mears,** from DCS/Log., Hq. MAC, Scott AFB, Ill., to Vice Dir., J-4, and Dep. Dir., Strat. Mobility and Resources, J-4, OJCS, Washington, D. C. . . . **B/G (M/G selectee) John M. Nowak,** from DCS/Maintenance, Hq. AFLC, Wright-Patterson AFB, Ohio, to DCS/Log., Hq. MAC, Scott AFB, Ill., replacing M/G Gary H. Mears . . . **B/G (M/G selectee) David C. Reed,** from Comdt., Air Cmd. & Staff College, Hq. AU, Maxwell AFB, Ala., to Cmdt., AWC, and Vice Cmdr., Hq. AU, Maxwell AFB, Ala., replacing M/G Harold W. Todd . . . **Col. (B/G selectee) Frederick A. Zehrer III,** from Cmdr., Eur. Communications Div., AFCC, and DCS/Communications-Computer Systems, USAFE, and Spec. Ass't to Cmdr., AAFCE, for Communications-Computer Systems, NATO, Kapaun Adm. Annex, Germany, to Vice Cmdr., Hq. AFCC, Scott AFB, Ill., replacing retiring B/G Wayne E. Schramm.

SENIOR EXECUTIVE SERVICE (SES) CHANGES: Donna J. Back, to Dep. Comp., Hq. ASD, AFSC, Wright-Patterson AFB, Ohio, replacing Charles Adams . . . **Stephen L. Davis,** to Dep. Dir., C&M, Warner Robins ALC, AFLC, Robins AFB, Ga., replacing William D. Ernst . . . **Diann L. McCoy,** to Ass't Dep. to Cmdr. for Int'l Log., Int'l Log. Ctr., Hq. AFLC, Wright-Patterson AFB, Ohio, replacing Roger M. Darnell . . . **Richard F. Shomper,** to Ass't DCS/C&M, Hq. AFLC, Wright-Patterson AFB, Ohio, replacing James Barone . . . **Phillip W. Steely,** to Dep. Dir., C&M, San Antonio ALC, AFLC, Kelly AFB, Tex., replacing Robert L. Blocker, Jr. . . . **Dr. Richard R. Weiss,** to Dir., Air Force Astronautics Lab, Space Div., AFSC, Edwards AFB, Calif. . . . **Gerald L. Yanker,** to Ass't Dep. for Aeronautical Prgms., AFALC, Hq. AFLC, Wright-Patterson AFB, Ohio, replacing Philip Panzarella. ■

glide bomb recorded its fifth consecutive success in a test at the Naval Weapons Center at China Lake, Calif., on March 17. The missile was launched from an F-111F at 500 feet above ground level. It climbed, descended, and was then manually guided to a direct hit on a billboard target fourteen miles from and 100 feet higher than the launch point. The AGM-130 will have one more developmental launch and will then undergo nine operational test launches.

If a one-year field trial now taking place is successful, all of NATO's ground vehicles may run on the same fuel as the organization's airplanes. The field trial is being conducted at Fort Bliss, Tex., by the Army's Belvoir Fuels and Lubricants Research Facility at the Southwest Research Institute in San Antonio, Tex. The goal is to see if NATO ground vehicles now using diesel fuel will work using JP-8, a jet engine fuel. Approximately 3,800 vehicles are being tested, and the results so far are promising. JP-8 is a kerosene-based fuel that is more refined and burns more completely than diesel fuel. JP-8 also does not have to be tailored for regional use as diesel fuel does. JP-8 can be pumped directly into a diesel engine, and it is very similar to the Jet A-1 fuel used in commercial aircraft. If the results prove conclusive, JP-8 will be the standard fuel for NATO ground forces by FY '91.

Eight officers currently assigned to the 90th Strategic Missile Wing at F. E. Warren AFB, Wyo., are second-generation missileers. The father-son combinations are: retired Lt. Col. Bruce Curington (Minuteman I at Grand Forks AFB, N. D.) and 1st Lt. Dale Curington (Minuteman III at Warren); retired Lt. Col. Donald Avance and retired Col. John Bacs (Titan II at McConnell AFB, Kan., and Davis-Monthan AFB, Ariz., respectively) and Capt. Derek Avance and 2d Lt. Steven Bacs (both Minuteman III at Warren); retired Col. Richard Schoonmaker (Titan II at Vandenberg AFB, Calif.) and retired Col. Paul Murphy (Minuteman I at Whiteman AFB, Mo.) and 2d Lts. Richard Schoonmaker and Richard Murphy (both Peacekeeper at Warren); retired Col. Joseph Kinnan (Atlas at Walker AFB, N. M.) and 1st Lt. Christopher Kinnan (now performing Peacekeeper instruction and evaluation after Minuteman III crew duty); then-Maj. Phillip Moore (Commander of the 321st Strategic Missile Squadron at Warren) and 2d Lt. Steven Moore (Minuteman III with the 321st SMS). Dinner conversation must sometimes be boring for Mrs. Beverly Burchfield as her son, Richard, is a second lieutenant with the 90th SMW's standardization and evaluation section, and her husband, Edward, is a colonel commanding the 341st SMW at Malmstrom AFB, Mont.

★ **DIED**—Retired Air Force **Gen. Richard H. Ellis,** Commander in Chief of Strategic Air Command from 1977 to 1981, of cancer on March 28 at Malcolm Grow Medical Center at Andrews AFB, Md. He was sixty-nine. General Ellis flew more than 200 combat missions in the Western Pacific during World War II. Recalled to active duty in 1950 after earning a law degree, he later served as Ninth Air Force Commander, Vice Chief of Staff of the Air Force, and Commander in Chief of US Air Forces in Europe before being named CINCSAC. After retirement in 1982, General Ellis was appointed US Commissioner on the US-USSR Standing Consultative Committee, which meets to discuss problems arising from arms-control agreements.

Retired Air Force **Maj. Gen. Matthew K. Deichelmann,** the first commandant of Air Force Reserve Officer Training Corps, of unreported causes in a hospital in Montgomery, Ala. He was eighty-three. Commissioned as a second lieutenant in the Coast Artillery Corps in 1927, he transferred to the Air Force in 1947. He served as AFROTC commandant from 1952 to 1956, during which time more than 47,000 cadets were commissioned through ROTC, the most in Air Force history. He later served as a senior member of the United Nations Military Armistice Commission in Panmunjom, Korea. ■

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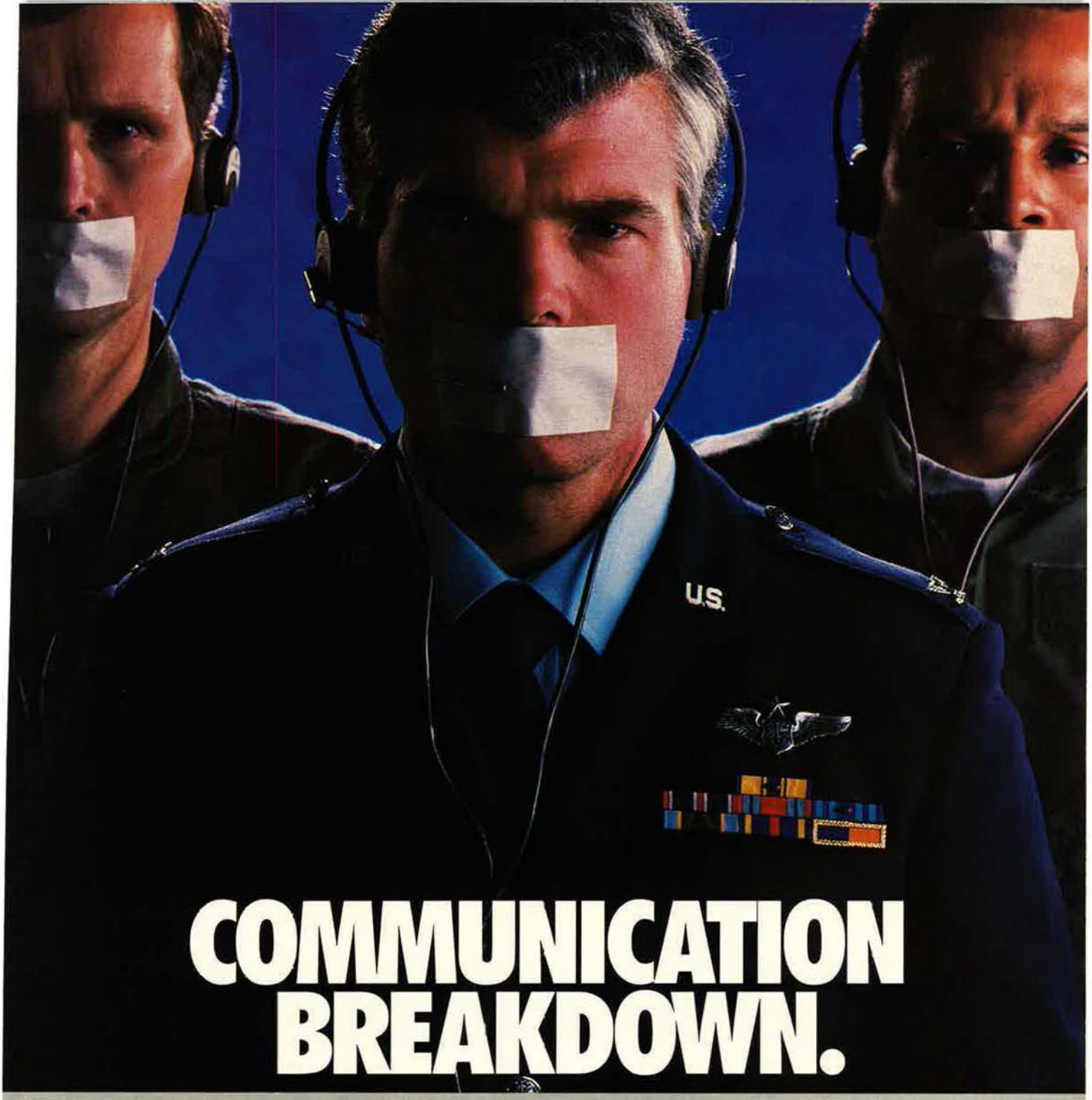

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In test flights, the airborne radar scanned a broad sweep around Cocoa Beach and picked out cars moving along the causeway.

The Battle Vision of Joint STARS

BY ROBERT S. DUDNEY
EXECUTIVE EDITOR

AN exotic radar aircraft now beginning to take shape has rekindled confidence that Air Force technologists will be able to meet one of their most formidable challenges in years.

The team developing the Joint Surveillance Target Attack Radar System is no longer a struggling group plagued by setbacks, as in times past. Joint STARS developers have been staging a comeback for months.

Now, say officers, the technologists seem likely to succeed in producing the plane that Washington wants to provide big-picture radar coverage of a ground war in Europe. The E-8A will be the key sensor in a new plan to locate and attack onrushing Soviet armor. The team run by Electronic Systems Division (ESD) at Hanscom AFB, Mass., overseer of the $6.6 billion program, is strengthened by several factors.

These include breakthroughs in operation of the plane's ultracomplex, steerable, multimode radar; completion of the communications, navigation, and data-link systems; verification of the test vehicle's airworthiness; establishment

of a workable systems architecture; and the first production of vital operations and control software.

No one is complacent, but officers are optimistic they can meet next year's goals of completing development testing and a system-level performance verification of prime contractor Grumman's total product. "We could still fail," says Col. John Colligan, the program director. "But the chances of failure are a lot less than [they were] a year ago."

Washington, too, evidently regards the Joint STARS craft as a going concern. The Pentagon has given USAF authorization to develop an electronic-warfare suite for self-defense, expand force structure from ten to twenty-two airplanes, procure new airframes rather than used Boeing 707s, and provide mission simulators—all expensive propositions.

Effects of recent radar breakthroughs are most evident in the sharp pointing accuracy and precise beam-formation properties that are now being displayed by the first test airplane's ultrasophisticated electronic sensor.

In a series of tests starting last December 22, the 1,700-pound X-band radar slung under the aircraft has shown its capability to focus intently on a single spot on the ground and propagate beams of carefully modulated intensity and shape. The upshot of the tests is summarized by Colonel Colligan:

"Did we prove that a lot of the tough things we wanted to do have now been done? Yep. Sure did. Will we be able to do the job? Yes. From the 'does it work?' standpoint, yes, we can make this radar work."

The side-looking radar, built by Norden Systems, can be operated either in a Doppler mode to detect moving targets or in a synthetic aperture radar mode to see stationary features. Standing off behind the Forward Line of Troops (FLOT), the E-8A radar will be able to scan deep into enemy areas in search of enemy ground activity.

The radar antenna is a large, complex device, steered in two ways. First, mechanical means are used to set the beam's elevation—the point at which it strikes the earth. Secondly, the beam is scanned by electronic means in azimuth. The electronic scanning is carried out by a set of software-controlled phase-shifters in the antenna, and the operation requires complex and precisely timed software instructions. Making sure that the mechanical and electronic operations work together creates an even greater software challenge.

Meeting the Challenges

The Air Force is now confident that it has met those software challenges. In a six-hour flight of the test aircraft on December 22, ESD verified that the complex digital steering commands do, in fact, focus the beam properly. The phase-shifters swept a beam across the earth and precisely struck a receiving device on the ground.

The December test, program workers note, also showed the integrity of airborne high-power radar transmission elements. The signals exchanged between the Joint STARS aircraft and Grumman's ground-based Integration and Test Facility in Florida confirmed that there was proper formation of the transmit and receive beams.

"We proved that we could put energy, in a controlled sense, through the transmitter, through the antenna, on the ground, to a spot that we could control, in a form of energy that we could control," notes Colonel Colligan.

The radar, unsurprisingly, is not yet working perfectly. Minor glitches crop up. For example, problems with a Joint STARS inertial navigation system in one flight threw the radar off, causing it to mistake one Florida causeway for another nearby. Engineers also found some saturation of the analog-to-digital conversion system.

"But we're not talking about rocket science here," remarks Colonel Colligan. "The important thing is that we understand, and are proving we understand, the radar software. That was the tough part."

In addition to demonstrations of mechanical capabilities, progress in verifying the radar's planned target-detection abilities has been heartening to Air Force officers and their contractors.

The E-8A will be the key sensor in a new plan to locate and attack onrushing Soviet armor.

The Joint STARS team in recent months has successfully put together the transmission and receiving functions of the radar. In a test conducted last March 16, Joint STARS technicians beamed energy to the ground and got data back in the form of a target for the first time. The process was repeated days later and has been repeated at regular intervals since.

As a result, ESD is convinced that it has produced workable clutter-rejection algorithms to differentiate between actual targets and background. "The guys who know what they're looking at," notes Colonel Colligan, "say, 'Aha! Here's Cocoa Beach, here's Merritt Island, here's the mainland, here's the causeway. See the cars.' "

Producing this kind of capability has been nothing if not difficult. Because of the ground-clutter problem, the job of the Joint STARS radar is more complex than that of the E-3 Airborne Warning and Control System's radar. The magnitude of radar-processing demands can be seen in the fact that the Joint STARS signal processor, several programmable units built by Control Data Corp., perform a staggering 625,000,000 operations per second.

Long months have been spent developing prototype software containing basic algorithms that make the radar look out and spot a moving target on a background of clutter. The code will be written to military specifications later.

Increased Precision

From today's relatively rudimentary operations, the radar is expected to progress to awesome capabilities. That is made plain by Maj. Gen. Eric Nelson, ESD Vice Commander. In addition to performing broad surveillance, he says, the radar operator will be able to "get a lot more precise, put in a lot more cultural data—road networks, cities, political borders, other reference areas. There will be a zoom capability down to the individual road, very small towns . . . individual vehicles, to tell which way they are moving and at what speeds."

The initial phase of airborne radar testing, completed in April, was limited in scope. It focused on calibrating the Joint STARS radar performance against targets of controlled size and speed—an officer describes them as "a few off-road vehicles and four-wheel drives"—operating in a 100-square-kilometer sector of Florida. While the radar performed well, it was undermatched. The sensor is built to survey areas as large as 30,000 square kilometers.

Demonstrations of wide-area surveillance, which are to focus on the grounds of Eglin AFB, Fla., and a range in southern Alabama, are just now getting under way. By summer's end, the Air Force will be pitting the radar against slow-moving, hard-to-spot targets, such as tanks. "That's the next step in the process," says Colonel Colligan. "That's where you really can see how well you can break into the clutter and bring up a target."

Helping to speed the tests will be full operation, starting in September, of a second Joint STARS test aircraft.

Joint STARS's prospects had gotten a boost from other developmental successes. Airworthiness problems—principally, how to control a craft carrying a large, canoe-shaped radome under its fuselage—were resolved. Voice communications and navigations systems and software were installed and verified.

More significant was ESD's success in fashioning a new surveillance and control data link (SCDL) to transmit Joint STARS information to users on land. The SCDL system, built by Cubic Corp., is pivotal to operational users.

Plans call for on-board Air Force systems to convert radar returns into C³I information. The Army, needing to supply many users at all levels, will use the SCDL to transmit raw radar returns as well as processed data to the 107 Joint STARS ground stations it is slated to build.

USAF only recently took delivery of the first full set of data-link equipment, but it has been flying test parts since September. ESD officers, Colonel Colligan remarks, have found "very few problems with it. Range, antijam margins, data rate—we're getting what we need."

Sharing Data

Efforts are under way to ensure that Joint STARS data can be shared with similar NATO battle management systems—France's Orchidée (Observatoire Radar Coherent Héliporte d'Investigation des Éléments Ennemis) and Britain's ASTOR (Airborne Standoff Radar) systems. Cubic's data link will be used in the British demonstrator. France plans to use its own data link. ESD will provide an interface permitting interplay of Joint STARS and Orchidée data.

The ESD program office expresses lack of enthusiasm for Cubic's management of the effort, which brought in the data link twenty-one months behind schedule. As a result, Grumman has opened discussions with three other potential contractors—Harris Corp., General Dynamics, and Unisys—about prospects for modifying an existing data link to do the job. A final decision lies several months ahead.

How far the technology program has come, and has yet to go, is nowhere clearer than in operations and control features—functions for manipulating the radar information into usable data. As ESD officials tell it, Grumman has made steady strides in this difficult area.

The company has established what appears to be a realistic, workable architecture for integrating the various radar functions into a harmonious electronic whole. "There are three kinds of guys working on this program: brilliant, very smart, and smart," comments a program officer. "We've got an architecture that the brilliant guys say will work. The very smart guys are implementing it. We're making progress."

The challenge stems from the unprecedented complexity of Joint STARS's data-processing system. It does not have a central control computer. Instead, the craft will use twenty-seven processors that enable large numbers of computer functions to occur in parallel. The object is to allow processed radar data to be displayed in different forms at the same time at any of the aircraft's ten full-color operator consoles.

This system accounts for the aircraft's vast software requirements. At present, plans call for Joint STARS to run about two million lines of code, some 600,000 lines of it new and complicated. A large fraction of this total focuses on operations and control. Today, all Grumman software has passed

through preliminary design, half of it through detailed design, and a third of it through code-writing.

Still, experts such as Colonel Colligan regard operations software as the most likely place where Joint STARS may be tripped up. "If you talk to Grumman guys, they'll say they're getting a handle on the radar software," says the colonel. "But we've asked them to do an awful lot of things to make this data have very high utility for the operator. Doing all that simultaneously is going to be a tough job. We've said we want all ten consoles to be completely independent. Each one of these guys ought to be able to act like it's *his* radar."

In the end, some maintain, the Air Force may have to relax or modify some of its ambitious goals. This could have a relatively modest impact. For example, time required to provide a complete replay of the foregoing three hours of radar data, now planned at thirty seconds, may go up to forty-five seconds. Other functions could be affected more seriously or dropped altogether. ESD is consulting with Tactical Air Command to establish priorities.

All signs are that Grumman faces a workable, but tight, development schedule. The contractor will have to complete some ninety-five percent of its software before the start of the demanding, three-month, system-level performance verification tests. That could come as early as next summer, but in any case no later than November 1990, barring a major snag in the program. Officials say Grumman looks to be on schedule. But, one acknowledges, "There's a very tough integration job in front of us."

New Development Problems

The Pentagon, persuaded that Joint STARS is here to stay, has reshaped and expanded the program. The steps will require new attention from the developers.

Most conspicuous, but by no means most important, is the new technological task caused by Pentagon approval of a different airframe for the E-8A role. Originally, plans called for the use of older, refurbished Boeing 707 commercial aircraft for the Joint STARS fleet. In 1988, the Air Force selected and the Pentagon approved use of new 707-320 frames, the same used by the Navy for its E-6A plane. The changeover, however, will pose no great technological challenge. It will entail installation in the Air Force E-8 of a cargo floor not found in the Navy E-6 and perhaps minor structural alterations.

Possibilities include a radar warning receiver, approach warning radar, flares, chaff, and a deceptive jammer.

Another Pentagon decision—to fit future Joint STARS aircraft with self-defense suites to enhance their survivability—will not be executed so readily. ESD is in the throes of an effort to examine its needs, define the system it wants, and determine the fastest, cheapest, and least disruptive way to install it.

There is little doubt that such a system is needed. From the beginning, experts within and outside the Air Force—particularly the chief of the Pentagon's systems analysis office, Deputy Assistant Secretary David Chu—warned that a large, slow-flying, and extremely valuable aircraft would present a tempting target.

The matter came to a head last year with completion of a new Pentagon analysis. "Basically," says Colonel Colligan, "the conclusion reached was that we're pretty survivable, with the defenses that are in place, at standoff ranges from the FLOT. But there, we couldn't provide as much utility [to Western forces] as we would like. We would not be looking as deep as we would like to look, obviously."

In order to operate closer to the front with security, he adds, Joint STARS requires an EW suite to deal with a "leaker," a single aircraft that gets close enough to take a potentially lethal shot.

ESD has hired a contractor to examine the problems and solutions. Electronic-warfare specialists based at Aeronautical Systems Division are being consulted. Possibilities include installation of a radar warning receiver, approach warning radar, flares, chaff, and a deceptive jammer.

Even if ESD uses existing equipment, as it plans to do, new development costs could reach $200 million. Final decisions are not expected for another year, and first tests will not take place until 1992 when the third test aircraft becomes available.

One aspect of the aircraft, a weapons data link, is in limbo. Part of the initial Joint STARS plan approved in 1985, the link was supposed to permit the radar to broadcast present target positions to a black box resident on an airplane or a missile. Inasmuch as no one has developed the black box, ESD has declined to spend money developing the 15,000 lines of software needed for the link.

If events go as planned, the Grumman system-level performance review will be followed by long-lead funding for the first production aircraft and the start of initial operational tests, which would run through 1991. An Air Force production decision would come in October 1991, with deliveries starting in 1994 and limited operation in 1995.

There is optimism that the timetables will hold. "Basically, we're keeping to the plan that we laid out for the leadership," says Colonel Colligan. "If we can continue to do that, I'm happy." ■

Despite the budget setbacks, there is steady if unspectacular progress in many programs.

Electronics in a Pinch

WITH Air Force budgets being hit by one setback after another, the health of big electronics projects is coming under scrutiny. Among the questions being asked:

What impact is the budget pinch having on high-profile command control communication and warning programs—strategic and tactical—begun in the Reagan era? How are the fiscal troubles affecting USAF's electronic-combat initiatives?

The answer is that times are difficult, with projects being slowed or scaled back. Even so, there is steady if unspectacular progress in many areas, as seen in a survey of selected programs.

Strategic Warning and C^3

Gains—and setbacks—can be discerned in projects designed to provide warning and assessment of missile, bomber, and cruise missile attacks on the United States.

Washington is improving its day-to-day warning with the Over-the-Horizon Backscatter (OTH-B) radar system. Air Force Systems Command's Electronic Systems Division (ESD), working with GE, is developing and deploying the far-

seeing radars in four widely dispersed sites.

The OTH-B East Coast system is now becoming operational, the West Coast system is budgeted and under construction, and the Alaskan system is budgeted but not yet on contract. Funding for the Central US system will be requested for 1991. However, fiscal pressures have caused USAF to defer two sixty-degree surveillance sectors from a planned four-sector Central system, cutting costs by $275 million.

USAF personnel have staffed the East Coast operations center for two years. OTH-B's power to detect bombers approaching North American territory is unparalleled. Tests run in 1988 showed that it has some capability to spot cruise missiles, though not enough for it to be regarded as a fully operational cruise missile detection system.

Elsewhere, the US-Canada North Warning System (NWS) is headed toward full operation in 1993. Comprising fifty-two new radar stations facing into the Arctic, NWS will replace the aging Distant Early Warning (DEW) Line. The NWS's fifteen GE long-range radars were recently activated. Another thirty-nine short-range radars are to be on line in three to four years. The system will provide continuous, unbroken radar coverage from Alaska across Canada and down the east coast of Labrador.

USAF is proceeding steadily on upgrades of the Ballistic Missile Early Warning System (BMEWS), radar sites giving tactical warning and assessment of an ICBM attack. Contractor Raytheon is upgrading the United Kingdom site at RAF Fylingdales, England, with phased-array radar, aiming at completion in the early 1990s. Modernization of the BMEWS radar in Alaska is in prospect. The upgraded BMEWS site in Greenland went into operation in 1987.

In communications, building EHF Milstar satellite terminals is a priority. Under ESD, Raytheon, teamed with Bell Aerospace and Rockwell, is at work on development of nuclear-hardened terminals for Lockheed's Milstar, which will provide secure, jam-resistant voice and data links between various attack sensors and National Command Authorities and between

What impact is the budget pinch having on high-profile C³ and warning programs—strategic and tactical—begun in the Reagan era?

NCA and US forces. In 1988, the program passed important testing milestones. ESD thinks most of the technical problems are solved, and the program is making a transition from development to initial production.

Advances also can be seen in development of the Ground Wave Emergency Network (GWEN), a multistation net of LF radio towers and receivers resistant to the effects of electromagnetic nuclear pulse. ESD, working with RCA, has nearly completed installing an initial, fifty-six-node "thin-line" segment for flashing emergency messages to Strategic Air Command units. Budget pressure caused a restructuring of the GWEN program from the proposed 127 relay stations down to ninety-six. Target date for completion is 1992. ESD has completed development tests and is well along in operational test and evaluation.

Tactical Warning and C²

In tactical surveillance, USAF is pressing forward with modifications to its thirty-four sky-sweeping E-3 Sentry Airborne Warning and Control System (AWACS) airplanes. ESD has started full-scale development on the AWACS Radar System Improvement Program (RSIP), which will incorporate a new signal processor, a new waveform, and a new data processor to increase detection capabilities as well as reliability and maintainability. Boeing and Westinghouse are contractors.

With the modifications, the Westinghouse APY-1 and APY-2 radar sensitivity will be doubled, giving the AWACS the ability to pick up cruise missile signatures and to serve as a hedge against possible Soviet stealth fighters. RSIP's systems will be entering service in the mid-1990s. Plans call for the upgrade—which will cost $626 million—to be completed by 1998.

Already, ESD is well along in full-scale development of new equipment and software for its AWACS Block 30/35 Upgrades. The four-part program, managed by Boeing, recently passed critical design review. Tactical Air Command E-3s will begin receiving equipment in 1992. On tap is an upgrade of the main IBM CC-2 computer, increasing its memory by a factor of four; installation of Global Positioning System terminals; and development of electronic support measures. The ESM, a cooperative US-NATO development effort, will give US and the eighteen NATO AWACS aircraft a passive detection system to augment their active radar sensors.

In a fourth step, the Block 30/35 program calls for the integration in AWACS of Joint Tactical Information Distribution System (JTIDS) Class II terminals. AWACS planes currently use the older and larger Class I terminals. Class II terminals, being developed by Singer and Rockwell Collins, are expected to give air defense platforms a high-capacity, secure, jam-resistant data-transfer link for a variety of tactical forces. Greater awareness of the air situation will be achieved by providing information gathered by E-3s and ground stations to fighters, allowing a pilot to put together a broader, clearer picture of the battle.

ESD officials note that the Class II program has gone back into testing following a one-year hiatus caused by reliability problems in the initial fighter terminals. Flight tests revealed lower-than-expected mean-time-between-failures rates. Now

that a year-long redesign and test of the Class II is complete, a decision to begin low-rate initial production could come this summer.

A spin-off of JTIDS, the new Multifunctional Information Distribution System (MIDS) program, is getting off the ground at ESD. MIDS is a cooperative NATO effort in which the US currently has the lead. The object is to make use of new microelectronics to build a more compact, JTIDS-like terminal that will fit into fighters smaller than the F-15. These could include the multination European Fighter Aircraft, the French Rafale, the Canadian CF-18, US Navy F/A-18s, and USAF and allied F-16s. MIDS now is in concept definition, with Singer as contractor.

Elsewhere, tactical-force communications are being improved by deployment of TRI-TAC Joint Tactical Communications, digital equipment that replaces less secure analog items. AN/TRC-170 digital troposcatter radio terminals, now in production, will provide secure transmission of messages over a range of 200 miles. Raytheon and Unisys are contractors. The Litton TRI-TAC Modular Control Element, in production, replaces the TSQ-91.

ESD also is pressing ahead with its Joint Services Imagery Processing System (JSIPS), an Air Force/Marine/Army program to develop a ground station to receive, process, and disseminate imagery to combat commanders. E-Systems, the contractor, is in full-scale development on JSIPS. JSIPS ground stations will substitute digital photo-processing and interpretation for the current film-based techniques. Plans call for JSIPS to take electro-optical and infrared data from manned and unmanned aircraft and then process and distribute it directly to theater commanders and Army operation centers. The Air Force Tactical Air Command plans to acquire a ground station for each reconnaissance squadron. JSIPS stations also will be located at Air Force tactical air control centers.

Electronic Combat

The Air Force is striving to improve electronic combat powers across the board, whether in suppression of enemy air defenses (SEAD) or electronic warfare (EW). The task, notes a Pentagon report, is one "in which we have faced some of our greatest technical challenges."

The Air Force is striving to improve electronic combat powers, whether in suppression of enemy air defenses or electronic warfare.

In weapons for direct-attack SEAD, the AGM-88C High-speed Antiradiation Missile (HARM) is a success story. HARM is a joint service program in which the Navy has the lead. Operational since 1983, HARM is undergoing an upgrade to keep it current. The US is working to improve coverage, effectiveness, and versatility by means of the HARM Block IV upgrade and Low Cost Seeker programs. Initial testing began on the AGM-88C, designed to cope with new frequency-agile threats. It has a new guidance section. Also in the works is an improved warhead. Texas Instruments is the HARM contractor.

In another direct-attack-weapon program, the AGM-136A Tacit Rainbow, the Air Force has experienced some bumps. The Northrop weapon is an antiradiation cruise missile developed jointly by USAF, the Navy, and the Army. A "smart" weapon, it is designed to loiter outside a target area until an enemy radar emits a signal, which the weapon rides to the ground. Due to developmental difficulty, low-rate initial production—originally planned for 1989—has been moved to 1990. The system is to remain in testing, with 1989 procurement funds used to buy test missiles. A ground-launched variant, BGM-136, may enter development next year.

The two-phase F-4G Wild Weasel Performance Update Program (PUP) has seen mixed results. In the 1970s, the F-4G was modified to be able to locate and destroy enemy radar and SAMs. With McDonnell Douglas as prime contractor, the update of the F-4G's APR-38 system to the APR-47 configuration in an effort to cope with an advancing Soviet threat is under way. In Phase I, Unisys developed a new on-board computer to provide more memory and processing speed. The computer, now in production, will be retrofitted into all F-4Gs. In the second phase, E-Systems was trying to develop an advanced receiver, but the effort did not pan out. The receiver project was halted in 1988, and Phase II has been restructured.

As a result, TAC has placed new emphasis on replacing the aging F-4G with a Follow-on Wild Weasel aircraft. The project is now in the study phase. Air Force electronic combat officers have been gathering contractor information on new technologies that might be used in such an aircraft. The expectation is that it will be years before a new plane—possibly a modified F-15 or F-16—enters service. *(For more on Wild Weasel upgrades, see "Slam 'Em and Jam 'Em," by Jeffrey Rhodes, on p. 50 of this issue.)*

In the field of disruptive SEAD, the EF-111A Raven Update remains an important effort, but it has suffered setbacks. The Air Force's Raven fleet would jam enemy early-warning, acquisition, and ground-control radars. The need is to improve the Tactical Jamming System's ALQ-99E receiver/processor subsystem, a task that has been assigned to Eaton's AIL division. But in 1988 the Air Force, claiming the project had fallen behind schedule, declared the contract in default. The Air Force is now attempting to restructure the program and will apparently try again.

—R.S.D.

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TEXAS INSTRUMENTS

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Over hostile territory, it's essential to destroy, disrupt, or degrade the enemy radar.

Slam 'Em and Jam 'Em

BY JEFFREY P. RHODES, AERONAUTICS EDITOR

PHOTOS BY GUY ACETO, ART DIRECTOR

"ELECTRONIC combat is a tough game to play," says Col. Richard Hellier, Commander of the 366th Tactical Fighter Wing at Mountain Home AFB, Idaho. "Except it's not a game."

Electronic combat is a difficult concept to grasp. Because of its "electron-vs.-electron" nature, it can't be seen or touched. With the exception of destroyed enemy radar emitters, there is no physical evidence after an electronic battle. Success in the electronic battle, however, determines the success or failure of the overall mission.

Electronic combat takes many forms, but the primary tactics employed to get a force package of fighters or bombers into a target area is a combination of radar equipment destruction, signal elimination, and jamming to achieve radar suppression.

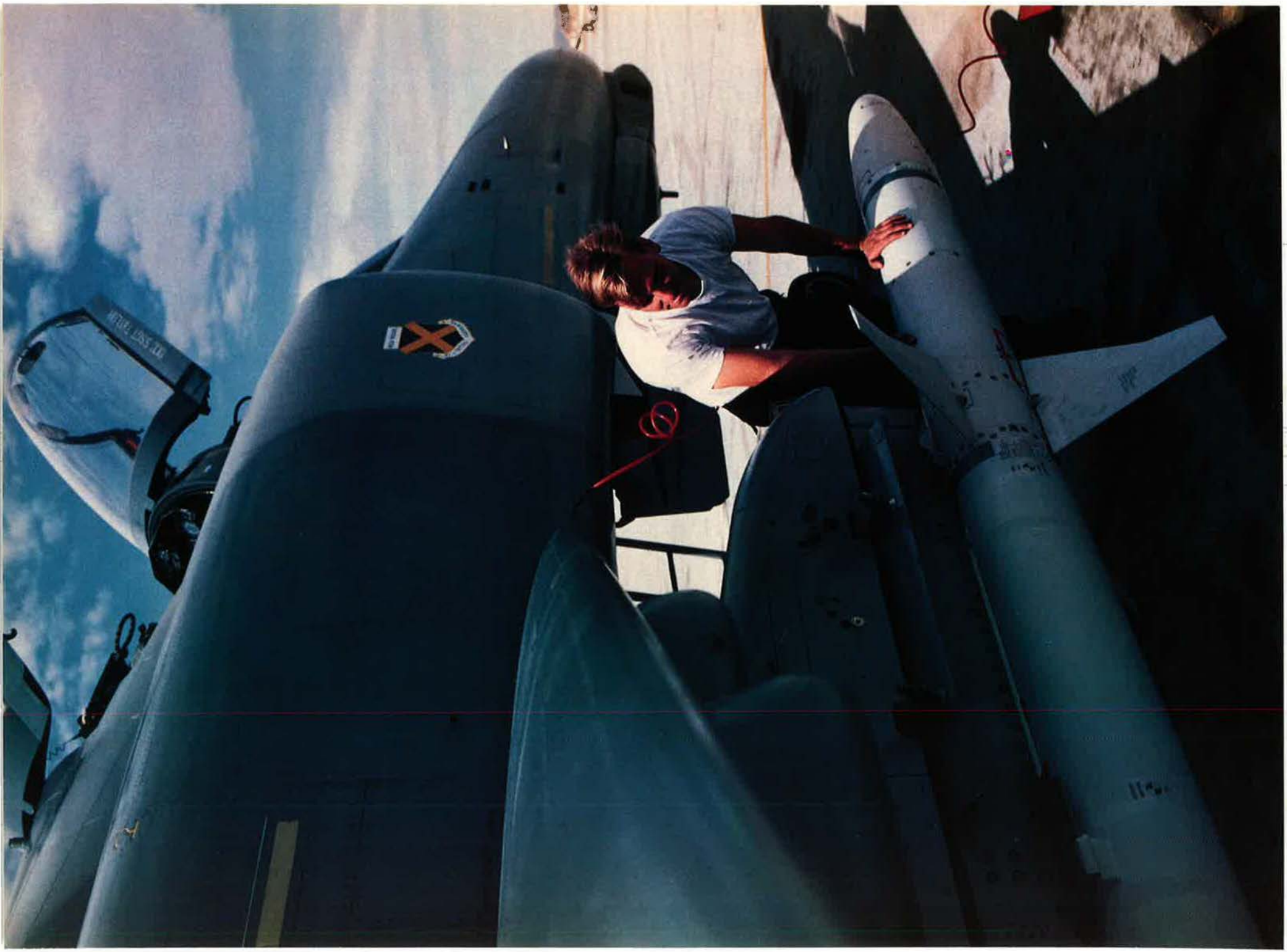
Airborne jamming began during World War II when aluminum strips called chaff or "window" were thrown out of bombers by the bale to confuse German radars. Today, jamming (obliterating radar returns by more powerful emissions on the same wavelength) is more complex, simply because of the larger number of emitters working on a multitude of frequencies.

Individual aircraft carry self-protection jammers (and chaff, too) into combat to ward off radar-directed antiaircraft artillery (AAA) and air-to-air and surface-to-air missiles (SAMs). Jamming over a wide area to mask an incoming strike package from enemy radars, though, requires the power of the Air Force's Tactical Jamming System (TJS), the EF-111A Raven.

Radar suppression was a response to Soviet-built SA-2 SAMs and "Fan Song" radars that the North Vietnamese used to down American planes in 1965. Eighty-nine days after initial development, four North American F-100Fs modified with radar homing and warning receivers and other equipment arrived in Thailand to begin "Wild Weasel" operations against the radars and SAMs. After a rocky start, the Weasel program developed into an outstanding success using Republic F-105F and F-105G and McDonnell Douglas F-4C aircraft.

Radar suppression was described by one Vietnam-era pilot as "three-

The beginning and the end of another busy day on the ramp at George AFB, Calif. At right, SrA. Robert Collins makes sure the Texas Instruments AGM-88A High-speed Antiradiation Missile (HARM) is securely attached to its launch rail while preflighting "his" F-4G. With its standoff range and devastating accuracy, HARM is the weapon of choice for Wild Weasel crews. Above, a 37th TFW electronic warfare officer climbs out of his office at the end of a training sortie.



dimensional chess where cheating is legal." It is the same today. "The Wild Weasel fundamentals haven't changed since Vietnam," notes Col. Bill Payne, Vice Wing Commander of the 37th TFW at George AFB, Calif. "Electronically, there is a world of difference."

Different But the Same

While targeting and jamming are quite different, there are many similarities. At the top of the list, both missions are dangerous.

The Wild Weasel crews play a continuous cat-and-mouse game with enemy radar, trying to get it to "come up" (turn on) so the electronic warfare officer (EWO) in the F-4G's backseat can find the site and destroy it, or to make the radar operator so fearful of attack that he does not turn on his set.

"If we get the radar to shut down, we're doing our job, even if it is just for the minute or so we're there," says Lt. Col. Les Moore, Assistant Deputy Commander for Operations for the 37th TFW. "They turn off, and the force package can get in."

The Soviets have developed successive generations of increasingly sophisticated radar, AAA, and SAMs. This has forced the Weasels to operate at lower and lower altitudes. "We've had to go lower since Vietnam, often as low as 100 feet," says Capt. Tom Finke, an EWO with the 37th TFW's 561st Tactical Fighter Squadron. "The front-seater has no time to look inside [the cockpit]. Make a mistake and in two seconds you are in the ground."

The EF-111As, meanwhile, are unarmed. The Ravens are just as susceptible as the Weasels to ground threats. Unlike the F-4Gs, which carry air-to-air missiles, the EF-111s don't have any means of defending themselves except for a terminal jammer and speed. "At 600 knots, EF-111s are not lucrative targets," says Capt. Greg Menke, an instructor EWO with the 390th Electronic Combat Squadron at Mountain Home AFB. "Speed is life."

A second similarity is that both missions are task-intensive and task-specific. When standard F-111As were redone as Ravens, all navigation and communications equipment was moved from the right-seater's station to the center console. This allows the aircraft commander to do everything necessary to fly the plane during the height of combat while the EWO tends to the jamming.

Demanding Missions

The combination of scarce airframes and demanding missions requires that the Weasel and Raven crews be among the most experienced in the Air Force. In the past,

The 390th ECS at Mountain Home AFB, Idaho, represents the nonlethal side of electronic warfare—radar jamming. EF-111A crews can jam transmissions in several ways. Above, A1C John Moore and Sgt. Curtis E. Sargent prepare an EF-111 for one of the uprated TF30-P-109 engines now being fitted to the Ravens.

"In the F-4G, the backseater is the key guy," adds Colonel Moore. "He determines the order of battle. It's really EWO-intensive. 'Weaseling' is a team-oriented concept. We are tied to the force package in a supportive role. We don't just go out and destroy radars. We have to be in support of some specific objective."

Another "given" is that nothing in electronic warfare is as constant as change. "All electronic warfare is essentially reactive," notes Colonel Hellier. "We see a potential adversary develop a capability, and we have to move to counter it."

For electronic combat to be effective, the Weasels, Ravens, and other aircraft, such as EC-130H Compass Call communications jammers, have to be used together. But that highlights the limited numbers—forty-two EF-111s and fewer than 130 F-4Gs—of each of the electronic warfare assets. "We don't try to spread the Weasels out along the whole FEBA [Forward Edge of the Battle Area]," says Colonel Payne. "We want to mass our forces in one area at the proper time."

an EWO needed at least 500 hours to become a Weasel, and pilots for both the F-4Gs and EF-111s needed at least 1,000 hours coming in the squadron door. These requirements have been lowered slightly, but not much.

At George, crews go through the Replacement Training Unit (RTU), the 562d Tactical Fighter Training Squadron, which takes an average of four months. The 562d TFTS also trains crews for the other Wild Weasel units—the 52d TFW at Spangdahlem AB, West Germany, and the 3d TFW at Clark AB in the Philippines.

Mission-qualified F-111 crews go through two levels of training before becoming full-fledged Raven operators. "It takes one year to [prepare] a mission-ready crew member," says Lt. Col. Rich Meeboer, the 390th ECS Commander. "Even then, he is not really ready—we are just scratching the surface." The 390th ECS is also the EF-111 RTU. There is only one other Raven squadron in the Air Force—the 42d ECS at RAF Upper Heyford, UK.

Close coordination is needed between pilot and EWO in both air-


Spirit of Idaho
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planes. Thus, a crew is paired off more or less permanently. A pilot and EWO in the two operational Weasel squadrons at George, for example, will fly with each other more than seventy percent of the time.

Weasel and Raven crews both have the same basic objective—to disrupt the Soviet Integrated Air Defense System (IADS). The goal is to get a radar emitter to "go autonomous," that is, to break out of the chain of radars that are linked to provide a coordinated defense. Once isolated, the radar can be dealt with. If the radar is destroyed, it is no longer a threat. If the radar is jammed or shuts down, that creates a hole for the strike package. Either way, the effectiveness of the entire IADS is degraded.

Opening holes in the FEBA is the primary task for the F-4G and EF-111 crews, but both also train to go to the target with the force package. Europe will be an electronic jungle, and once the force flies through the first layer of defenses, the Weasel and Raven crews will be needed to go against threats both en route and surrounding the target.

Intelligence is vital for every operation, but it is paramount in the battle of electrons. "We will not send out Weasels without good, up-to-date intelligence," says Colonel Moore. Adds 1st Lt. Paul Hylton, the 390th ECS's Intelligence Officer, "Electronic warfare intelligence is just a little different. We have to tell our crews not just, 'There is a target here.' We have to tell them what kinds of radars, how they operate, and what frequencies they operate on."

How They Operate

The Wild Weasels operate in hunter-killer teams of two aircraft, an F-4G with an F-4E at George and Clark and an F-4G with an F-16C at Spangdahlem. (The latter combination may be the wave of the future.) The F-4G "hunters" find the emitters with their equipment and then launch ordnance, or the information is passed to the "killer" aircraft, which can't find the emitters on their own but can certainly attack them.

The weapon of choice is the Texas Instruments AGM-88 High-speed Antiradiation Missile, or HARM. With a range of more than ten miles, HARM gives the Weasel crews a true standoff capability. The nearly fourteen-foot-long missile can be launched from a level delivery and greatly expands the working area for the Weasel crews. "The AGM-88 is a great weapon," says Maj. Walt Michalke, a pilot with the 561st TFS at George. "You launch it, and there's a pretty good chance of it's hitting what you want it to hit."

HARM's only negative is that it is not overabundant. That leaves the older, less reliable but more numerous AGM-45A Shrike to be used by the "killers." In the inventory since Vietnam, Shrike has a range of about three miles, which brings the aircraft closer to the SAMs and AAA. A "loft" delivery, where the "killer" pulls up and launches, gives the AGM-45 a little more range.

If a war lasts long enough for the Weasel crews to run out of HARMs and Shrikes, the next weapon to be used would be the AGM-65D Imaging Infrared Maverick. Principally an antitank weapon, Maverick's devastating accuracy would work well on a radar. After that, it's down to iron bombs and directly overflying the target, which is a method that crews would just as soon avoid.

The heart of the EF-111A is the AN/ALQ-99E jamming system, a version of the ALQ-99 used in the Navy's EA-6B Prowler. The receivers and antennae for this system are located in the "football," the blunt pod on the tip of the aircraft's fin. The transmitters are housed in the "canoe" on the belly. The processors and other equipment are permanently installed in what was the F-111's weapons bay.

Unlike the system in the EA-6B, which requires three crew members to operate, the EF-111's jamming system is much more automated and requires only one EWO. The Intelligence Support System (ISS) is a computerized program that provides information about radars in the area where the Raven crew will be working. Before the start of the mission, ISS data are fed into the Mission Data Generator (MDG) and then loaded into the aircraft via Raymond cassette.

Through the use of the MDG, the Raven's computer system can determine what radar is "up," its priority as a target, and how to jam it. The computer can jam automatically, or the EWO can jam manually. The EWO also has the option of jamming other emitters as the situation dictates. Where there is an air-to-air threat, the EWO will let the computer take more of the work load so he can get his head out of his console and help the pilot look for airborne "hostiles."

There are three primary types of jamming. Standoff jamming blankets a number of emitters to mask friendly forces. Its primary advantage is to keep the EF-111s

Playing the electronic "bad guys" is a role the 392d Electronic Combat Range Squadron takes very seriously. Here, Sgt. Dan McDaniels (left) and Sgt. Hoyt Hagens track a target in the AN/MSQ-T43 Modular Threat Emitter, which accurately simulates Soviet antiaircraft artillery and surface-to-air missile radars.

away from the thick of enemy defenses. Close-in jamming obscures radars in a specific area to open a corridor for the strike package and increases the Raven's exposure to surface threats. The third type is escort jamming, wherein the EF-111s protect the strike package all the way to the target, as in the 1986 USAF/Navy reprisal raid on Libya.

Preparing to Go

Maintenance for the F-4s (and the EF-111s as well) is a labor-intensive activity. "You are definitely a crew chief on an F-4," noted TSgt. Mark Mantz, a crew chief with the 37th TFW's 563d Aircraft Maintenance Unit. "You know you will have to work hard. On some newer aircraft, the crew chief is a glorified gas-station attendant, but not here."

All of the George F-4Gs are 1969 model F-4Es that were converted to Weasels, so while some of the electronic equipment is new, the airframes and most of the electronics are not.

One major problem is parts. "I have to spend a lot of time on the phone trying to get spares," says SSgt. Charles Clark, the assistant NCOIC maintenance supply liaison for the 37th TFW. "We have to get some things out of AMARC [Aerospace Maintenance and Regeneration Center at Davis-Monthan AFB, Ariz., where old aircraft are stored]. Getting parts for the G-models is particularly hard. It gets hairy at times."

Likewise, the EF-111 airframes are old. The F-111As, from which the EF-111s were modified, were built in 1966–67, but Grumman did not make the electronics modifications to the aircraft until the early 1980s. The electronics are of a newer, modular type and are fairly easy to repair or replace. Finding parts for the airframe is a problem, but such parts are more plentiful than those for the F-4, which the Air Force is phasing out of the inventory.

Despite the hurdles, the maintenance sections for both units are getting the job done. The Fully Mission Capable (FMC) rate for the 37th TFW's aircraft was 52.8 percent in 1982. Last year the rate was 82.6 percent. The Mission Capable (MC) rate, which allows some system degradation, is around seventy-seven percent for the EF-111s, a dramatic increase from just two years ago. These percentages come despite the EF-111s' having among the highest utilization rates in the Air Force. The F-4Gs also see a great deal of use.

New technology is one reason matters have improved. The Weasel Attack Signal Processor (WASP) part of the APR-47 system that was recently installed in the F-4Gs is much more reliable and easier to fix than the APR-38's Homing and Warning Computer (HAWC) it replaces. It is also easy to change the software to keep the system current. The AGM-88 can be bench-tested with a single connection to the DSM-160 computer, which in minutes can run a complete diagnostic test on the missile.

There are also many easier, smarter ways of doing things. "We have to assemble the AGM-45s in the field," says MSgt. Stephen Cotta, Assistant Chief of the 563d Combat Munitions Unit. "It's like a big Erector Set. The guidance and control sets have to match up or the missile won't work." The HARMs come as all-up rounds—just add fins.

"We are doing very well, maintenance-wise," says Col. Robert "Slick" Andrews, Deputy Commander for Maintenance at Mountain Home. "Dedicated people make it happen."

The keepers are rewarded for their efforts in several ways. At George, if a squadron meets its sortie goal for a month, the AMU gets the day off. Both the 37th and 366th TFWs offer orientation rides as an incentive to the maintainers. "When deployment season comes, our guys are ready to go," says Capt. Lee Cherry, officer in charge of the 390th AMU at Mountain Home. "We go to Korea, Puerto Rico, and Europe. We thrive on that."

Deployment is not just an occasional thing with these two units. The Weasel and Raven crews participate in every Joint Chiefs of Staff exercise and in every Red Flag and Green Flag exercise at Nellis AFB, Nev. The Ravens deploy overseas periodically and are frequent guests at Navy exercises, adding a new wrinkle to what the Navy electronic warfare players usually see.

Ready for Anything

Another unit at Mountain Home that spends lots of time on the road is the 392d Electronic Combat Range Squadron. This small, specialized unit functions primarily as the ground "aggressor" force for the Raven crews, but it also trains many other units. The radar operators simulate the Soviet IADS and take it personally when they get jammed or "destroyed" by strike packages on training missions.

The unit has established one training range at Saylor Creek, Ida-

Mountain Home's EF-111s have one of the highest utilization rates in the Air Force. This Raven is being "Euked" (towed) from the maintenance hangars out to the flight line. The "football" on the vertical fin and the "canoe" on the belly house the receivers and transmitters that make the EF-111s so effective.

Close coordination between pilot and electronic warfare officer in both Wild Weasel and Raven aircraft is essential. This team concept is illustrated here, as Lt. Col. George Osborne flies the F-4G and looks for threats while Capt. James Avrit has his head in his console searching for radar emitters on a training sortie over a range in the California desert.

ho, with another under construction, but the 392d ECRS also goes on approximately thirty deployments a year. These deployments range from two people and no equipment at a Red Flag exercise to as many as sixty people and twelve radars at the Dugway Proving Ground in Utah for a joint force deployment.

The squadron has nearly thirty different radar systems with which to train. "All of the radars are American-made," says Lt. Col. Carl Newman, the Squadron Commander. "The part of the operation that looks like the Soviets' is the RF [radio frequency] part. But we have a tough time keeping them up because some are so old." The Soviets seldom retire anything, but merely pass it on to their client states. A 1949 model MPS-9 radar given to the Soviets under World War II Lend-Lease is still used in some parts of the world, so today's crews still have to train against them. Another radar set used by the unit was found in a museum.

The unit regularly works with the intelligence section to keep current in the Soviet order of battle. Intelligence also helps with aircrew ground training. "We prepare the crews to fight a war in a different part of the world each month, so they are ready for anything," says Lieutenant Hylton. "You also see a lot of pilots and EWOs coming in to do self-study."

Mission academics at both George and Mountain Home is taught under contract by civilians working for McDonnell Douglas Training Systems Inc. At George, there is a G-suit/G-seat Weapon Systems Trainer (WST) operated by CAE Link. The simulator doesn't allow for two-ship or tactics work, but does provide highly realistic mission simulations for aircraft procedural training. There is a WST at Mountain Home, too, and the EWOs also have the opportunity to practice jamming procedures on an elaborate part-task trainer (PTT).

There are a number of changes being planned for the Air Force's electronic warriors. The 37th TFW is scheduled to be merged with the 35th Tactical Training Wing (the F-4 "schoolhouse"), also at George. Once the consolidation is complete, the new wing is tentatively scheduled to move to Mountain Home, probably in 1992. This will mean that most of the Stateside electronic assets will be in one place. George AFB is expected to be closed.

To make room for the Weasels, the two F-111A squadrons at Mountain Home are scheduled to be transferred to Cannon AFB, N. M. While Mountain Home has the ramp space for the expected F-4s, new facilities will be needed. "There appears to be justification for another runway, given the number of aircraft movements per hour," says Col. Ron Kroop, the base civil engineer. (Mountain Home has only one active runway.) "The number-one priority is housing and feeding the 2,000 additional military people."

In the meantime, incremental changes are being made to the Weasel and Raven aircraft. The EF-111s will be getting new instruments, terrain-following radar upgrades, global positioning system equipment, and a new inertial navigation system under the Avionics Modernization Program for all F/FB-111s. The EF-111s are now getting the uprated Pratt & Whitney TF30-P-109 engines. A program to integrate HARMs into the EF-111 to increase its lethality (and survivability) is in the idea stage.

Several electronic upgrades have been proposed under the Weasel Performance Upgrade Program, but the Air Force is increasingly turning its attention to a Follow-on Wild Weasel platform. Several candidates have been proposed, including derivatives of the McDonnell Douglas F-15E, General Dynamics F-16D, and the Panavia Tornado, which would be built in the US by Rockwell. A decision is expected in the early 1990s.

One thing is certain. "The [electronic combat threat] situation will do nothing but get worse," concludes the 390th ECS's Captain Menke. "We can't disregard it. We have to get better with it. It is not going to go away." ■

What exactly is a 'single-engine mentality'?

It's not a preference for single-engine aircraft.

It's as true for an F-14 or F-15 as it is for an F-16.

It has absolutely nothing to do with a 'single-seat mentality.'

Although it does give your pilots an extra shot of confidence.

It's not an attempt to end competition for fighter-engine business.

We all agree that competition has been good for the defense program and good for the country.

So what the heck is a 'single-engine mentality'?
Here's the way we see it . . .


PRATT & WHITNEY
DEPENDABLE ENGINES

We make every engine as if it's the only one you've got.

And that's true for every single engine we make.

You told us what you need to keep America strong.
We read you loud and clear.


UNITED
TECHNOLOGIES
PRATT&WHITNEY

A Checklist of Major ESD Systems

Work in progress at the Electronic Systems Division

Advanced HF Concepts
Development and acquisition of new technologies for existing high-frequency radios; narrowband and wideband items for uses after 1995. **Contractor:** None. **Status:** Concept definition.

Advanced Tactical Battle Management System
Program to identify alternatives to satisfy future tactical C^3 needs. **Contractor:** None. **Status:** Research.

Airborne Battlefield Command and Control Center III
A C-130-based, automated airborne command and control system for TAC use in forward battle areas and with special operations forces. **Contractor:** Unisys. **Status:** Production.

Airborne Warning and Control System (E-3)
A major upgrade program for the AWACS surveillance and battle management aircraft. Includes additional sensors, antijam communications, and radar systems upgrades to keep the plane in service into the next century. **Contractor:** Boeing, Logicon, Westinghouse. **Status:** Full-scale development, production.

Aircraft Alerting Communications Upgrade
An EMP upgrade program designed to provide assured communication from CINCSAC to alert aircraft squads, secure from effects of electromagnetic pulse. **Contractor:** BDM Corp. **Status:** Full-scale development, production.

Air Defense Initiative
Definition, development, and demonstration of new technologies required for future construction of comprehensive active air defense system. Emphasis is on technologies for surveillance, battle management, and C^3I against advanced air vehicles. **Contractor:** Multiple. **Status:** Concept definition.

Air Situation Display System
Procurement of system composed of six operator display positions, used at Allied Tactical Operations Center at Sembach AB, West Germany. **Contractor:** COMPTEK Research. **Status:** Production.

AF JINTACCS
USAF input to a program for joint interoperability of tactical command and control systems, designed to ensure that Air Force standards are included in the program. **Contractor:** JTC^3A, Martin Marietta. **Status:** Full-scale development.

AF SAFE Program
Procurement of physical security equipment for deployment to seventy USAF bases and 210 sites overseas. **Contractor:** None. **Status:** Deployment.

AF Tactical Shelter Systems Development Office
This Air Force focal point for all mission systems requirements for mobility and transport gives early engineering support to all program offices that use Mobile Tactical Shelters. This office is overall manager of R&D on shelters. **Contractor:** Multiple. **Status:** Full-scale development.

Air Traffic Control and Landing System
Development of an AN/GPN-20 electronic countermeasures program to protect approach-control radar performance against countermeasures. **Contractor:** None. **Status:** Concept definition.

AF Worldwide Military Command and Control Information System
The C^3 systems planning and engineering center for USAF elements of the defense-wide system. **Contractor:** GTE, IBM. **Status:** Full-scale development.

Air Logistics Centers Local Area Network
Provides for development, installation, testing, and integration of a local communications system connecting the five Air Logistics Centers. **Contractor:** TRW. **Status:** Deployment.

Alaskan HF Networking Demonstration
An eleven-node, high-frequency networking demonstration, conducted with Alaskan Air Command, using ESD software. **Contractor:** MITRE. **Status:** Conceptual.

Automated Message Handling System
Program to provide an intelligence analyst with capabilities for local electronic message handling and access to databases. **Contractor:** None. **Status:** Full-scale development.

Automated Tactical Aircraft Launch and Recovery System
Development of a system to automate air traffic control and to integrate aircraft systems. Would control independent landing locations and integrate the battle management systems. **Contractor:** Transportation Systems. **Status:** Concept definition.

Automated Weather Distribution System
Program to enhance the Air Weather Service's meteorological support for the Army and Air Force by using advanced computer technology and graphic presentation software. **Contractor:** Unisys, Contel, Federal Electric. **Status:** Production.

Automated Weather Distribution System P^3I
Preplanned Product Improvement to AWDS, focused on improved graphics, interoperability, and communications. **Contractor:** None. **Status:** Full-scale development.

Avionics Intermediate Shop Mobile Facility
Program provides for developing shelter systems for F-15, F-16, A-10, and F/EF-111 avionics maintenance. **Contractor:** Medley Tool & Model Co. **Status:** Production.

AWACS Interface System
Program to provide Royal Saudi Air Force

with interface to its E-3 AWACS Sentry aircraft. **Contractor:** Boeing. **Status:** Deployment.

Base Air Defense Ground Environment
Program to provide engineering technical support to the Japan ASDF for a BADGE upgrade. **Contractor:** MITRE. **Status:** Deployment.

Battlefield Weather Observation Forecast Systems/Prestrike Surveillance Reconnaissance System
Program to provide decision aids in assessing weather effects on various weapon systems in specific battle situations. **Contractor:** None. **Status:** Full-scale development.

Battlefield Weather Observation & Forecast System/Tactical Decision Aids
A tactical decision aids system for providing weather observation from enemy areas and other inaccessible areas. **Contractor:** None. **Status:** Conceptual.

BMEWS Modernization Program
Program to upgrade the Ballistic Missile Early Warning System radars in Greenland and the UK, plus modernization of BMEWS radar in Alaska. **Contractor:** Raytheon. **Status:** Full-scale development, production.

Caribbean Basin Radar Network
Program to upgrade US air surveillance in the Caribbean via transmission of radar data via satellite and land links to US C^3 centers. **Contractor:** Westinghouse. **Status:** Production.

Cobra Dane Modernization
Upgrade to replace aging computers and software and improve processing of land-based, phased-array radar at Shemya AFB, Alaska. **Contractor:** None. **Status:** Full-scale development.

Combat Communications Access for Support Elements
Program to develop system for transfer of logistic information within battle areas and between battle areas. **Contractor:** None. **Status:** Full-scale development.

Combat Grande
Joint USAF and Spanish Air Force program to modernize Spain's air defense system. **Contractor:** MITRE. **Status:** N/A.

Combat Identification System/Indirect Subsystem
Program to develop and deploy NATO-compatible system for accurate and timely target identification to battle commanders. **Contractor:** None. **Status:** Full-scale development.

Comfy Sword
Program to develop a jamming and deception system for training aircrews to operate in electromagnetic environment. **Contractor:** Tracor Flight Systems. **Status:** Deployment.

Command Center Evaluation System
Program to provide central facility to evaluate technologies that might meet needs of USAF command centers. **Contractor:** None. **Status:** Conceptual.

Command Center Processing and Display System Replacement
A replacement system, part of the ballistic missile warning network, to receive warning information from sensors and produce integrated warning and attack assessment displays for Cheyenne Mountain AFB and SAC headquarters. **Contractor:** TRW. **Status:** Full-scale development, production.

Communications System Segment Replacement
A replacement system to improve the reliability, capacity, and flexibility of Cheyenne Mountain communications processing. **Contractor:** GTE. **Status:** Full-scale development.

Computer Resource Management Technology
Engineering development program to translate industry, university, and laboratory software advances into use in USAF weapon systems dependent on computer resources. **Contractor:** HH Aerospace. **Status:** Full-scale development.

Constant Source
Development of means to correlate and display intelligence information to unit-level forces. **Contractor:** None. **Status:** Conceptual.

Deep Space Surveillance Radar
Program to develop radars that will gather surveillance and warning information on critical synchronous-altitude space assets; expected to be an integral part of US Deep Space Surveillance Network. **Contractor:** None. **Status:** Concept definition.

Defense Message System
Program to improve all hardware, software, procedures, standards, and facilities used in the electronic exchange of messages in DoD. **Contractor:** None. **Status:** Conceptual.

Digital Brite
System that will replace the existing Brite display system with more reliable equipment displaying alphanumeric beacon data. **Contractor:** Unisys. **Status:** Production.

Digital European Backbone
Incremental upgrade to portions of the European Defense Communications system from insecure analog systems to secure digital systems. **Contractor:** GTE, Gould, TRW. **Status:** Production, deployment.

Diversity Reception Equipment
System to improve low-frequency communications for the Worldwide Airborne Command Post fleet. **Contractor:** Sonicraft Corp. **Status:** Full-scale development.

DoD Base and Installation Security System
RDT&E program to develop physical security equipment for DoD sites worldwide. **Contractor:** None. **Status:** Full-scale development.

Egyptian Encryption Acquisition
Acquisition of commercial digital encryption devices to link Egyptian E-2C aircraft and the ground-based air defense system. **Contractor:** Rockwell. **Status:** Full-scale development.

Egyptian E-2C/776 Interoperability
Technical assistance to Egypt on how to coordinate the E-2C Hawkeye aircraft and the 776 Ground System. **Contractor:** Hughes. **Status:** Deployment.

Egyptian Radar Repair and Upgrade
Program provides Egypt with repair, reengineering, and refurbishment capability for air defense radars. **Contractor:** EG&G. **Status:** Production.

FAA/Air Force Radar Replacement
Joint effort to replace 1950s-type surveillance and height-finding radars with modern three-dimension radars. **Contractor:** Westinghouse. **Status:** Production.

GEODSS
A ground-based, electro-optical deep space surveillance system that will extend Air Force Space Command's spacetrack capabilities involving objects up to 20,000 miles in space. **Contractor:** TRW. **Status:** Deployment.

Granite Sentry
Program that will replace the current NORAD computer system and modular display system and upgrade command post, air defense operations center, battle staff support center, and weather support unit in Cheyenne Mountain. **Contractor:** AFSPACECOM & DEC. **Status:** Full-scale development.

Ground Mobile Forces SATCOM Terminals
Program to produce highly mobile satellite communications terminals for the tactical air forces and others. **Contractor:** RCA, Harris. **Status:** Production, deployment.

Ground Wave Emergency Network
C^3 program to provide US strategic forces with long-range communications that can continue to function even in the presence of electromagnetic pulse. **Contractor:** RCA. **Status:** Full-scale development, production.

Have Quick II/IIA
An upgrade to the Have Quick antijam UHF voice communications radio. **Contractor:** Multiple. **Status:** Full-scale development, production.

Have Sync
Development of a single-channel ground and airborne radio system (SINCGARS) for antijam, secure-voice VHF/FM/AM communications to replace the AN/ARC-186 radio. **Contractor:** Cincinnati Electronics. **Status:** Full-scale development.

High-Power Microwave
Program to develop a tactical, point-de-

fense, high-power microwave for protection of C³I assets. **Contractor:** MITRE. **Status:** Conceptual.

Information Processing System
Provides automated support for command and control functions at the top six MAC command echelons. **Contractor:** Multiple. **Status:** Full-scale development.

Integrated Tactical Warning and Assessment System
Acquisition of new systems and upgrade of existing systems of the Integrated Tactical Warning and Assessment System. **Contractor:** None. **Status:** N/A.

Intelligence Work Station
Joint ESD/Rome Air Development Center project to replace standard intelligence terminals with modular, stand-alone stations. **Contractor:** Contel Federal Systems. **Status:** Production.

Intratheater Imagery Transmission System
Program to develop a hard-copy image dissemination system to allow the tactical air forces to transmit photographs and other intelligence information swiftly by electronic means. **Contractor:** GE, Litton. **Status:** Full-scale development, production.

Joint Services Imagery Processing System
Development of a ground station to receive, process, and disseminate national, strategic, or tactical imagery to combat commanders. **Contractor:** E-Systems. **Status:** Full-scale development.

Joint Surveillance Target Attack Radar System
A joint Air Force/Army program to develop the primary sensor needed to carry out the AirLand Battle doctrine; integrates a sensitive, side-looking multimode radar into an E-8A platform to create a targeting system able to detect ground-based objects, whether stationary or moving. **Contractor:** Grumman. **Status:** Full-scale development.

Joint Tactical Fusion Program
An evolutionary program to develop the Air Force's Enemy Situation Correlation Element and the Army's All-Source Analysis System, two programs that use data from numerous sources to create a picture of the battlefield. **Contractor:** NASA, JPL. **Status:** Full-scale development.

Joint Tactical Information Distribution System
A program to develop a high-capacity, jam-resistant, secure digital information system that will permit the distribution of intelligence data among fighter aircraft, surveillance aircraft, ground air defense units, and naval vessels. **Contractor:** Singer, Hughes, IBM, Rockwell. **Status:** Full-scale development.

JTIDS Multifunctional Information Distribution System
Low-volume terminal program to provide a highly jam-resistant, secure digital information distribution system for US and NATO aircraft. **Contractor:** Singer. **Status:** Conceptual.

Joint WWMCCS Information Systems
Development of system to replace and modernize current WWMCCS automatic data processing. **Contractor:** GTE, IBM. **Status:** Full-scale development.

Logistics Information Management System
A program to produce logistics information architecture and recommendations for helping to keep USAF weapons in a high state of readiness. **Contractor:** Transportation System Center. **Status:** Concept definition.

MAC Global Decision Support System
Program to upgrade MAC's six principal command centers. **Contractor:** NASA. **Status:** Deployment.

Microwave Landing System
A four-part DoD program to develop and produce landing systems to replace existing Instrument Landing System and Precision Approach Radars. **Contractor:** Multiple. **Status:** Full-scale development.

Milstar Satellite Terminals
Development of reliable, antijam, and survivable EHF satellite communications terminals for strategic and tactical use among all services. **Contractor:** Raytheon. **Status:** Full-scale development.

Miniature Receive Terminal
A program to develop survivable, low-frequency terminals to upgrade communications among NCA, SAC, and SAC bombers; terminals will be designed to work even in a nuclear environment. **Contractor:** Rockwell. **Status:** Full-scale development, production.

Modular Control Equipment
Development of a transportable, modular, automated air command and control system. **Contractor:** Litton Data Systems. **Status:** Production.

NATO Air Base SATCOM Terminal Program
Development of survivable terminals for wartime communications between NATO Air Operations Centers and allied airfields. **Contractor:** Harris, Ford. **Status:** Production, deployment.

NATO AWACS Program
Development, production, and enhancement of NATO's eighteen AWACS sentry planes; installation of a major upgrade, Electronic Support Measures, to provide a passive sensor system as a complement to active radar sensors. **Contractor:** Boeing. **Status:** Full-scale development.

New Mobile Rapcon
Program to acquire new approach-control radar systems to replace aging, mobile AN/MPN-14 systems. **Contractor:** Unisys (Radar AN/TPS-73), Aydin Computer System (NMR OPS). **Status:** Production (Radar AN/TPS-73), full-scale development (NMR OPS).

North Atlantic Defense System
Program to provide four long-range radars to enhance ability of Air Forces Iceland to perform NATO missions. **Contractor:** GE. **Status:** Full-scale development.

North Warning System
A program to develop new long- and short-range radars that will replace the aging Distant Early Warning (DEW) Line and provide continuous coverage from the northern slopes of Alaska across Canada and down the east coast of Labrador. **Contractor:** Unisys, GE. **Status:** Full-scale development, production.

Over-the-Horizon Backscatter Radar
Program to develop and deploy a series of four radar systems for long-range detection, early warning, and attack assessment of bomber and cruise-missile threats. **Contractor:** GE. **Status:** Full-scale development, production.

PACAF Interim National Exploitation Segment
Program aimed at providing an interim soft-copy exploitation capability. **Contractor:** Hughes. **Status:** Full-scale development, production.

Pakistan Aircraft Early Warning Study
A joint survey of Pakistan's requirements for aircraft early warning systems; detailed comparison of candidate systems to meet these needs. **Contractor:** None. **Status:** N/A.

Pave Paws
A program to develop and deploy advanced, large-scale, phased-array radar systems to provide precise early warning and attack characterization of enemy sea-launched ballistic missiles from all directions. **Contractor:** Raytheon. **Status:** Production, deployment.

Peace Shield
Development and acquisition of a ground-based C³ system for the Royal Saudi Air Force; includes equipment, facilities, and support units that will link up with existing Saudi tactical radars, the Saudi AWACS planes, and elements of other Saudi military forces. **Contractor:** Boeing. **Status:** Full-scale development.

Rapid Execution and Combat Targeting
Program to modify Minuteman and Peacekeeper launch-control centers. **Contractor:** None. **Status:** Full-scale development.

Royal Thai Air Defense Systems
Program aimed at upgrading and automating existing Royal Thai Air Defense System and expanding its long-haul communications network. **Contractor:** Unisys. **Status:** Full-scale development.

Saudi Arabian AWACS
Program to acquire and outfit five US-built AWACS E-3 aircraft for the Royal Saudi Air Force. **Contractor:** Boeing. **Status:** Deployment.

Scope Shield Phase I
Program to create a security police com-

munications system that will replace radios currently used by USAF security police in air base defense, weapon system security, and law enforcement. **Contractor:** Magnavox. **Status:** Production.

Scope Shield Phase II
Program to provide better communications for USAF security police and other forces. **Contractor:** None. **Status:** Production.

Security Pro
A security products program to design and develop secure computing systems able to meet war-planning, intelligence, and force-management requirements generated by Strategic Air Command. **Contractor:** None. **Status:** Validation.

Seek Score
Development of a radar bomb-scoring system made up of a ground radar that tracks aircraft and a computer that determines the bomb impact point after a simulated bomb release. **Contractor:** LTV. **Status:** Production.

Seek Screen Arm Decoy
Program to build a decoy that would protect the AN/TPS-43 radar from destruction by incoming antiradiation missiles. **Contractor:** Multiple. **Status:** Production.

Seek Screen Ultra-Low Sidelobe Antenna
Development of modification kit to provide enhanced electronic counter-countermeasures and performance for the AN/TPS-43E tactical radar. Kit will make this radar more resistant to enemy aircraft jamming, increase the radar's range and sensitivity, and make it more survivable. **Contractor:** Westinghouse. **Status:** Production.

Sentinel Aspen Phase I
Fabrication of a general-imagery intelligence training system for Air Training Command; uses computer-aided instruction in preparing imagery analysts for operational systems. **Contractor:** Loral. **Status:** Full-scale development.

Sentinel Aspen Phase II
Program to modernize the Air Intelligence, Targeting Indications, and Warning and Fusion Training conducted by Goodfellow Technical Training Center. **Contractor:** None. **Status:** Full-scale development, production.

Sentinel Bright I
Development and acquisition of a voice-processing training system with 460 workstations for the training of cryptologic linguists. **Contractor:** Engineering Research Co. **Status:** Deployment.

Sentinel Bright II
Design, development, and acquisition of a classified training system with 275 workstations and an unclassified training system with 113 workstations; used to train operators, analysts, and maintenance technicians for modern crypto systems. **Contractor:** American Systems Corp. **Status:** Full-scale development, production.

Sentinel Byte
Program to provide unit-level intelligence support system focused on automated use of data in tactical units. **Contractor:** Infotec Development. **Status:** Deployment.

Soft-Copy Exploitation System
Development of a common family of workstations for exploitation of digital imagery; a DoD program managed by ESD. **Contractor:** Classified. **Status:** Production.

Space Defense Operations Center
Program to develop new SPADOC at Cheyenne Mountain AFB; central C^3I element of the Space Defense Command and Control System to be used to collect and distribute information on space status and warning. **Contractor:** Ford. **Status:** Full-scale development.

STARS
Program known as Software Technology for Adaptable, Reliable Systems; pursues DoD goal of dramatic improvements in weapon software quality while reducing costs. **Contractor:** Boeing, IBM, Unisys. **Status:** Full-scale development.

Strategic Defense Initiative Battle Management
Analysis of and experimentation with promising concepts and technologies for C^3 and battle management of a future strategic defense system. An experimental version of Strategic Battle Manager will be used. **Contractor:** Sparta, Inc. **Status:** Concept definition.

Strategic Defense Initiative Planning/Test-Bed
Design and development of the National Test-Bed for SDI. This is an environment for evaluation and validation of possible SDI systems. **Contractor:** Martin Marietta. **Status:** Concept definition.

Survivable Base Communication System
Program aimed at dramatically reducing the time required to assess damage and direct efforts of air base recovery teams; combines communications equipment and computers for effective command of recovery personnel. **Contractor:** None. **Status:** Full-scale development.

Survivable Communications Integration System
Development of a multimedia management and control system for sending missile warning data between sensor sites and command authorities. **Contractor:** E-Systems. **Status:** Full-scale development.

System Trainer and Exercise Module
Development of trainer for personnel operating CRC/CRP AN/TSP-91 radars; provides capability to prepare exercise scenarios simulating flights of tactical aircraft. **Contractor:** GTE Sylvania. **Status:** Production.

Tactical Digital Facsimile
System to receive transmission of and reproduce photographs, maps, fingerprint replicas, and other forms of hard-copy images; compatible with standard modems. **Contractor:** Litton, Amecon. **Status:** Production.

Technical On-Site Inspection
Program to investigate technologies and concepts for on-site inspections of international arms-control agreements; procure prototype for continuous monitoring system supporting this goal. **Contractor:** Sandia Laboratory, Hughes. **Status:** Full-scale development, deployment.

TRI-TAC AN/TRC-170
Development and production of digital troposcatter radio terminals for use by tactical forces; provides secure transmission of messages; performs analog and digital voice transmission and transmission of digital data over a range of up to 200 miles. **Contractor:** Raytheon, Unisys. **Status:** Production, deployment.

TRI-TAC Communications Nodal Control Element
CNCE program to enhance technical assessment and control of tactical communications; capability to monitor performance and rapidly restore essential communications after failures and rapidly reconfigure communications to meet changing circumstances. **Contractor:** Martin Marietta. **Status:** Production, deployment.

TRI-TAC Joint Tactical Communications
Program to investigate and acquire new ground-based tactical digital communications equipment for multiservice use. **Contractor:** Multiple. **Status:** Production, deployment.

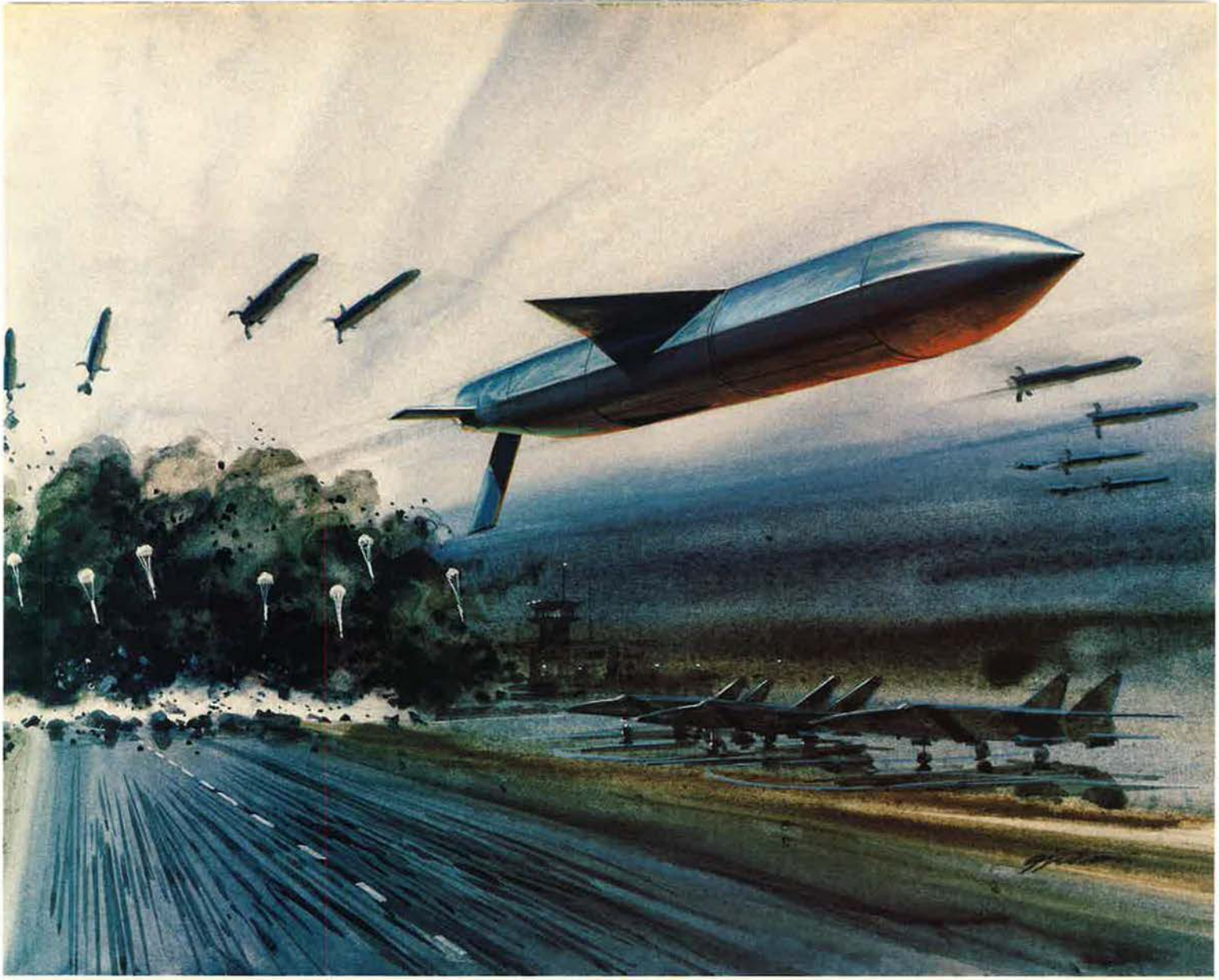
TRI-TAC United Arab Emirates
Program to modify and develop an AN/TRC-170 troposcatter radio set with support equipment for the UAE Hawk missile program. **Contractor:** Raytheon. **Status:** Production.

UHF Satellite Terminal System
Development of a deployable, multiple-access communications system based on a single UHF satellite channel for Military Airlift Command and DoD users. **Contractor:** Military Airlift Command. **Status:** Full-scale development.

Universal Modem
Program to develop an antijam, nuclear-hardened modem for use in all SHF SATCOM terminals that use the Defense Satellite Communications System. **Contractor:** Raytheon, MAC. **Status:** Full-scale development.

USTRANSCOM C^2 Study
Development support for US Transportation Command's effort to deploy new command and control systems linking various parts of its structure. **Contractor:** None. **Status:** Conceptual.

Weapons Storage and Security System
Research effort to determine new ways to provide dispersed, unattended tactical weapons storage using hardened vaults beneath the floors of aircraft shelters. **Contractor:** Bechtel National. **Status:** Production. ■



Our MSOW Team Is Right On Target.

In 1986, General Dynamics formed a multinational team to begin work on the Modular Standoff Weapon System (MSOW). The result of pooling our extensive, related technical capabilities and experience is a superior MSOW design.

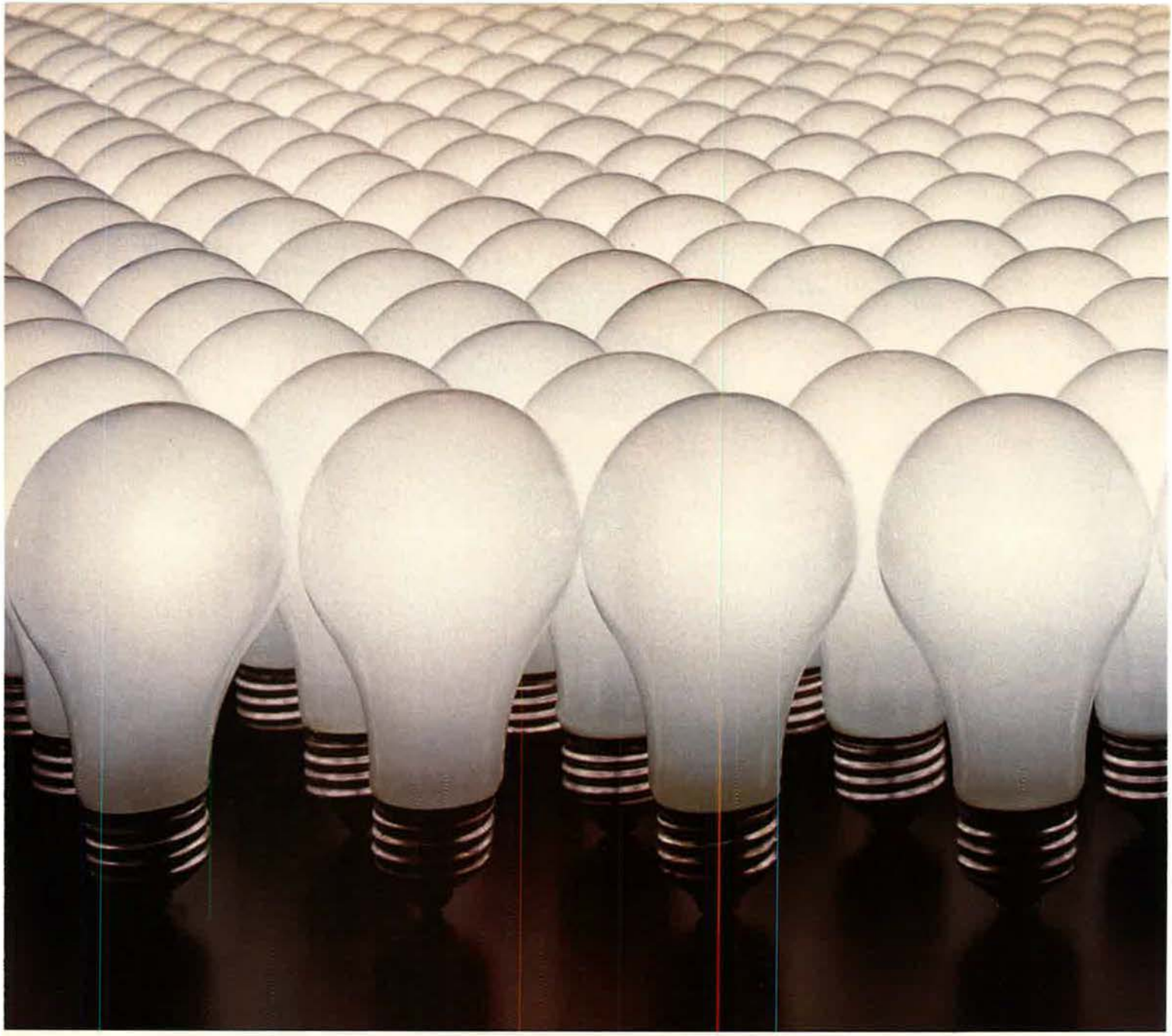
Verified in wind tunnel and RCS tests, our design promises an MSOW system that will supplement and enhance NATO fighter aircraft capabilities. By extending standoff range, penetration, and survivability, MSOW will effectively deliver a variety of payloads to desired targets.

Best of all, the complementary technologies of our strong multinational team enable us to deliver cost-effective MSOW systems with equitable technical work shares, and without compromising overall system costs or performance. MSOW: Technologically and economically right on target.

GENERAL DYNAMICS

A Strong Company For A Strong Country

THE MSOW TEAM: General Dynamics, Brunswick, Hunting Engineering, Sener, Dornier, Agusta



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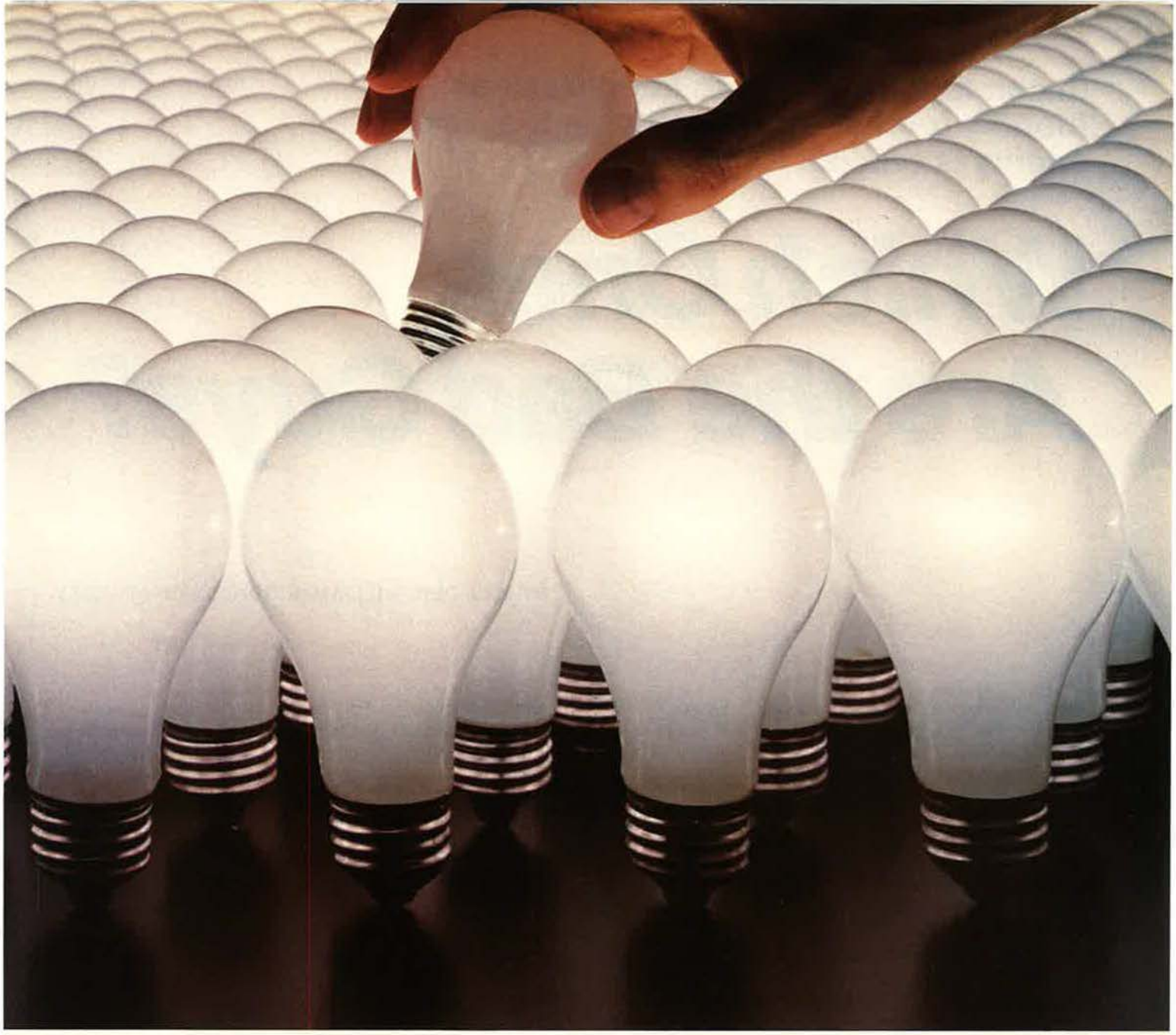

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In combat, it's useful to keep track of friendly forces—but identifying the enemy is crucial.

Which Ones Are the Bad Guys?

BY MAJ. GEN. WILLIAM A. GORTON, USAF (RET.)

Soon, a new air-superiority missile will become operational. The AIM-120A Advanced Medium-Range Air-to-Air Missile (AMRAAM) will give fighter pilots the latest in "smart" weapon technology. The $7.5 billion program will produce the type of high-tech weapon that advocates of competitive strategies are relying on to offset Warsaw Pact numerical superiority.

With AMRAAM, a single aircraft can engage multiple targets simultaneously. This would be a distinct advantage against a numerically superior foe. To achieve AMRAAM's fullest potential, it must be launched early in the fight—before pilots visually acquire their targets. Today, however, because US forces lack the means to positively identify enemy aircraft beyond visual range (BVR), AMRAAM will fall far short of achieving its full potential.

Shooting at targets beyond visual range is risky business. Before air commanders can establish rules of engagement that authorize such a launch, they need high confidence that the bad guys will be shot, not the guys in white hats.

The Dilemma

Surface-to-air and air-to-air missiles that can engage targets beyond visual range have been deployed for years. In actual combat, however, air defense forces rarely have operated with rules that allowed them to shoot at targets beyond visual range. Because air defense forces cannot positively identify hostile aircraft at this range, air commanders are rightfully concerned about fratricide—inadvertent destruction of friendly aircraft.

To reduce fratricide, air commanders usually establish rules of engagement that require a positive identification of the target as enemy before shooting. In most cases, this means closing with the target for a positive visual ID.

In a close-in fight, BVR weapons are severely limited. The situation is analogous to that of being in a fight in a telephone booth when your opponent is armed with a knife and you're armed with a rifle.

Not since the advent of BVR weapons have US forces been engaged in large-scale air battles against a numerically superior force. Therefore, engagement rules constraining the use of these weapons have not, in the past, been a significant factor. This would not be the case in a future Central European air war.

The struggle for control of the sky over Central Europe would likely be characterized by large-scale air battles, fought in prolonged, violent engagements with friendly and hostile aircraft intermixed. Command and control would be difficult. Because MiG-29s and Su-27s resemble many US and allied aircraft, even positive visual identification would be uncertain.

If friendly forces are required to "check tail numbers" before shooting, they will be denied the technological advantage of AMRAAMs. "Don't fire until you see the whites of their eyes" may have been the correct rule of engagement for the troops at Bunker Hill, but its modern equivalent would spell disaster in the sky over Central Europe.

IFF: Myth and Reality

Virtually everyone in the military knows the words represented by the abbreviation IFF: "Identification, Friend or Foe." That's where the problems start. IFF systems can't identify foes. In fact, they can't even identify all the friendlies. Today's systems, and those being developed, would be better called ISF: "Identification, Some Friends"!

IFF systems can be expected to identify only friendly aircraft, and then only those friendlies that cooperate. All IFF systems are, by design, question-and-answer (Q&A)

20/100	E	100 FT. / 30.5 m
20/70	D G	70 FT. / 21.3 m
20/50	E L 	50 FT. / 15.2 m
20/30	A  V D G	30 FT. / 9.14 m
20/20	R D L O P E	20 FT. / 6.10 m
20/15	C E K S I X O R D	15 FT. / 4.57 m

devices. They require the transmission of compatible signals between the interrogating air defense element and the aircraft to be identified. For a friendly aircraft to be identified, an IFF transponder must be installed, and it must be turned on, not malfunctioning, and set to the correct code. In combat, IFF codes would be changed frequently. These changes, in theory, would be given to all aircraft by C^2 elements, which would be under intense enemy attack. Enemy jamming would compound the problem further.

Today, a significant number of "inside-the-Beltway experts" sees IFF as the solution to the BVR rules dilemma. Evidently, they believe it is feasible to identify all friendlies, identifying foes by a process of elimination. Considering IFF limitations and the real world of combat operations, one doesn't have to be a rocket scientist to figure out that the probability of identifying one hundred percent of friendly aircraft one hundred percent of the time is zero.

Strategic vs. Tactical Air Defense

IFF systems grew out of a need to provide positive command and control of friendly forces. They are particularly useful in strategic air defense operations such as air defense of the US and the Navy's Outer Air Battle. These types of operations normally are characterized by enemy attempts to penetrate a defined perimeter that is being defended by a homogeneous force under close control with rules that authorize BVR engagements.

There are a number of reasons why BVR rules are typical in strategic air defense operations. First, there is a high probability that the air defense system will be able to identify most of the friendlies over a prolonged period. Second, targets being defended are of the highest value; therefore, engagement of attacking forces must begin early—as soon as they are within lethal range of defending weapons. Finally, because the stakes are so high, concern for fratricide is not as great. Should the carriers be sunk, for example, the defending aircraft would soon go down as well.

Though strategic air defense operations are relatively controlled, tactical air defense operations are far more complex. One need only look at recent events in the Persian Gulf for an example.

The circumstances in which Iran Air Flight 655 was destroyed by the USS *Vincennes* are well known. That it was a tragic error there is no doubt. Nor is there any serious doubt that the captain of the *Vincennes* acted correctly, given the information he had. How was it that the most advanced air defense ship in the world could make such an error?

The *Vincennes,* like all Aegis cruisers, is designed to be the heart of naval forces' command and control, particularly for the Outer Air Battle. On July 3, 1988, however, the *Vincennes* was not in the open ocean, ringed by radar picket ships, E-2Cs, and F-14s providing advance warning and control. It was in confined waters, receiving mixed indications of friendly, hostile, and unknown air traffic, and it was under surface attack. On a very small scale, the environment was similar to the tactical air defense situation that would confront the Commander, Allied Air Forces Central Europe (COMAAFCE), in a NATO-Warsaw Pact war.

Most important, the 1987 Iraqi attack on the USS *Stark* had brought about a change in the rules of engagement for Persian Gulf naval forces. The *Vincennes* was operating under BVR rules. It was clear to shoot beyond visual range based on a determination of "hostile intent." Even though Iran Air Flight 655 was on a "normal flight path" and transmitting the proper code with its IFF transponder, the confusion of battle led to a tragic mistake.

One can speculate about why a civilian airliner was allowed to enter an active combat area, or why it did not respond to repeated radio calls. The important point, however, is that the problem lay not with the *Vincennes* and its crew, nor with the rule of engagement, but with means of identification. The affair provides a window on the complexity of tactical air defense operations and the limits that confront air commanders employing BVR weapons without adequate means to identify what they are shooting at.

Initially, a fight for control of the skies over Europe would resemble strategic air defense operations. Experts believe that Pact forces would attack key NATO air bases, logistic sites, nuclear units, and C^2 nodes. Under these circumstances, COMAAFCE would have high confidence that everything approaching from east of the political border would be hostile. Defending NATO fighters and SAMs would be operating in separate zones. They would be operating with rules authorizing BVR engagements.

COMAAFCE's Dilemma

From the moment an attack on NATO begins, COMAAFCE would seek authority that would dramatically change the air defense environment. For NATO forces to prevail, they must strike Pact forces across the border. COMAAFCE must conduct offensive counterair operations against Pact airfields, SAMs, and C^2 nodes and carry out air interdiction operations against ground forces and supporting infrastructure. He must have border crossing authority from NATO—and he must have it fast.

Once this authority is granted, the air defense environment would get very messy, very quickly. Not all aircraft proceeding east to west would be hostile; nor would all aircraft proceeding west to east be friendly.

Sorting out who's who among hundreds of NATO and Pact aircraft will be difficult, if not impossible. While detailed procedures are in place to assist in sorting friends from foes, most analysts agree that this system will rapidly deteriorate in the confusion of battle. When this happens, rules that allow BVR engagements would cause an unacceptable level of fratricide.

Thus, COMAAFCE would be confronted with a dilemma. To continue BVR engagements would compound his losses. To stop them would deny him the full combat capability of his air defense weapons. Whatever his choice, the probability of success would be dramatically reduced.

Judging from program funding, the Defense Department believes that the answer to COMAAFCE's dilemma is a new IFF system named Mark XV. In a program called Combat Identification Systems (CIS), the bulk of funding is directed toward Mark XV. Paralleling the US

CIS program is the NATO Identification System (NIS) program. Mark XV is the centerpiece of both programs. Just the US portion of full Mark XV implementation reportedly will cost nearly $7 billion. When allied forces are added, NATO's total cost could top $12 billion.

Plans call for Mark XV to be installed in all US and allied fighter aircraft, most helicopters, some ships, and key C^2 nodes. At first glance, this seems a logical thing to do—particularly in view of the fact that some NATO aircraft don't have any IFF while most others have the older Mark X and Mark XII, systems increasingly vulnerable to jamming.

The reality is that Mark XV is no different from any Q&A system, only more reliable and less susceptible to jamming. Even when all US and allied aircraft are equipped, it will still be an "ISF" system. It won't identify a single foe.

And when will Mark XV replace current IFF systems? After more than twelve years of arguments about frequencies, wave bands, and priorities among nations and services and constant "top-down" direction from OSD, the US recently awarded a $708 million full-scale development contract. Even if there are no further delays and funding continues as planned—two big ifs—initial low-rate production won't start until 1994, with full-rate production no earlier than 1996.

It will be well into the next century before Mark XV will replace current IFF systems. By then, AMRAAM will have been in service for years, all currently planned improvements to Patriot and Hawk SAMs will have been made, a new generation of short-range air-to-air missiles will have entered service, and new air defense weapons will be in development. Yet unless there is a major change in today's CIS priorities, COMAAFCE will still lack sufficient capability to positively identify the bad guys.

The Keys to Foe ID

The CIS program is divided into four elements: Mark XV, Indirect ID, Noncooperative Target Recognition (NCTR), and Multisource Integration (MSI).

Mark XV identifies only friends. Indirect ID focuses mostly on improvements to C^2 elements. Thus indirect systems can identify both friends and foes. "Constant tracking from source" by an E-2C is one such indirect method, used to good effect in the recent shoot-down of Libyan MiGs. Other inputs to the C^2 system from intelligence sources, position data, etc., can contribute. Indirect systems, however, are most effective when the probability of control is high—as in strategic air defense operations and "few-on-few" engagements such as the Navy's encounters with Libyan aircraft. Indirect systems can be expected to be less effective in large-scale tactical air defense operations, particularly when the C^2 system comes under attack.

Of the four CIS elements, only NCTR is aimed directly at foe ID. NCTR technologies are focused on unique aircraft and ship characteristics such as sound, shape, and electronic emissions. There are several NCTR technologies that offer excellent potential for positive BVR identification of foes.

The problem with NCTR is that no single technology appears to offer a surefire means of foe identification. All have limitations: atmospheric conditions can disrupt optics and acoustics, emissions can be attenuated, even shapes can be changed or made to appear that they have changed.

The fourth CIS element, MSI, is directed at development of algorithms by which the input of the other three CIS elements can be "fused" and processed. The output is intended to provide fighter pilots, SAM operators, and C^2 units with accurate target classification. Today, the output is some friends, a few foes, and a lot of unknowns.

Though all four elements of CIS are needed to provide a complete air-situation picture, the need for NCTR systems and MSI processing is most pressing. Considering that US and allied air commanders have for many years listed positive foe ID well above their need for friend ID, it is surprising that Mark XV continues to garner eighty percent of CIS funding.

The more pragmatic proponents of Mark XV recognize that achieving 100 percent friend ID is an ideal rather than a realistic goal. Some believe, however, that attaining seventy-five percent friend ID is possible and that at this level NATO can fully exploit its air defense weapons. What they fail to realize is that no tactical air commander can afford to establish rules of engagement that will place twenty-five percent or even ten percent of his force at risk.

The combat power inherent in AMRAAM and in improved Patriot and Hawk SAMs will not translate into a war-winning capability unless the allies increase their capability for positive foe ID. Mark XV alone won't hack it.

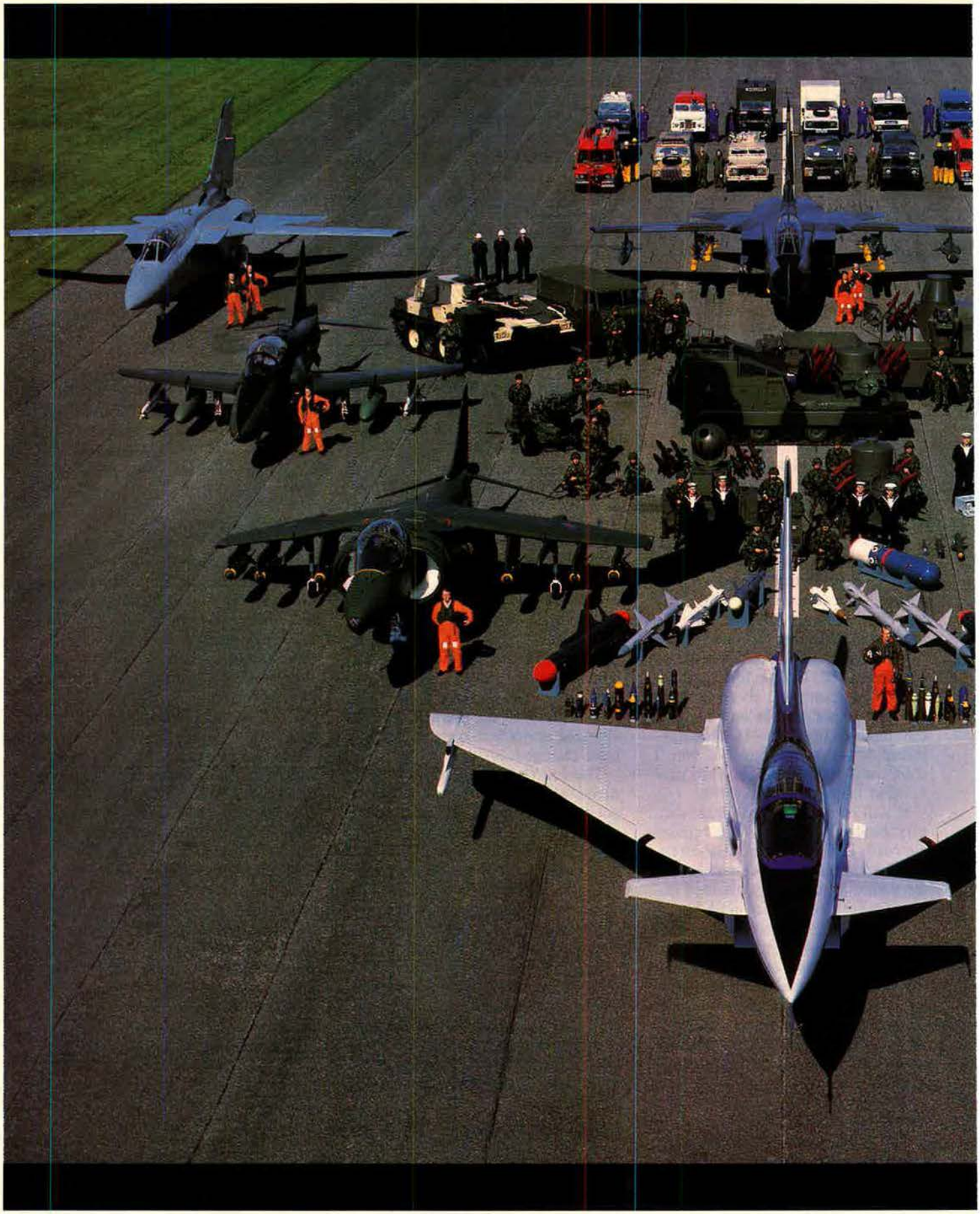
A War-Winning Priority

It is time to shift CIS program priorities to match the priorities of those responsible for winning the air war—the operational commanders. Increased CIS funding is not required. What is required is a redirection of the energies of industry toward NCTR technologies and the MSI algorithms necessary to process all of the CIS input, including IFF.

There is no need to identify all foes before air commanders can authorize BVR rules. All they need is confidence that what is identified as a foe *is* a foe. They will then be able to establish rules that authorize BVR engagement of those so identified. Destruction of fifteen to twenty percent of an attacking force before they employ their weapons would likely disrupt an attack and dramatically increase the West's ability to achieve air superiority.

While IFF is important to the process, foe identification is a critical operational need that demands more attention from industry, Congress, and DoD. ■

Maj. Gen. William A. Gorton, USAF (Ret.), is Vice President of International Planning and Analysis Center (IPAC, Inc.) in Washington, D. C. He is the former commander of USAFE's Sixteenth Air Force and Director of USAF Operational Requirements. As a tactical command pilot, he had more than 5,000 hours of flying time and was operationally qualified in eighteen types of aircraft. His byline last appeared in AIR FORCE *Magazine with the October '88 article "Of Mudfighters and Elephants."*



Displayed are: EAP (Experimental Aircraft Programme) – forerunner of the new European Fighter Aircraft, Harrier II GR.5 (advanced V/STOL fighter), Sea Harrier FRS2, Hawk 100 (advanced jet trainer/strike aircraft), Hawk 200 (single-seat fighter), Tornado ADV x 2 (Air Defence Variant), Tornado IDS (Interdictor Strike); Active Sky Flash, Boosted Sea Eagle, Sea Skua, Seawolf, ALARM air launched weapons; Merlin, Swingfire and TRIGAT anti-tank weapons; Sea Urchin and VEMS underwater systems; British Aerospace Systems and Equipment products (BASE); Rapier, Laserfire and Rapier 2000 surface-to-air defence systems. Royal Ordnance 105mm light gun, 30mm Rarden gun, 81mm Mortar,

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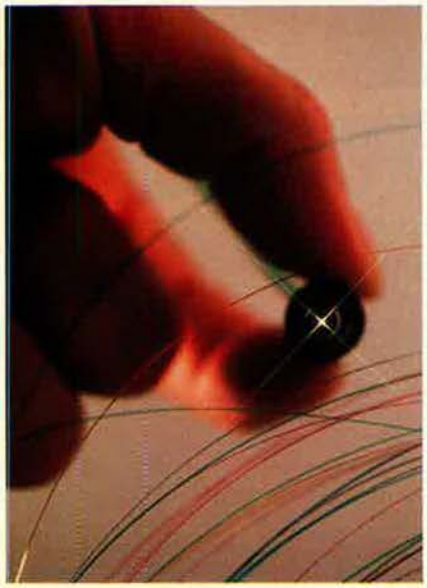
The Air Force is edging toward the photonic future along three parallel paths.

Beyond Electronics

BY JOHN RHEA



Images "seen" by a new type of infrared missile seeker (right), being developed for the Army's Fiber-Optics-Guided Missile, appear on a video monitor. The seeker's "eye" is one platinum silicide hybrid focal plane array chip.

PHOTONICS, the technology that the Air Force has identified as the logical successor to electronics for weapon systems of the twenty-first century, is evolving along three parallel paths—but not necessarily at the same rate.

Leading the way are fiber optic data distribution networks, which convert electronic signals into streams of photons for secure, high-volume traffic within airborne systems.

Following behind are analog optical devices to replace such front-end sensors as radar and further reduce vulnerability to detection and increase bandwidth.

Bringing up the rear are new digital optical devices that would complete the job by processing the information in the form of photons rather than electrons, thus matching the immunity to electromagnetic interference (EMI) and high data rates of the other two breeds of photonics.

These are the three basic technological thrusts of USAF's new Photonics Center at Rome Air Development Center (RADC), Griffiss AFB, N. Y. Its purpose is to fulfill the Air Force's goal, as outlined in the Project Forecast II studies completed in 1986, to replace electronics with photonics wherever possible.

Of the three elements, fiber optics is the one that is here today. This technology will be employed in the generation of weapon systems currently in development, such as the Air Force's Advanced Tactical Fighter (ATF).

Fiber optic data buses will serve as the link between two types of advanced electronic systems developed under sponsorship of the Defense Advanced Research Projects Agency (DARPA): powerful front-end sensors using gallium arsenide (GaAs) analog devices from the Microwave/Millimeter Wave Monolithic Integrated Circuit (MIMIC) program, and high-capacity airborne digital computers from the Very-High-Speed Integrated Circuit (VHSIC) program.

Ever-Smaller Circuits

The reason why the Air Force identified photonics as the technology that would be pervasive throughout future systems is that today's silicon-based electronics technologies (and even emerging GaAs technologies) are approaching their theoretical limits. Individual elements on the chips, such as transistors, have to be made smaller in order to carry the increased data traffic projected for the future.

It can't be done. The goal of the VHSIC program was to get the size of the elements down to half a micron. (The human hair is about 100 microns in diameter; it would take 200 of these microminiature transistors to equal that diameter.) That ambitious VHSIC goal has been realized, and this technology is being inserted into operational systems, beginning with Westinghouse's AN/ALQ-131 jammer pod for the Air Force.

MIMIC should do a little better because GaAs has at least five times the electron mobility of silicon and should soon find its way into digital applications. Control Data Corp.,

the Navy's prime contractor on the AN/AYK-14 airborne computer for the A-12 Advanced Tactical Aircraft (ATA), is studying ways to replace conventional silicon integrated circuits on that computer with more powerful GaAs devices fabricated out of entire wafers.

Experts in solid-state physics speculate that another tenfold reduction in size—down to 1/20th of a micron, or 2,000 devices lined up in the width of a human hair—is possible before the elements become jammed so closely together that the required electrical current causes them to overheat, thereby destroying the circuits.

Beyond that point, optical devices will be needed. By handling the data traffic as photons, they eliminate the heat and power-dissipation problems inherent in electronic devices. They also reduce vulnerability to EMI and electromagnetic pulse (EMP) radiation from nuclear blasts. This is because there are fewer electrical systems to be affected.

Pushing Speed Limits

USAF is serious about pushing optical technology to its limit. One measure is the ambitious data-rate goals the service has set. According to John L. Stacy, an electronics engineer in the Photonics Center's Lightwave Signal Processing Group, the minimum goal for next-generation fiber optic data buses is to achieve data rates 10,000 times greater than that of today's 1553 data bus.

The 1553, an all-electronic device, can transfer data at a speed of one megabit (one million bits) per second, which is considered adequate for the needs of today's aircraft. Then will come the current-generation fiber optic bus, which will be seen in the Air Force's ATF and the Navy's ATA. For those aircraft, planners have specified the use of a fiber optic unit with an initial capability of fifty megabits and potential to grow to 100 megabits.

Even that rate looks primitive compared to what is expected to emerge from the next generation of photonics research. In the new R&D cycle, says Mr. Stacy, "we're looking for a new plateau of performance. We're not interested in even one gigabit [one billion bits] per second. . . . We're starting at ten gigabits."

Current research is using a neodymium/yttrium aluminum-garnet laser with 150 watts of peak pulse power as the source to generate 100 picosecond (trillionths of a second) pulses. These signals are time-division multiplexed onto a fiber optic local area network (LAN). The researchers are looking at the pulses on a twenty-gigahertz oscilloscope and report error rates of less than one in a billion.

The work at this point is being conducted strictly on a laboratory-prototype basis, using standard, off-the-shelf optical fibers such as those already used by the commercial telephone industry. The goal is to create what are known as star-coupled networks, capable of high-volume data traffic from any station on the LAN.

That's only the beginning, according to Mr. Stacy. By using pulse-compression techniques, he hopes to reduce the time between pulses to two picoseconds and increase the data rate to 100 gigabits per second. Further improvements are expected to stem from wavelength multiplexing.

Data rates like these will be needed for other futuristic, Forecast II-type systems such as "smart skins." Mr. Stacy cites the example of how the reduced weight and interference, increased bandwidth, and precise delays made possible by this technology will enable the Air Force to build advanced phased-array antennas right into the structures of future aircraft.

These powerful new data distribution systems will also enable the Air Force to create reconfigurable system architectures for mission flexibility on future space platforms, such as the X-30 National Aerospace Plane, much as the Pave Pillar architecture contributed to today's airborne information processing systems.

Analog vs. Digital

Photonics is inherently more adaptable to analog than to digital applications. Consequently, the first optical signal processors to find their way into weapon systems are likely to be analog front-end sensors. This situation is similar to the early days of computers in the late 1940s, when analog systems were competitive for a brief period until the groundwork was laid for today's universal digital, electronic, stored-program computer. Digital technology has led the way in electronics ever since. The most recent example is the relative pace of the VHSIC and MIMIC programs.

Lt. Michael J. Ward, a physicist at the Photonics Center, is working on an analog acousto-adaptive processor that may greatly reduce the vulnerability of future aircraft to hostile electronic jamming. The rule of thumb is that a radar can be jammed by only one-tenth of its required output power, so Ward is looking into optical techniques that would separate out jamming noise. This noise is converted into a measurable time delay and subtracted from the total signal in order to negate the jammer.

Another promising analog application of optical processing technologies is pattern recognition, according to Andrew Pirich, chief of the Photonics Center's Analog Optical Signal Processing Branch. Pattern recognition is an important military requirement that has strained the capabilities of conventional electronic devices that measure the intensity of the target signal. Today, Mr. Pirich is investigating use of optical filtering to provide phase information about targets.

The idea is to find the targets faster and with greater resolution, which in turn dictates the need for more powerful processing techniques capable of generating more picture elements (pixels). This research is heavily dependent on the technology of advanced materials, including barium titanate, lithium niobate, and GaAs doped with aluminum.

Analog technologies are able to carry out the vital data-fusion and threat-assessment functions, either by themselves or through use of algorithms to convert the data to digital format, according to Dr. Richard J. Michalak, chief of the Digital Optical Computing Branch at the Photonics Center. His interest is focused on the complex signal processing functions of the early twenty-first century that will require digital optical methods.

Two are at the top of his list: the Strategic Defense Initiative (SDI)

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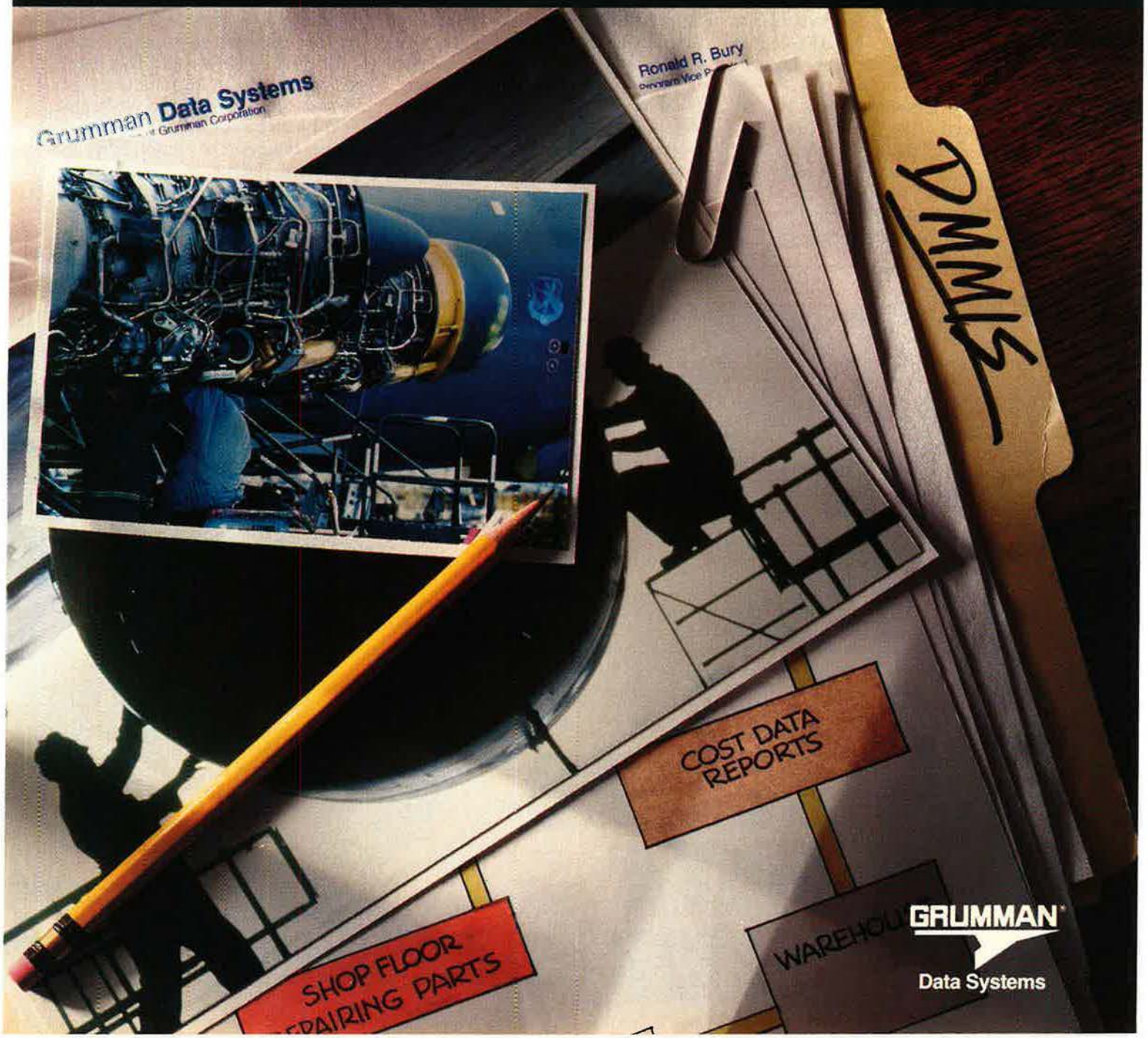

task—particularly the vexing battle-management problem—and tactical command and control. In each case, throughput performance many orders of magnitude higher than that of today will be needed to achieve real-time operations. This requires parallel processing, which is being developed today for electronic systems, but it also demands more powerful digital switches.

"The premier challenge is [developing] low-power, high-speed optical gates," Dr. Michalak says. The first prototypes have been successfully fabricated. Under an Air Force study contract, Professor Chung Tang of Cornell University's electrical engineering faculty has developed such a prototype gate. In this prototype, laser diodes on a GaAs substrate can switch signals by turning the laser output at right angles. This technique, known as "mode switching," promises to bring greatly expanded efficiency. Unlike conventional electronic switches, in which the devices are turned on and off, digital optical devices can be left on at all times.

There is a problem, however. The cost of such gates will have to come down drastically. The prototype gate costs $10,000. After more than twenty years of production, the most common electronic gate—transistor-transistor logic, known in the semiconductor industry as "T-squared L"—is down to a cost of one cent per gate. That's a price differential of a million to one. Of course, T-squared L didn't start at a penny per gate, but it didn't start at $10,000, either. More economical fabrication techniques will have to emerge if optical devices are ever to challenge electronics in digital logic.

Dr. Michalak isn't sure that this will ever happen. "Electronics is good and getting better," he says. One technology that might keep electronics progressing—and at a rate at which photonics would not be able to catch up—is superconductivity. Potentially, at least, superconductivity could replicate the single most important attribute of optical devices: their lack of damaging heat and power dissipation.

There is another problem. Although optical switches don't generate excessive heat, the same cannot be said for the lasers needed to operate them. This is another worry for Dr. Michalak, who says the heat of the laser today is greater than that of comparable electronics.

As a result, says Dr. Donald W. Hanson, head of the Photonics Center, there may ultimately be a technological marriage of electronics and optics (variously known as opto-electronics or electro-optics) in which each party will retain some degree of independence in a hybrid arrangement.

The ideal solution, explains Dr. Hanson, would be to do everything within a computer optically, because optical technology possesses inherently greater bandwidth. He adds, however, that there would still be the problem of communicating with the outside world. This external connection, in which the signals have to be converted to electronic or even electromechanical formats, also is the point of vulnerability for EMI and EMP.

This, in turn, requires that technologists place great emphasis on coming up with the right overall sys-

tem architecture, according to Dr. Hanson. "Replacing an optical part with an electronic part is not the best way to go because of their different properties," he notes.

That's what the Photonics Center is all about: determining the rate at which photonics can be inserted into future systems in order to complement existing electronic methods. Dr. Hanson calls this "a catalyst for technology transfer," adding, "We have to get the technology out of the lab and into some sort of product."

When the Air Force established the Photonics Center in 1987 as its focal point for photonics research, it comprised only four persons, working in temporary offices. Now, two years later, the staff numbers twenty-seven and is projected to grow to fifty. This summer, the Center is moving into remodeled facilities of its own at Griffiss AFB. This will triple its work space to 8,500 square feet of laboratories and another 7,500 square feet of offices.

Basically, the Center's work is an in-house operation at the 6.2 and 6.3 levels of research, although the Photonics Center is eager to tap local universities and industries for experts it can hire for temporary projects. "People from the outside have fresh ideas," Dr. Hanson says, "and when they understand Air Force and DoD needs, they can also take them back to their universities."

The Center is also working with the Air Force Office of Scientific Research and the National Science Foundation on some contracted research and has had discussions with the New York state government about cooperative projects. Even so, the focus remains on building an internal capability. The research program is budgeted at about $30 million a year (out of the total Rome Air Development Center budget this year of an estimated $465 million, from 6.1 to 6.4). Dr. Hanson emphasizes that it is applications-driven, not technology-driven.

RADC's commander, Col. Raymond A. Shulstad, gives special attention to practical applications. "RADC is first and foremost a laboratory and the Air Force's center of expertise in C³I [command control communications and intelligence]," he says. "Photonics will be pervasive . . . and the drivers will be optical processing for speed and capacity."

Thus, photonics researchers stand at the brink of a potentially enormous technological advance. Barring unforeseen technical barriers, or the rise of another technology such as superconductivity that obviates the need for optical signal processing, photonics could bring about a revolution comparable to the replacement more than forty years ago of the vacuum tube by the transistor. That revolution provided the foundation for all of today's advanced electronic circuits. If such indeed proves to be the case, photonics would be very pervasive indeed. ■

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Some of these can deliver benefits in the next decade. Others promise dramatic new capabilities after the turn of the century.

Ripe Technologies

BY GEN. ROBERT T. MARSH, USAF (RET.)

CHAIRMAN, AFA SCIENCE & TECHNOLOGY COMMITTEE

NEW military capabilities spring from several roots. One is the conventional, well-understood requirements process, in which the operational commands specify the features and characteristics they desire in weapon systems for the future. There is much to be said for this approach, but it tends mainly to seek improved variations on existing systems.

Another source of new capabilities is the push by zealous advocates for some technological opportunity, frequently in the face of a "show-me" attitude, or even a negative attitude, on the part of the operational community and approval authorities.

I worry that if we depend too much on the former "pull" process to the exclusion of the latter "push" stimulation, we will become trapped in incrementalism and fail to achieve important outflanking capabilities. It was pursuit of technological opportunity in the past that led to the development of ballistic missiles, space surveillance and communications systems, AWACS, cruise missiles, and stealth.

Despite the declining condition of the technology base *(see accompanying box)*, opportunities today are ripe or ripening. For practical reasons, it is useful to divide them into two categories: technologies that can deliver benefits in the next decade and those that hold promise of dramatic new capabilities in the early twenty-first century.

The lengthy defense acquisition process probably precludes the fielding of any significant new weapon system capability in this century unless development has already begun. The defense budget outlook exacerbates that problem. Shorter lead times are still possible, though, in the case of lesser system capabilities or improvements to existing capabilities.

The Department of Defense and the Air Force are already committed to a substantial acquisition program for much of the next decade. In fact, it will be a major challenge to maintain support for all of these programs. At the same time, the services must assimilate the numerous new systems and capabilities they have acquired recently, plus those that will be coming out of development in the next few years.

It seems clear that there will be little room for additional major acquisitions. That being the case, my list of ripe technologies for the next decade emphasizes those that could aid with the assimilation of new weapon systems or those that might enhance their planned capabilities.

Improving O&M

First, consider how technology could improve the productivity of maintenance and training, achieve a substantial reduction in operations and maintenance costs, and ameliorate the budget problem.

The technology is at hand for big improvements in every aspect of maintenance. All maintenance requirements and diagnostic and repair procedures could be managed in a distributed digital network system. This system would be supported by a common distributed database containing all weapon system design and configuration information needed for Air Force purposes. It could also satisfy the data needs of contractors and suppliers.

The networks would extend all the way to the maintenance technician on the flight line. His tasks would be accomplished with the aid of a small interactive terminal by which he could obtain all necessary instructions and diagnostic assistance. This same system would be linked with the supply system to call up replacement parts. Paper would be eliminated. The system will also facilitate changes and improve responsiveness.

Training would be simplified and skill requirements would be reduced. I believe that new trainees could learn and adapt more readily to such a computer-based system than to our current paper-intensive maintenance system.

The long-term O&M savings potential is very great. The challenge is how to introduce such a change into our large, existing, multiweapon-system, paper-dependent logistics environment.

Much of industry has already made such a transition. Some recent Air Force initiatives have taken a step in that direction, but widespread implementation still lies ahead. It is clear that the force will operate in this manner in the future. The only question is: How soon? The investment, although not inconsequential, could be amortized over a few years, after which large savings would result.

Technology is also available to ease the problems of rising costs and environmental constraints on realistic combat training. DARPA and the Army have made considerable progress in multiplayer exercise training, linking together many low-cost simulators by means of a high-data-rate digital network called SIMNET. They have proven that this system provides valuable individual and team training to tank and helicopter crews.

A similar approach could be useful in aircrew training. An easy first step could be taken in close air support and battlefield interdiction. Low-cost aircraft simulators might be linked not only to each other but also to Army simulators. In addition to its training value, the network would be a tactics development tool. The concept could be expanded into other air operations areas as users gain experience. Several companies, including McDonnell Douglas and British Aerospace, have already started "linked simulator" systems for air-to-air combat.

Still other simulation schemes are within sight, thanks to the availability of relatively low-cost, high-capacity digital data links and remarkable advances in digital scene generation and projection.

For example, with the avionics data bus architecture of our current-generation aircraft, it would be possible to link the cockpits of operational aircraft to a simulation module, enabling pilots to rehearse their planned mission. By linking several such cockpits together, a capability

Our Store of Technology Is Becoming Sparse

Today, we are reaping the fruits of wise technology investments made in the past. Our current generation of military systems and the even more capable ones now emerging would not have been possible had it not been for the technology base.

These systems are the outgrowth of tech base projects in such areas as inertial guidance; advanced turbine technology; fly-by-wire controls; terrain comparison and matching guidance; composite, high-temperature, and radar-absorbent materials; forward-looking infrared sensors; synthetic aperture radars; and multimicro detector focal plane arrays.

Now, however, there are disquieting indications that the health of our technology base is not what it should be and that the favorable development conditions we enjoyed in the past may not exist in the future. Air Force investment in the technology base in constant dollars has declined since the early 1960s. Except for a short period of modest growth—four percent a year—from 1982 through 1986, it is still declining.

The OSD annual assessment clearly shows that our lead over the USSR in a number of important military technology areas is dwindling. The more pronounced narrowing of our lead in comparison to many friendly nations in the world is equally disturbing. Although some might disagree with the evaluation of our current relative position in specific technology areas, none denies the dramatic decline of our lead over the short period of the last ten to twenty years.

As we embarked on design of a new capability in earlier years, we were seldom limited by technology in establishing such criteria as the accuracy, range, or combat margin required. In most cases, the challenge was to make cost-effective choices between competing technical approaches. Usually, there seemed to be plenty of technology on the shelf to construct a winning capability.

Increasingly in recent years we have had to precede our systems efforts with a technology maturation phase. We see it in the Advanced Tactical Fighter, the Strategic Defense Initiative, space-based radar, Joint STARS, the hypervelocity missile, the B-2, the National Aerospace Plane, and other programs. We refer to this effort by such names as pre-full-scale engineering development, risk reduction, demonstration/validation, and just plain technology maturation. But the purpose is the same: to mature the key technologies involved to a point where we have sufficient confidence to proceed with a reasonably low-risk, full-scale engineering and development program. These efforts are becoming more intense and are taking longer.

Some would argue that we are reaching further with today's systems and that technology maturation is needed for that reason. I say that our store of technology on the shelf is becoming sparse.

to develop and practice team tactics might be created. I am aware of the concern that increased use of simulators may threaten the essential flying training program, but I believe that it can and should be viewed as a supplement that helps offset the limited opportunities for realistic combat-crew and joint-exercise training.

Enhancing Communications

In another area, technology is available to close the intelligence/operations gap. Great strides in sensor development have produced an ever-increasing wealth of real-time threat information and precise target location data. Unfortunately, there has not been similar progress in the effective use of this information by the combat elements.

Despite past skepticism based on disappointing results of earlier efforts, I am now convinced that communication, artificial intelligence, and processing technology are adequate to synthesize this information and present it to decision-makers in useful form in near-real time. Equally important, technology will support affordable data communications from the command centers to elements of the strike force for real-time transmission of targeting and threat-awareness information. Means will soon exist in most aircraft to provide such information to crews on their multifunction displays.

The opportunity is near at hand to break out of the twenty-four-hour planning/execution cycle that we have been saddled with since World War II.

That leads to the broader area of command and control. No one doubts that there is plentiful technology to achieve major improvements. Despite the rhetoric, false starts, and the expenditures over the past decade or so, not much progress has been made. This is particularly true of tactical command and control. The problem is not the lack of enabling technology but a fault of the requirements and acquisition processes. Existing technology could provide each command and every operating level with appropriate access to current threat data, automated tools of high quality for planning and decision-making, and real-time information on friendly and enemy forces presented on a situation display suited to that operating level.

One could argue that the 1990s ought to be the "munitions decade." There is no area where ripe technology promises more leverage in the near term. Continuing progress in sensors, microelectronics, and microprocessing makes the goal of affordable "brilliant" weapons both possible and urgent. Admittedly, these new assured-kill weapons will cost much more than older "dumb" bombs, but their effectiveness, combined with the reduced exposure of the strike aircraft, warrant the investment. More important, weapons with increased killing power are the most effective means to offset constrained force structure.

Fortunately, now we can do it. Millimeter-wave technology is sufficiently advanced from both a technical and cost viewpoint to provide a highly effective night and adverse-weather, precision-guided munitions capability. Long-range tactical standoff weapons can be made every bit as effective as direct-attack guided weapons, since infrared, millimeter wave, laser radar, and synthetic aperture radar technologies make possible accurate waypoint-fixing in midcourse as well as high-value fixed target discrimination from natural background in the target area.

We know how to reduce the observability of weapons for compatibility with our stealthy aircraft and also how to reduce the weapons' vulnerability to countermeasures. We are acquiring a complete new stable of aircraft for all mission areas. Now we have the opportunity to multiply the effectiveness of that new force with far more capable weapons. The funding requirement for such an initiative is relatively small.

Now, let's shift our focus to the longer-term technologies that hold promise for use in systems of the next century and deserve careful nurturing and demonstration today.

An Eye On the Future

Since major new system starts will be few in the coming decade, it is likely that a number of pressing needs, requiring accelerated pursuit, will emerge once funds become available. Therefore, we should attempt to minimize the technology maturation phase so frequently required today. This dictates a strong science and technology program during the 1990s. It should include key technology demonstrations to lay a solid base for follow-on engineering development programs.

We cannot know with assurance which technologies will be critical to the capabilities we will be pursuing in the next century. A great deal can happen in ten years. For perspective, consider that a decade ago we had just begun the stealth programs, the birth of SDI was still three years away, parallel processing was in its infancy, 64K RAM had just emerged, and superconductivity was only achievable at liquid helium temperatures. Acknowledging that we cannot predict all of the technologies that will be important in the early twenty-first century, we can still identify a few now that we know will be important.

Given the long, unbroken pattern of the Soviets mirroring our new capabilities, it is only a matter of time before they present us with a low-observable threat. It is essential, therefore, that we develop means to cope with such a threat. We are in a good position to focus our broad stealth technological base and our advanced sensor technologies on means to detect, track, and intercept low-observable systems. We must not let enthusiasm and advocacy for our own stealth programs inhibit an aggressive quest of countermeasures. We should pursue a priority program to prepare for the time when—not if—countermeasures are required.

Next, we should strongly support the National Aerospace Plane. Although it is now apparent that the original vision of an "Orient Express"—or even of a low-cost, single-stage-to-orbit capability—is unachievable in this century, we must continue the effort to extend our aeronautical horizon into the hypersonic.

It is easy to imagine exciting possibilities. An aerospace plane would obviously compress the time required for operations. More important, though, the aerospace plane is one of those special multidiscipline programs that by its nature ad-

vances a large number of technologies as it moves forward. Propulsion will take a giant step with the development and flight-testing of the hydrogen-fueled scramjet. The program will extend and validate hypersonic computational fluid dynamics codes, the aircraft and propulsion designer's basic design tools. It will accelerate the development of higher-strength materials and new approaches to structural design. It will force the development of advanced integrated flight and propulsion control concepts and systems. It will require advanced cooling concepts and mechanisms. I can't think of another program that promises to open up more exciting opportunities.

Today, we acknowledge the great strategic value of DSP (Defense Support Program) satellites that monitor ballistic missile activity and provide warning of attack. A complementary capability for surveillance of airborne threats would be of great value. It appears that all of the requisite technologies—radar and infrared sensors, power generation, on-board signal processing, and spacecraft construction—to make that possible and practical are near at hand. They will be a reality early in the next century. This capability should be a high-priority candidate for technology development.

The increasing role of space systems in military operations makes it unconscionable that we are denied a means to destroy such systems during war. High-powered lasers, beam forming and control, adaptive optics, and power-generation technology will soon be available to construct a highly effective, ground-based antisatellite system out to geosynchronous altitude. Just a few sites would provide the necessary coverage.

Such a system would have much better altitude and coverage capability than was provided by the abandoned F-15 miniature homing vehicle system. It seems to be an ideal candidate for technology maturation and demonstration during the next decade. Our political leadership will surely come around to acknowledging its military necessity. It also seems apparent that this is an area where we should expect aggressive defensive countermeasures. Therefore, we should pursue a vigorous technology program to cope with that eventuality.

We have seen electronics take over the management and control of all the inner workings of our systems—the operation of the aircraft's flight control system, the control of the engine, the weapon delivery, the missile guidance and fuzing, and the processing and display of nearly all of our information. It's been happening as well in ships, helicopters, tanks, artillery, and even the individual soldier's equipment. There has been a relentless trend toward miniaturization of sensor elements, microcircuitry, solid-state RF devices, microprocessors, and micromemories. We see the same trends in Soviet and Soviet-bloc equipment.

Possible Programs

One of the most serious design challenges with microelectronics is protection against spurious, unwanted signals. This characteristic of enemy equipment—and ours—is one that technology enables us to exploit. Pulse power generation and microwave amplifier and transmission technology make a high-power microwave weapon a distinct possibility. A first step could be a capability to disrupt and upset critical electronic components, followed by a capability to burn out and destroy enemy systems. We should aggressively pursue this potential high-payoff technology to position ourselves for later full-scale development.

It is likewise obvious that we must develop means to reduce our own vulnerability to similar measures from the other side.

Given the improbability of new aircraft development starts in the next decade, it is especially important that we pursue an advanced technology air vehicle program. The ongoing turbine technology and materials programs promise to double the thrust-to-weight capability of turbine engines by the end of the next decade while reducing specific fuel consumption by fifty percent. I feel comfortable with that prediction.

Remarkable advances are being made in the use of advanced, lightweight composite materials in load-bearing aircraft structures. An all-composite high-performance aircraft is now close to reality. About fifty percent of an aircraft's weight today is in the fuel and engine system. Imagine the combined effect of doubled thrust-to-weight, halved specific fuel consumption, and all-lightweight-composite structure.

It could give us short takeoff and vertical landing in a supersonic airframe, an F-15-sized machine capable of sustained speeds greater than Mach 3—or a smaller fighter with truly spectacular performance. Such possibilities mandate one or more advanced technology demonstration programs during the next decade to advance and confirm the technology base to support the full-scale development programs that are sure to follow soon after the turn of the century.

Those are some, but not all, of the opportunities. There are others, including noncooperative target recognition, unmanned vehicle applications, and autonomous guided weapons. I have deliberately avoided the topic of ballistic missile defense because I see technology supporting only a limited terminal defense of questionable value in the next decade. I do, however, support the steady pursuit of technologies that could make possible a highly capable, cost-effective system after the turn of the century.

Nothing has been said here about superconductivity, extra-smart unmanned vehicles, highly maneuverable space vehicles, directed-energy weapons for combat aircraft, or superenergetic propellants and explosives. I feel sure that most of these are in our future, but they require further development in the technology base. I wonder, though, if they might have been on my list had the technology base received stronger support over the past decade or two. ■

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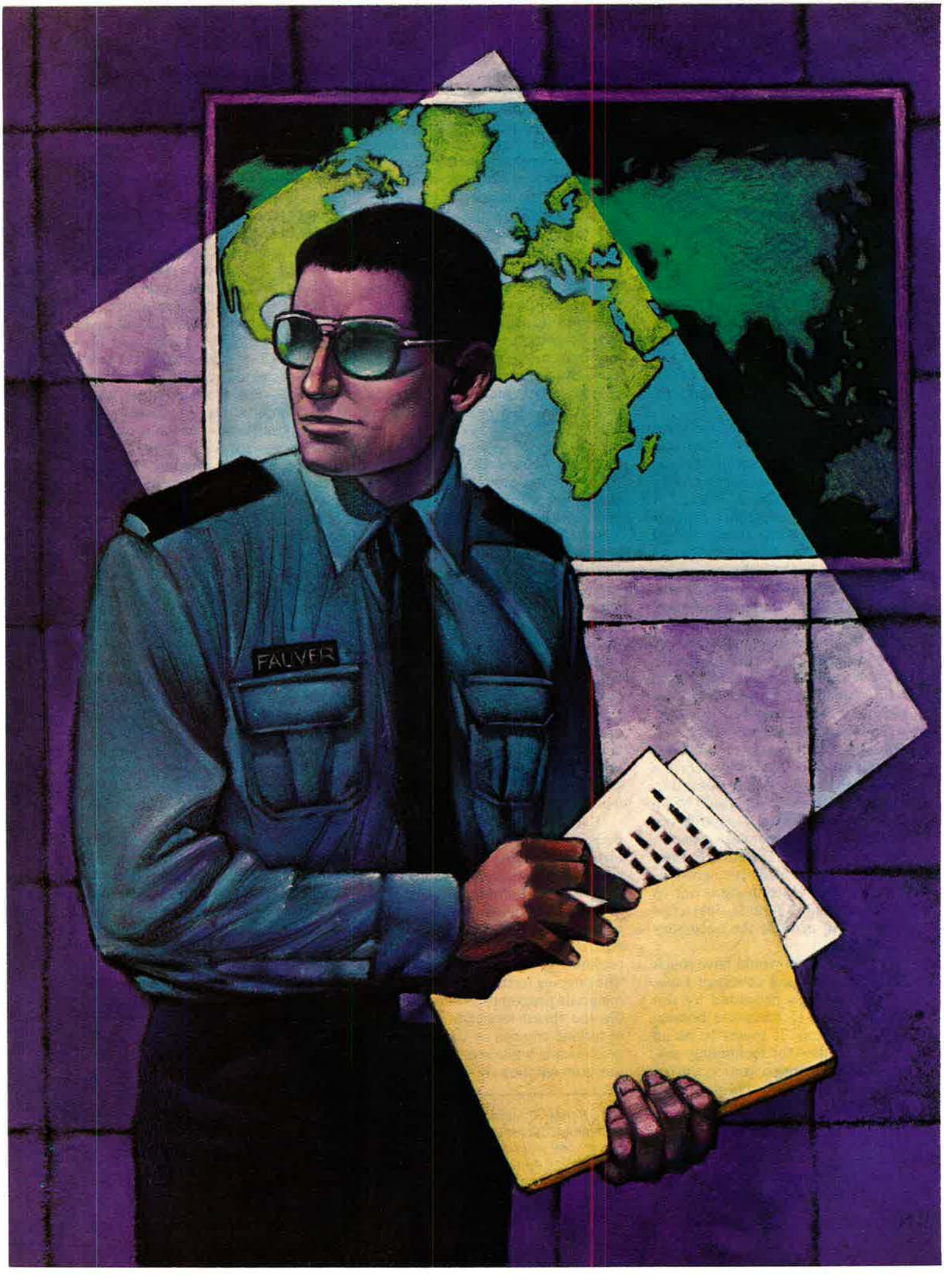
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The evidence points to great harm done by the traitors who sold US signal security to the Soviet Union.

The Crypto Bandits

BY NORMAN POLMAR AND THOMAS ALLEN

"THE ultimate goal is . . . to protect your signals and penetrate the other guy's signals security." These words of the late James Jesus Angleton, long the CIA's chief of counterintelligence, carry an ominous implication for future US military operations.

Over the past ten years—the decade of the spy—the US may have lost its own signals security as well as part of its ability to read Soviet signals. Indeed, one top analyst has speculated that the situation may be helping Soviet leader Mikhail Gorbachev take prudent risks in Soviet defense reductions under his program of *perestroika*.

Can American military leaders assume that, in a future conflict, their communications will be secure from eavesdropping by Soviet forces or Soviet clients? One must give a cautious answer. Though US traitors have told much to the Soviets, the US government has said little about what they have disclosed. Even so, evidence of serious compromise is strong.

After the 1985 espionage arrests of Navy radio specialists John Walker and Jerry Whitworth, Secretary of the Navy John Lehman said that the US cryptographic secrets sold to the Soviets "very well could have" led to deaths of some American servicemen in Vietnam. "Had we been engaged in any conflict with the Soviets" while the Walker ring was operating, asserted Lehman, "it could have had the devastating consequences" that the Allied breaking of the German Ultra code had on Nazi operations in World War II.

In addition, high-level US knowledge of the possible compromise of US cryptography led to restrictions on tactical communications that some consider to have been the key factor in the failure of the 1980 hostage rescue mission in Iran. When that rescue effort was launched, a handful of US officials knew that for some time the Soviets had been able to decode some US communications. Concern about the danger led to a decision to cut back on communications during the operation. The mission failed, in part—if not primarily—due to severe restrictions on communications.

Several US agents in the Soviet Union have been compromised dur-

—Illustration by Chris Fauver

ing this period, possibly because the Soviets were reading supposedly secret American messages.

Reading Our Mail

Compromise of US encryption and communications methods and equipment has enabled the USSR to reexamine and decipher millions of messages previously intercepted and recorded. Moscow has been able to "read our mail," as US officials put it. Some of these officials also believe that something worse has occurred: Soviet cryptologists may be in a position to keep pace with US encryption development—to read our mail in the future as well. In the past, there have been indications of "problems" with US communications security. However, due to the high cost of remedial action, bureaucratic turf considerations, and a simple reluctance to believe that US codes had been broken, the military establishment had done relatively little until the spying by the Navy's Walker and Whitworth was revealed.

For possibly thirty years, Soviet cryptologists have had continuous access to US encryption and communications devices and, more importantly, to the logic behind them. This hemorrhage of secrets began in the mid-1950s when Army Sgt. Robert Lee Johnson, assigned to the US Command in Berlin as a file clerk in the intelligence section, agreed to spy for the Soviet KGB.

Over the next decade, Johnson systematically photographed and passed every significant-looking paper that came into his Berlin intelligence office. More important, in 1956, he was assigned to the Armed Forces Courier Transfer Station at Orly Airport, near Paris. The courier stations are warehouses of secrets. Dispatched to and from these stations are some of the most valuable secret documents in US possession. Key lists for code machines, prepared by the National Security Agency (NSA), are sent to the stations for further distribution, as are other cryptographic materials and documents too large or too sensitive to transmit by machine. The Orly station handled cryptographic materials and highly classified documents destined for NATO, US European Command, and the Sixth Fleet.

Johnson gained access to station storage vaults, where the secrets were kept from the time they arrived from the United States until the time couriers picked them up. Beginning in 1962, he regularly removed about fifteen top-secret envelopes from the vault in a night and then passed them to the KGB, which would copy the documents, expertly reseal the envelopes, and return them to Johnson to be replaced in the vault. Johnson gave himself up in 1965 and was sentenced to twenty-five years in prison. In 1972, Johnson's twenty-two-year-old son stabbed his father to death.

Similarly, Army Warrant Officer Joseph G. Helmich sold the Soviets details of US code machines beginning in 1963. Also in this period, NSA suffered the loss of two defectors, William H. Martin and Vernon F. Mitchell, to the Soviet Union.

Navy Leaks

Navy communications specialist John Walker may have begun to provide the Soviets with "yellow" in the late 1960s. "Yellow" is a Navy term for sheets of yellow paper from the continuous printout of teletype communications traffic. Printouts contain everything from messages about ship information and instructions about taking on fuel and supplies to birthday greetings to sailors at sea. All "yellow" is classified, but radiomen scoff at the classification because so much is innocuous and boring.

Walker at the time was a chief radioman on board the Polaris missile submarine *Simon Bolivar* (SSBN-641). The submarine's yellow was low-grade stuff. Walker's opportunity to get into the big time came in January 1968, when the US spy ship *Pueblo* (AGER-2), operated by the Navy for NSA, was captured by North Korea. The *Pueblo* had been monitoring electronic emissions off the North Korean coast. On board were cryptographic machines, key lists, repair manuals, and a vast number of classified documents.

Not all of the ship's cryptographic material had been destroyed when the *Pueblo* and crew were captured. Walker, as a radio specialist, could easily learn of *Pueblo*'s last messages: "Destroying all key lists and as much elec equip [electronic equipment] as possible. . . . We have the KW-7 [machine] and some cards in the [KWR]37 and [KG]14 to smash. I think that [is] just about it. . . . Destruction of pub[lication]s [has] been ineffective. Suspect several will be compromised." Two minutes after this last message from the spy ship, North Korean soldiers boarded *Pueblo,* and the ship was brought into the port of Wonsan.

Pyongyang quickly shared its prize with Soviet technicians, who flew to North Korea immediately after the ship's capture. Walker was

—Illustration by Chris Fauver

then a warrant officer assigned to the communications center of the Atlantic Fleet's submarine force in Norfolk, Va. The Soviets had code machines (some damaged), manuals, and other documents. They would need a flow of key lists in order to use the machines. John Walker would provide them.

The treasure from the *Pueblo* was soon augmented by the acquisition of US code machines that had fallen into the hands of the North Vietnamese during the Vietnam conflict and after the fall of the Saigon government in 1975. A US official said thirty code machines were lost in Vietnam. Some—if not all—were passed to Soviet code specialists, along with more documentation.

After the capture of *Pueblo,* serious questions about the security of the US cryptographic system began circulating in the Navy and NSA. Congressional and military investigations focused on how and why the ship was captured, overshadowing grave concern about the intelligence aspect. There were many classified documents on board the ship, and there was neither a plan nor the means for swift destruction of these documents and the electronic-intercept and cryptographic gear. Most of all, intelligence experts were infuriated that no one at senior government levels seemed to care that the Soviets now had equipment to read the most secret US communications—if they could obtain key lists.

Sometime early in the 1970s, NSA became concerned about possible breaches in US cryptography. Word was passed through intelligence and communications communities, with special emphasis on Navy communications: Your message traffic is not as secure as you may believe. Navy communications officers pressed NSA for information on this possible vulnerability. "Give me concrete examples of messages you think were compromised," a naval officer recalls having asked at the time. The NSA answer, he says, was simply, "That's not the way we do business."

Vulnerable Equipment

The Orestes KW-7 machine, which had been compromised in the *Pueblo* capture, was at the time the most widely used piece of crypto equipment around. It was used not only in the US Navy, but also in the Air Force and Army and with several allied military forces. The KW-7 uses a worldwide key list card, which means that, with the key list card for a specific date and a KW-7 machine, one could decipher communications between any ship and shore activity anywhere in the world. Walker and Whitworth, beginning in 1968, provided the Soviets with an almost continuous flow of key lists as well as page-by-page photographs of updated technical manuals for the KW-7.

These manuals were particularly significant, although they were given lower classifications than the machines themselves. Using only these manuals, the USSR could build the machines from scratch. Several years ago, to prove that this could be done, NSA technicians were given manuals and told to build a functioning code machine, which they reportedly did.

Since the mid-1970s, all Navy ships have had a fleet-wide satellite broadcast system. The system was developed to use the KW-7 to transmit and receive messages via high-frequency (HF) signals at night and via low frequency by day to prevent continuous direction finding by Soviet intercept stations attempting to locate US warships. A "power limiter" device further enhanced the security of some transmissions. The Soviets were expected to listen only for HF transmissions on high power and thus fail to intercept most message traffic. But thanks to the Walker-Whitworth betrayal, the Soviets knew about these techniques, and with key lists for KW-7 they were able to intercept messages that the Navy thought to be extremely secure.

A directive put out by NSA said the Navy should drop the use of the KW-7 for higher levels of classified communications and after 1987 should operate it only at the level of confidential. A naval officer has recalled: "The KW-84 was to be the replacement [for sending higher classification messages]. All the services said to NSA, 'Go pound sand! We know you won't be able to deliver the KW-84.'" So KW-7 continued to carry vital military messages.

In another attempt to solve the problem, the Department of Defense tried to launch the Cryptographic Utilization Program, known by the acronym CUP. The idea was to "pass the cup" among the Pentagon users of cryptography, asking each one to pick up a share of the cost to upgrade the existing code machines. The changes were not made at the time, however, and more than money was involved. A change in code gear would require modification or replacement of several thousand machines, taking considerable time and effort in the training and document areas as well.

The Soviets Go Shopping

Meanwhile, the spies were keeping up with communications technology. Around the time that Whitworth began his espionage career in 1974, the Navy was switching from high-frequency radio transmission to satellite relay as its principal communications medium. One of the new machines used with satellites was the KG-36, which was able to handle high-speed data transmissions. When Whitworth learned about the KG-36 through its technical manual, he told Walker about it. Walker, in his next contact with the KGB, added the manual to what he called "the shopping list." The Soviets eagerly asked for the manual, and Whitworth supplied it by photographing every page and passing the film to Walker.

Walker and Whitworth served in several Navy ships and shore stations where they had access to vast amounts of cryptographic material. One of the most lucrative assignments—which both men had at different times—was on board the Navy supply ship *Niagara Falls* (AFS-3). A seemingly unimportant, noncombatant ship that provided supplies and provisions to the fleet, *Niagara Falls* also carried several months' supply of key lists. Walker, and later Whitworth, had access to them during several years on the ship and, in Walker's words, "if I had access, color it gone."

When Whitworth was based on the island of Diego Garcia in the Indian Ocean, he had access to forty or so cryptographic machines, including the KW-7, KW-26, KW-37, KG-14, and KG-13. All worked basically the same way, using key materials that Whitworth controlled.

—Illustration by Chris Fauver

Whitworth supplied so much cryptographic information to the Soviets that they eventually became discriminating. The Soviets did not want messages carried on KW-8 systems, encoded voice circuits, or intelligence information, which, apparently, they preferred to get from other sources.

While American communications were being compromised, the ability of the United States to read Soviet communications was being impaired. This resulted from the actions by several American traitors, especially Ronald W. Pelton, who had general knowledge of US intelligence and communications activities. Once an employee of NSA, Pelton revealed to the Soviets that US submarines were "plugging in" to communications cables on the bottom of the Sea of Okhotsk between the Soviet strategic missile submarine base at Petropavlovsk and other bases on the Pacific coast. These cables probably not only revealed actual communications but also provided a means to check and decipher radio communications sent on related subjects.

Known as Operation Ivy Bells, which dated from the 1970s, the US communications intercept effort was revealed to the Soviets by Pelton in the early 1980s. The United States learned that this source of high-grade intelligence was compromised when US spy satellites showed several Soviet ships clustered above the sea-floor device that was tapped into the cable and periodically visited by US submarines. Later, when a US submarine went down to the cable to replace the tapes, it found that the recording device was gone.

Quiet Submarines

Walker, Whitworth, and perhaps other Americans apparently encouraged the Soviets to change submarine designs and tactics. For several decades, Soviet submarines were considerably noisier than their US counterparts, making Red subs relatively easy to locate, track, and—in wartime—kill. US sub designs, antisubmarine tactics, and the massive SOSUS sea-floor acoustic detection system were all predicated on finding noisy submarines. In 1985, the Soviets sent to sea a new nuclear-propelled attack boat, which the US and NATO call Akula.

The Akula shocked Western intelligence analysts. Its self-generated noise was at a decibel level that the Soviets were not expected to achieve until the early 1990s, if then. Submarine sound levels and the sonar to detect those sounds are considered the principal advantages of US submarines. With the Akula, Secretary Lehman asserted, "the Soviets have closed the gap" to the point that "their new submarines are virtually as quiet as the subs we were building just a few years ago." He added that much of the advance could be attributed to the help of Walker and Whitworth.

As the decade of the spy closes, US officials are not sanguine about the future. Intelligence security—the protection of secrets—"is always on the chopping block in periods of budgetary stringency," maintains Robert M. Gates, former Deputy Director of Central Intelligence and now President Bush's deputy National Security Advisor. "Even when the budgets were growing in DoD and in the intelligence community in the early 1980s," he adds, "security was slow to get it together and make significant proposals for new investments. By the time they got their act together, big budget increases were over."

Undoubtedly, US officials concede, there are more spies to be found—even within the armed forces. Over the last six years, some sixty soldiers, sailors, airmen, Marines, and civilians in the Department of Defense have been accused of spying or violating serious security regulations. Key targets of Soviet intelligence are service members associated with communications.

Despite some US efforts to tighten up on its secrets, opportunities for astute spies still exist. That was made clear in a recent conversation with a group of junior officers serving aboard a US destroyer. Asked if it is now more difficult to steal shipboard key lists, a la Walker and Whitworth, one officer had this to say: "It's not difficult if you know how to do it."

The cost to the United States of this breakdown of communications security is high. In peacetime, intelligence and communications losses are irritating and are expensive to counter. In wartime, they would be deadly. ■

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There's a reason (unfortunately) for this way of purchasing underwear, eggs, socks, and plastic whistles.

How the Pentagon Buys Fruitcake

BY DR. JACQUES S. GANSLER

ONE frequently hears industrial managers—bemoaning high costs, low quality, and apparent mismanagement in the Department of Defense marketplace—state that "if only they could learn to do business the way we do, all of this wouldn't happen. These problems and abuses simply wouldn't occur in a free market."

In response to such cries, members of Congress pass laws "requiring" the Department to use "free market practices." The reality, however, is that no matter how much we might wish it, or even how much Congress legislates it, the defense market is not—and can never be—a normal free market.

Whether the Department of Defense is buying fruitcakes or strategic missiles, it must, by necessity, operate in a different way than the civilian economy operates. It is a unique buyer. No one else places an annual Christmas order for twelve tons of fruitcake. Certainly, there are no commercial buyers of nuclear weapons. The fact that DoD is a monopoly buyer makes for a special market.

The Department of Defense is subject to all of the laws of the land—as is the commercial buyer—and then some. Because DoD operates on public funds, it is also subject to the numerous laws that Representatives and Senators write in the interest of "fairness to constituents." These laws are written not in the interest of efficient defense procurement, but to help numerous potential suppliers.

Room for Improvement

In spite of its uniqueness, the Department of Defense need not be so different. Nor, more importantly, need it be so inefficient or ineffective in the results it achieves for its annual procurements of some $170 billion. Within the necessary constraints, there is ample room for improvement—both in the way DoD does business and in the laws that control these practices.

Which changes should be made? What will they mean to US industry and the US economy?

To understand how DoD, Congress, and US industry must approach this problem, one must recognize that there are three very different major areas of defense pro-

curements. The first is major weapon systems, which consume the overwhelming share of procurement dollars. Second is subcontracted items, which are part of major weapon systems. These two big-ticket areas do not lack for scrutiny these days.

But there is a third category, one that includes the millions of annual purchases of such items as socks, shoes, and underwear. In any given year, expenditure for these numerous, low-cost, commercially available items comes to almost $20 billion and will generate 15,000,000 separate procurement actions.

In this category, it is clear that DoD should be permitted to use commercial specifications and commercial buying practices if it is to take advantage of the wide variety of market-tested products available, rather than using highly specialized military specifications and unique Defense Department practices.

Mind-Boggling Statistics

The dimensions of this category are truly mind-boggling. Consider having to buy annually 13,000,000 undershirts, 6,000,000 pairs of green socks, 51,000,000 dozen eggs, 7,600,000 pounds of coffee, etc. The obvious question is: Why should buying these items be any different from how the normal consumer purchases them? Since defense procurement is highly decentralized, shouldn't local buyers on the military bases be able to go out and purchase the needed items and even receive a significant discount because of the scale?

The problems with such an approach become clear as soon as you begin to think in more depth about the process. For example, consider the case of DoD going out to buy twelve tons of fruitcake for the troops overseas at Christmas.

If the "invisible hand" of the free market were allowed to act, the DoD buyer would simply call accepted brand-name producers (identified by going to the supermarket and noting the names on the shelf) and ask them for bids on this purchase.

The sheer size of this procurement, however, would certainly attract a great deal of attention from all sorts of potential fruitcake producers across the US. Many might never have made fruitcake, but they would write to their Representative or Senator, soliciting an opportunity to bid on the purchase and saying that they were fully capable of making an excellent fruitcake.

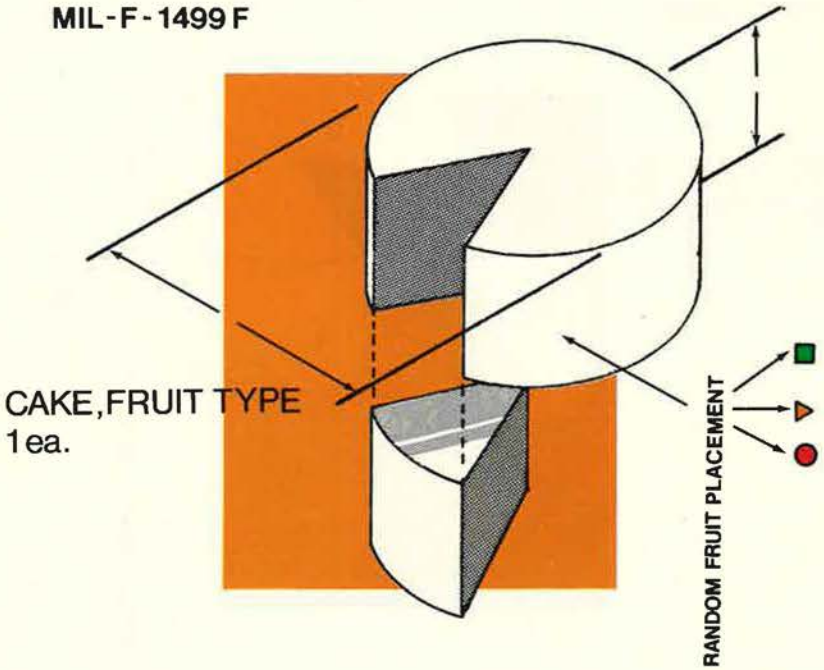
Congress, wanting to be "fair" to its constituents, has passed numerous laws that prohibit the government from simply buying brand names or from limiting the competition to a few qualified sources. In fact, laws require that anyone be allowed to bid ("free and open competition"). The simple shift of emphasis—from the buyer deciding who should bid to the requirement that all potential suppliers have an opportunity to bid—changes the market conditions dramatically. It is the first, most critical, step in the process of evolving a need for a detailed military specification for fruitcakes.

Frequently, Congress will go a step further and decide that a particular procurement might be an excellent way to pursue certain social objectives (help for areas of high unemployment, "set-asides" for minority-owned firms).

Operating under congressionally mandated rules, a DoD fruitcake buyer now is likely to receive hundreds, even thousands, of bids for the opportunity to produce some or all of this large fruitcake order.

How to Decide?

Now the question becomes how to decide who should get the award(s). If price were the sole criterion, troops at Christmastime would probably get inedible, and perhaps dangerous, fruitcakes supplied by inexperienced, low-cost fruitcake makers. A solution might be to ask for bid samples. This is a relatively common technique, but it involves establishing a laboratory and writing very clear criteria for differentiating among fruitcakes and for determining which are acceptable. This leads to a difficult DoD decision—namely, on what basis to make the award decision.



The broad choices are: (1) the best possible fruitcake; (2) a good-tasting but reasonably priced fruitcake (best value); or (3) a minimally acceptable fruitcake at the lowest possible price. For a few weapon systems, option one may be the necessary choice; but usually option two is the best choice for both weapon systems and fruitcakes. In fact, it is the option the consumer chooses at the food store, where he looks for the best value in what he purchases and is willing to pay a little bit more in order to get a better taste or higher confidence in a brand name.

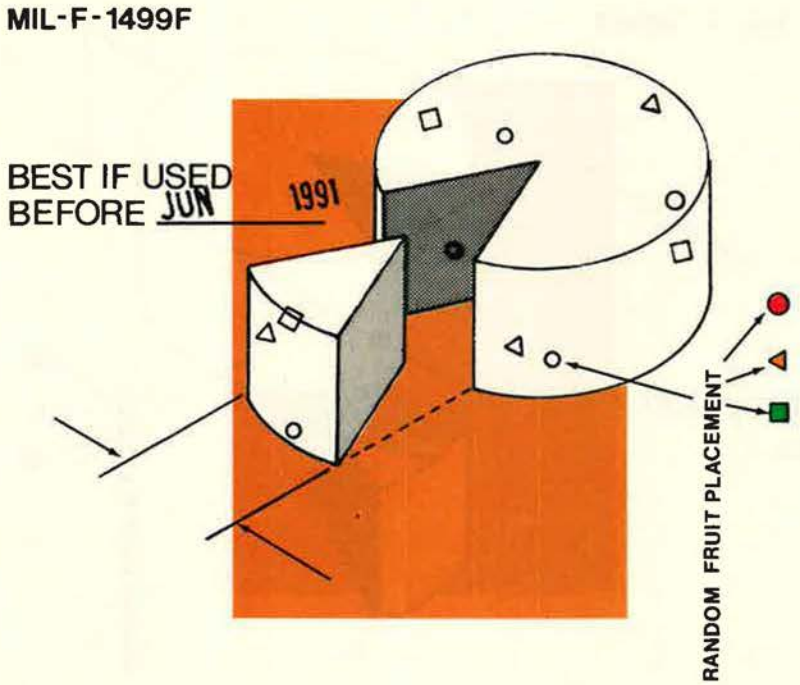
Unfortunately, in the Defense case, the low-cost fruitcake bidder will, after losing, write to his con-

gressman and claim that he was the victim of unfair treatment. He points out that he had offered a lower price for what was "clearly an acceptable fruitcake." In the commercial world, where procurements are based on the uniform commercial code, the best value judgments of the commercial buyer are accepted as the rule; there is nothing a loser can do. In the DoD case, Congress has written stacks of legislation giving the loser the right not only to protest but to delay procurement until the protest is adjudicated.

Thus, for the price of a stamp, anyone can begin litigation over the award of a contract and have the full support of his congressional representatives, as well as almost a guarantee of newspaper headlines.

With passage in 1984 of the Competition in Contracting Act, Congress went further. It actually encouraged the losers to expand their protests. So well did it work that, within four years, the protests had climbed from a few hundred a year to more than 3,000 annually. Procurement lawyers in Washington were happy, but it introduced increased delays and bottlenecks into the defense procurement system. Worse still, it expanded the emphasis on low bids at the expense of best value.

For DoD, the end result of all this is the specification—in this case, for fruitcake (military specification MIL-F-1499F). It describes, in pages of detail, exactly what must go into the cake, how it must be made, how long it must be able to sit on the shelf, what types of fruit it should contain, how it should stay together when cut, how it should be wrapped, etc.



All of this may be foolish, viewed from the perspective of how the normal consumer purchases fruitcake. But it all becomes perfectly understandable when it is recognized that, if one item can be left out of the specification, then each—or at least some—of the bidders are bound to leave it out (in order to be the low bidder).

An identical specification-writing process is carried out in every area of DoD purchasing of common items. For example, there is a twenty-page specification for towels, a twenty-page specification for underwear, a sixteen-page specification for plastic whistles, a seventeen-page specification for olives, a twenty-page specification for hot chocolate, and a seventeen-page specification for chewing gum.

If nothing else, these make outstanding material for stand-up comedians. Example: Large chunks are banned in hot chocolate. The specification has the injunction that, "when washed with petroleum ether, not less than ninety-eight percent [of the chocolate], by weight, shall pass through a US standard No. 200 sieve."

Foolish as all of this sounds, it does achieve the congressional objective of "fairness" and even yields acceptable products. The fruitcakes turn out to be of reasonable quality—a fact assured by government inspectors' testing of the products. Considering that DoD is probably the largest single buyer of food in the world—spending more than $5 billion annually—such cost and quality considerations are extremely important.

The low cost of such products, however, is usually more apparent than real. For example, in the case of the twelve tons of fruitcake produced for the 1985 Christmas season, competitive contracts yielded an average price of $1.51 per pound, far below the going rate in the local grocery store.

Of course, that price excludes the costs of the government buyers, inspectors, laboratory testers, storehouses, shipping, sales clerks, etc., all of which were covered by other DoD accounts. Nonetheless, a fruitcake at the corner supermarket at that same time was selling for $3.50 per pound, so at least the apparent price was attractive.

Minimizing Mistakes

The process also attempts to minimize opportunities for improper judgment on the buyer's part. By having a detailed specification and then making sure that each of the suppliers satisfies that specification, the government buyer is in a position to pick the low bidder and not have to make management judgments—as the normal consumer is forced to do whenever he or she goes to a food store and selects from a large variety of similar items having different quality and price.

Unfortunately, the really important issues associated with free-market buying are not the specifications at all. Consider the cost itself. As noted, the price paid by DoD for fruitcake specifically excludes all of the overhead that a supermarket has to cover—employee salaries, inventory costs, facilities costs, etc. In the case of the typical defense

procurement, these expenses are more than double those found in the commercial sector.

All these additional government costs are borne by the taxpayer but are authorized by Congress under operating and maintenance costs for DoD and thus are essentially buried within the $300 billion defense budget. Thus, the true costs of the items are not visible or easily controllable.

A second disadvantage of this system is that it develops a class of suppliers who are government suppliers only. Never testing themselves in the commercial market, they become totally dependent on doing business the defense way. Conversely, DoD becomes dependent on them, because they are the only ones who have special factories building millions of items to defense specifications.

Additionally, many highly qualified commercial suppliers simply won't put up with government regulations, paperwork, etc. So long as they can get enough business elsewhere, they refuse to deal with the government. In such ways are many of the nation's best producers lost to the government market.

Perhaps the worst result of DoD's buying process is that it doesn't pay a supplier to do a good job—that is, to provide high-quality goods or services. The procurement process starts over with each new bid. Prior performance does not matter at all, and there is a built-in incentive to cut corners. At best, the government gets marginal goods. Frequently, suppliers find ways to circumvent the specification and supply inferior goods. Particularly discouraging is that, on the next invitation for bid, these same suppliers may be treated just as though they had delivered outstanding performance on prior bids.

In effect, the invisible hand of the free market is not at work at all. In the commercial world, poor performers are forced to drop out. In the defense field, however, they prosper.

DoD must move more toward the use of standard commercial practice in buying commercially available items. It is the only way to have a dramatically beneficial impact on the quality and cost of the vast majority of DoD procurement actions. However, for this to happen, Congress will have to take specific action.

The Role of Congress

Interestingly enough, those who most frequently sing the praises of using commercial practices and even standard commercial equipment are members of Congress. Similarly, it is Congress that has the most fun ridiculing DoD fruitcake specifications and the like. Yet this Congress has passed the laws that require DoD to do its business in such a muddleheaded fashion.

As Rep. James Courter (R-N. J.) stated not long ago: "Congress is not the answer to waste. Congress is the problem. They mean well, but reformers are too often a cause of what's wrong with the military."

The problems with commercial procurements bear out Congressman Courter's comments precisely. The proper approach for Congress is not to legislate the price of every item, as it did in the case of a toilet seat (Senate Resolution S. 1958). Such overregulation works against marketplace discipline.

Rather, Congress must remove restrictions on the effective operation of the market. The place to start is with the numerous restrictions on government contracts that offer a major impediment to small businesses that want to bid on small-dollar items. If Congress were to exempt purchases of $25,000 or less from various social and other legislative dictates, then DoD would be able to buy the small-dollar items from market-tested goods and services using normal commercial practices. Only the price and delivery schedule would require negotiation.

This recommendation has been made repeatedly by many government commissions and private studies. Though the amount in dollars is small, seventy to ninety-eight percent of a defense agency's procurement actions are for less than $25,000. Removal of these legislative cobwebs would dramatically reduce administrative costs and greatly encourage many small businesses to enter the defense arena.

A more general solution would be to apply the Uniform Commercial Code to most DoD purchases. Obviously, special-purpose military equipment (*e.g.*, weapon systems) would have to be excluded, but the overwhelming majority (millions!) of DoD items could be purchased in a free-market fashion. This would entail exercise by the government buyer of his or her best value judgment and rule out protest by the losers (unless there were illegal action). It also means that, so long as the prices being bid are established by the commercial marketplace, there would be no detailed price breakdown and no detailed government auditing (again, the commercial practice).

Finally, and perhaps most important, the prior performance of a supplier should play a major role in the buyer's evaluation. When producers do a good job on prior work, they should be given favorable treatment, and when they do a poor job, they should be excluded from future procurements.

It would also mean that Congress will have to accept that, on some procurements, its constituents would not be able to bid, due to an existing abundance of highly qualified sources who have done a good job on prior contracts. Congress would have to recognize that there will occasionally be some errors of judgment. But this situation would be far better than trying to regulate millions of annual procurements.

These steps would bring enormous improvement to the efficiency and effectiveness of the overall process. Fraud would still be prosecuted. There would be no lack of watchdogs to make sure that the system is functioning properly.

It is high time for Congress to stop giving speeches about "ridiculous" DoD specifications for catsup and fruitcake and turn to changing the laws in ways that would allow DoD to buy commercial items, in a commercial fashion. ■

Dr. Jacques S. Gansler, a former Deputy Assistant Secretary of Defense and electronics-industry executive, is Senior Vice President of The Analytic Sciences Corporation (TASC) and faculty member at Harvard University. He is the author of The Defense Industry *(MIT Press, 1980) and* Affording Defense *(MIT Press, 1989). Some of the material in this article comes from the latter work.*

Over the years, the air arm produced some 3,000 of them, and they have flown virtually all types of aircraft.

Enlisted Pilots

BY BRUCE D. CALLANDER

WHEN MSgt. George Holmes finally retired, it marked a milestone in US Air Force history. Holmes, at fifty-nine, was neither the oldest nor the longest-serving master sergeant, but something more distinctive. He was the last pilot in the enlisted ranks.

Holmes left in 1957, thirty-six years after taking flight training during the 1920s. Commissioned in World War II, he rose to the rank of lieutenant colonel, but reverted to master sergeant after the war. Holmes was among a handful of nonofficer pilots who transferred into the new, postwar Air Force.

When MSgt. Tom Rafferty died in a 1950 crash, Holmes became the sole enlisted pilot on active duty. Then there were none.

In the postwar force, men such as Holmes and Rafferty were viewed as novelties. Few recalled that the Army had used enlisted pilots during the war. Fewer still were aware that, over the years, the service had produced some 3,000 of this unique breed or that they flew virtually all types of aircraft. At times, the failure to remember seemed almost deliberate. Only in recent years has the remarkable story of the enlisted pilots come to light.

—Photo courtesy of *Sergeant Pilots' Newsletter*

MSgt. George Holmes, the last of the "flying sergeants," stands in front of a PT-38 on Bluebonnet Hill near Mathis, Tex. He graduated from pilot training in 1921 and retired in 1957.

The Army had not been engaged in aviation very long before its first enlisted pilot arrived on the scene.

That man was Pfc. Vernon Burge. In 1910, Burge and seven fellow enlisted men accompanied the Army's single plane, a Wright biplane, and their commander, Lt. Benjamin Foulois, to Texas. After serving there two years as a mechanic for Foulois, Burge was sent to the Philippines with a new Wright Model B, the Army's seventh airplane. He reported to Lt. Frank Lahm, who was in charge of setting up a flying school.

When Lahm called for student pilots, however, only one officer volunteered. Burge, by now a corporal, applied, and Lahm gave him lessons. In June 1912, Burge received his certificate from Fédération Aéronautique Internationale. At the time, only a dozen other Army men—all officers—were similarly certified.

Burge's accomplishment, however, drew nothing but frowns from the brass. When Lahm informed Washington about it, the Chief Sig-

nal Officer of the Army declared that teaching enlisted men to fly ran contrary to War Department policy. Thus, although Burge continued to fly, he spent his next few years working mainly as an aircraft mechanic. He eventually won a commission, however, and retired in 1941 as a lieutenant colonel.

Following the Footsteps

Despite the Army edict, other enlisted men followed in Burge's footsteps. William A. Lamkey, who enlisted in the Signal Corps in 1913, had already taken flying lessons as a civilian, earning his FAI certificate in 1912. Following further flight training in San Diego, Lamkey then left Army aviation and flew missions for Pancho Villa's forces in the Mexican Revolution. He returned to flying in World War I, this time with the Navy.

Sgt. William C. Ocker also earned his pilot's certificate from a private, civilian flying school. While he was training as an Army mechanic in San Diego, Ocker moonlighted at the nearby Curtiss flying school. In payment, he got free flying lessons. Ocker later became an instructor. He was commissioned in 1917.

In July 1914, on the eve of a general war in Europe, the Army changed its mind and officially recognized enlisted pilots. An act of Congress created the Aviation Section of the Signal Corps and provided that "twelve enlisted men at a time shall, in the discretion of the officer in command of the aviation section, be instructed in the art of flying." Volunteers were to receive up to fifty percent more pay.

Though permitted to train a dozen at a time, the Army had produced only seven enlisted pilots by the end of 1914. Joining their ranks in 1915 was Cpl. Albert D. Smith, who had logged forty hours as a civilian exhibition pilot before enlisting. He was able to solo three days after reporting for duty. Though he soon left the Army, Smith returned as a captain in the war.

Enlisted pilots may have been legitimated in 1914, but getting flying time was a problem. There weren't enough planes to go around, and enlisted men rarely got a crack at them. Many of the enlisted pilots spent their time working as mechanics. Ocker and Smith were exceptions. They are counted among the pilots who helped test and develop airborne radio equipment in 1916.

By that time, World War I had been raging for two years, and the neutral United States was preparing itself for possible entry. Flight training schools were set up at Chicago, Memphis, and Mineola, N.Y. Harvard, Yale, and other universities formed flying clubs to train Army pilots. Reserve and National Guard units launched small programs. It was not an orderly buildup. Training was sporadic, subject to the whims of weather and officialdom. The status of the students was confused and changeable.

Even before the US entered the war, Americans were flying combat missions as enlisted pilots in the Lafayette Escadrille and the British Royal Flying Corps. Both outfits made use of enlisted as well as commissioned pilots. The British, in particular, found it hard to accept that anyone other than an officer and gentleman could fly. Socially, the enlisted pilots were ostracized.

The emergence of the US as a belligerent in 1917 saw many enlisted American pilots simply transfer from the foreign outfits to new American units. Most, however, were commissioned before going into combat. Only a handful of American pilots continued to serve in enlisted status, mostly flying as test pilots, couriers, and instructors. Among them was Sgt. Walter Beech, who later founded his world-famous aircraft company and provided thousands of trainers to the Army in World War II.

The only flying enlisted men known to have seen action in the war did so as observer-gunners. They were pressed into service because of a shortage of officers for the task. Of these, at least five were credited with shooting down one or more enemy planes.

—Photo courtesy of *Sergeant Pilots' Newsletter*

SSgt. Pilot Ralph Jackson of the 36th Squadron, 316th Troop Carrier Group, poses in his C-47 at Del Valle, Tex. (later home of Bergstrom AFB). Hundreds of sergeant pilots were assigned to newly created troop carrier groups in the summer of 1942. Jackson's plane and crew, together with eleven others of the 316th TCG, were destroyed by friendly fire during the Sicilian invasion.

The postwar era saw a severe contraction of forces. The US Army Air Service, which reached a peak strength of 200,000 in 1918, was down to barely 25,000 by 1919 and to 10,000 by 1920. Aircraft inventories plummeted. Many pilots left the service to barnstorm in surplus Jennies or to enter the emerging field of commercial aviation. Some, however, reverted to enlisted status and joined the small number of enlisted men still being trained to fly.

Exciting Time for Aviation

Still, the period after World War I was an exciting time for aviation. One of the most ambitious exploits came in 1924, when four single-

engine Douglas biplanes embarked on an around-the-world flight. Eight flyers, two of them enlisted, made up the team. Sgt. Alva Harvey flew with the mission commander, Maj. Fred Martin, in the aircraft *Seattle*. Sgt. Henry Ogden flew with Lt. Leigh Wade in *Boston*.

The tiny armada took off from Seattle, hugging the western coast of Canada and the southern rim of Alaska. There, *Seattle* crashed in a fog, and Martin and Harvey spent ten days hiking out to an Eskimo village. The other three planes continued southwest to Japan, down the China coast, across India and the Middle East, and up into southern Europe. All the planes made it to England, but *Boston* later ditched and was lost in the North Atlantic. A spare plane, *Boston II*, was pressed into service and caught up with the other two in Newfoundland. The three reached Seattle 175 days after takeoff.

Contemporary news photos show six smiling young men receiving the nation's acclaim. Not to be seen, however, were any wearing sergeant's stripes. Harvey had been left in Alaska. Ogden was wearing an officer's uniform; at Wade's request, he had been commissioned during the flight. Harvey later received his own commission and commanded a bomber group in World War II.

Two years later, the Army Air Corps came into being. Despite improved status and a planned five-year expansion, the force remained small, its officer corps limited by the ceiling on total Army strength. To fill the gap, the Army continued to train small numbers of enlisted pilots.

The ranks of enlisted pilots swelled after the October 1929 stock-market crash, when tight budgets forced the Army to trim commissioned officers. Faced with a choice between civilian job-hunting in the Great Depression or reverting to enlisted status, some officers chose to keep flying even if it meant doing so as privates.

Two flying staff sergeants even managed to gain wide attention in the mid-1930s. Billy McDonald and J. H. Williamson flew as wingmen to Capt. Claire Chennault in an aerobatic team known as "Three Men on a Flying Trapeze." Long before anyone ever dreamed of the Thunderbirds, the trio in their peppy little P-12s thrilled crowds and inspired a generation of youngsters to fly. The group didn't last long. Chennault retired in a few years, and McDonald and Williamson left the Army to fly in China. There, all three were reunited when Chennault formed the now-famous Flying Tigers in support of Chiang Kai-shek.

While Chennault's aerobatic team was wowing the crowds, other enlisted pilots were helping build the air transport system that would be vital in the next decade. The 10th Transport Group included some two dozen pilots in grades ranging from private to master sergeant. They flew everything from Keystone bombers to Bellanca C-27s to the first Douglas twin-engine transport planes. Within ten years, five of the enlisted pilots would be colonels commanding troop carrier groups in the Mediterranean, one would command a troop carrier group in the South Pacific, and another, former MSgt. Maurice Beach, would head the 53d Troop Carrier Wing as a brigadier general.

In the late 1930s, with war raging in China and about to commence in Europe, the United States was beginning to realize how unprepared it was for a fight. President Roosevelt ordered increases in both aircraft production and pilot training.

Rapid Expansion

The aviation cadet program expanded rapidly. To supplement this group, the Army proposed to train more enlisted pilots. The last enlisted training program had ended in 1933, however, and commanders were not eager to revive it. Noncommissioned pilots didn't fit in, they said. Neither fish nor fowl, they were not welcomed by the officers and were not happy with their lot as enlisted men. Despite such objections, Congress authorized the start of a new aviation student program in June 1941, six months before the Japanese attack on Pearl Harbor. Cadets were to be commissioned on graduation, while aviation students were to receive the newly created rank of staff sergeant pilot.

The Army did not plan to use the staff sergeant pilots in combat. The aviation student program was just one of several schemes designed to free rated officers for combat. Another was to use private flying schools and civilian instructors for the first phase of flight training. Overage commercial pilots received direct commissions and ratings as "service pilots" to instruct and fly noncombat missions. Female pilots were formed into a women's auxiliary, the WASP, or Women's Airforce Service Pilots, to ferry planes in the US.

Those were the roles envisioned for the new sergeant pilots. The Army particularly wanted to avoid putting them in the position of being in command of aircraft with officers serving as other crew members.

That was the plan as the first group of 183 men entered the aviation student program in August 1941. From the beginning, the Army wasn't sure how to treat this new breed of flyers. Aviation cadets were officer candidates; aviation students were enlisted men destined to remain enlisted men. They were given separate barracks and were socially isolated from cadets. They ate at the same mess, but not on equal terms. On graduation, sergeants generally were forbidden to exit by the same door used by cadets.

Over fifteen months, more than 2,000 staff sergeant pilots were graduated. Those assigned as flight instructors worked with commissioned officers by day but returned to enlisted barracks at night and, of course, were barred from officers' clubs. Often the sergeant pilots faced not only the elitism of rated officers but the hostility of jealous nonrated officers as well.

The situation did not last long. By early 1942, the demand for pilots had grown to the point that the Army had to lower its entrance requirements, even for cadets. Applicants needed only to be eighteen years old and possess a high school diploma. The aviation student program phased out. Graduates either received commissions or were warranted in the new grade of flight officer. In a short time, however, even the flight officer program was given up. All graduates received officer commissions.

Most graduates were officers by the time they went overseas, but not all. Some continued to fly transports in combat zones as enlisted pilots, and at least a few were shot

—Photo courtesy of *Sergeant Pilots' Newsletter*

At Mines Field, Calif. (later Los Angeles International Airport), during the summer of 1942, pilots of the 95th Fighter Squadron, 82d Fighter Group, await a scramble for coastal patrol. Left to right: SSgt. Pilot James E. Obermiller, Capt. Robert E. Kirtley (Squadron Commander), Lt. "Gummy" Joel, SSgt. Pilots Marshal Hyde and Charles Langdon, Lt. David Stentz, and SSgt. Archie F. Mallette.

down while wearing stripes. The men whom the Army had intended to use only in a backup role were flying every kind of mission in every theater of the war, most as officers but some as sergeant pilots.

Not Enough Room

In the postwar demobilization, there was no room for the tens of thousands of officers commissioned in the war. Most simply left the service. A few reverted to the enlisted grades in hopes that they could keep flying.

In July 1948, however, the newly created United States Air Force ordered all enlisted pilots—except those who had received pilot ratings before December 7, 1941—to cease flying by year's end. Those who didn't like the deal could apply for immediate discharge. The Air Force's ranks still contained about 140 enlisted pilots. Only a few, such as George Holmes, qualified to continue flying under the dispensation granted for pilots with prewar ratings.

In 1957, the Air Force did take official note of Holmes's retirement. Even so, it expressed a general lack of interest in documenting the era and the contributions of the enlisted pilots. It was willing to acknowledge that enlisted men had flown gliders and liaison planes during the war, but didn't appear very eager to remember that any had piloted "real" airplanes. Perhaps this was because the new Air Force was trying to build a new image. Fast, complicated jets were coming into the inventory, and the Air Force was looking for bright, highly educated officer pilots to fly them. It was not helpful to call attention to the fact that hundreds of pilots had flown proficiently without benefit of commissions.

The story of the enlisted pilots still might be buried in official archives if not for the efforts of a few World War II veterans who decided to bring it to life.

Over the years, individual pilots had kept in touch with each other. Small groups had met in reunions of wartime units, and modest attempts were made to organize alumni of specific classes. Still, there was no overall movement to tie things together. In the late 1970s, however, a small group of former sergeant pilots began to gather names and addresses of aviation students. They collected orders, class rosters, and personal histories.

One of the organizers was James H. MacWilliam of Columbus, N. C., a graduate of Class 42-G who flew with the Fifth Air Force in World War II, served with the Fifth Air Force in the Korean War, and retired in 1964 as a lieutenant colonel. By 1980, MacWilliam and his cohorts had gathered enough material to publish the first "Sergeant Pilots' Newsletter." Within a year, the newsletter grew into a slick publication, with MacWilliam serving as editor and publisher and Lee Arbon, of Johnson City, Tex., as contributing editor. Arbon, from Class 42-F, also retired as an officer. He specializes in researching the history of enlisted pilots from 1912 to 1933.

Now, even an "Army Air Corps Enlisted Pilots Association" has been established. It held its first reunion in 1982 and plans to hold another in 1990 at the Air Force Museum in Ohio. Thus is the story finally being told of all the men, from Corporal Burge through Master Sergeant Holmes, who have worn stripes *and* wings in service to the nation. ■

A World War II B-24 bombardier, Bruce D. Callander was recalled to active duty during the Korean War. Between tours of active duty, he earned a B.A. in journalism at the University of Michigan. In 1952, he joined Air Force Times, *becoming Editor in 1972. His most recent article for* Air Force *Magazine was "The Choppy Course of the Helicopter" in the May '89 issue.*

AFA

Advisors and Councils

BY TONI KUZMA, COUNCIL COORDINATOR

AFA President Jack C. Price has appointed the following advisors and councils for 1989:

AFA Presidential Advisors: CMSgt. Deborah S. Canjar, Enlisted Advisor; Dr. Ken Daly, Junior ROTC Advisor; Lt. Col. Roy A. Davis, Senior ROTC Advisor; Lt. Gen. John T. Flynn, USAF (Ret.), Veterans and Retirees Advisor; Lt. Col. William G. Morley, USAF (Ret.), Arnold Air Society Advisor; Kenneth A. Rowe, Civil Air Patrol Advisor; P. L. Schittulli, Civilian Personnel Advisor; Patricia Turner, Medical Advisor; and Capt. Paul A. Willard II, Junior Officer Advisor.

Enlisted Council: CMSgt. Deborah S. Canjar, ATC (Chairman); CMSgt. Roy R. Arakaki, AFRES; SrA. Melissa A. Bigham, AFSC; SSgt. Terry L. Cavallo, ESC; CMSgt. James R. Craig, Hq. USAF/DPXE (Liaison); MSgt. Mark R. Crandall, AFCC; TSgt. Neil A. Crow, ATC; MSgt. Joey W. Davis, AU; MSgt. Forrest D. Earley, ANG; MSgt. John A. Kittel, AFMPC; MSgt. Deborah L. Lee, AAC; MSgt. Michael J. Lynch, SAC; SMSgt. Noreen M. Macias, USAFE; SSgt. Kelly A. Meyer, USAFA; MSgt. Karen S. Murphy, AFDW; MSgt. Paul D. Murphy, TAC; MSgt. Glenn E. Palmer, MAC; TSgt. Rickey T. Pierce, Jr., PACAF; MSgt. Thomas C. Voegtle, AFSPACECOM; TSgt. Donald E. Wallace, AFLC. CMSAF James C. Binnicker, Advisor.

Junior Officer Advisory Council: Capt. Paul A. Willard II, AFSC (Chairman); Capt. Richard W. Aldrich, ATC; Capt. Kevin A. Ashley, USAFE; 1st Lt. Brenda J. Blackman, AU; Capt. Daniel Caulkins,

Civilian Personnel Council


Kausal


Aimone


Brower


Carter


Casaus


DiCarlo


Dillinger


Dumas


Mattice


Maust


Page


Perez


Schell


Schittulli

AFA Presidential Advisors


Canjar


Daly


Davis


Flynn


Morley


Rowe


Schittulli


Turner


Willard

USAFA (Recorder); Capt. Gray K. Coyner, AFRES; 1st Lt. Diane S. DeGeer, AFSPACECOM; Capt. Marta H. Girone, AFCC; Capt. David L. Gray, PACAF; Capt. James R. Hawkins, SAC; Capt. Edward E. Huling III, ESC; Capt. Trevor R. Jefferies, TAC; Capt. Joel R. Maynard, MAC; Capt. Michael J. McGrevey, Hq. USAF (Liaison); Capt. Dave R. Phillips, AFMPC; 1st Lt. Thomas P. Poole, ANG; Capt. Earl Shellner, AFSINC; 1st Lt. Jay B. Silveria, ATC; 1st Lt. Gary Stevenson, AAC; Capt. M. LaFaye Thigpen, AFLC. Brig. Gen. James M. Hurley, USAF Director of Personnel Plans, Advisor.

Civilian Personnel Council: Benedict A. "Tony" Kausal (Chairman); Michael A. Aimone; Dr. Paul W. Brower; Garry D. Carter; Leonard Casaus, Jr.; Teresa DiCarlo; Dennis R. Dillinger; Louis K. Dumas; James A. Mattice; Martha Maust; Robert Page; Al Perez (Liaison); Dr. Allan Schell. P. L. Schittulli, USAF Director of Civilian Personnel, Advisor.

Veterans and Retirees Council: Lt. Gen. John P. Flynn, USAF (Ret.) (Chairman); CMSAF Thomas N. Barnes, USAF (Ret.); Nathan H. Mazer; Robert Puglisi; James E. "Red" Smith; Sherman W. Wilkins.

The Air Force Reserve and Air National Guard Councils are also being formed, but were not fully constituted at this writing. ■

Enlisted Council

Junior Officer Advisory Council

Veterans and Retirees Council

The Japanese Connection

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

We need Japan as an ally if we are to remain a Pacific power. The public argument over the FSX is not helping to strengthen the defense partnership.

Thirty years ago, the man who had done most of the planning for the attack on Pearl Harbor was Chief of the Japanese Air Self-Defense Force. Minoru Genda, who had been a commander in the Imperial Navy, held the rank of lieutenant general in the newly created service. Like its newborn sister services, the air force carried the abject "self-defense" modifier as a disclaimer against aggressive behavior.

Genda was a brilliant man, generally acknowledged in the prewar years to be Japan's best naval aviator and tactical thinker. When the self-defense forces were formed, he was the obvious choice to head the air arm. Up to that time, there had not been a separate Japanese air force, only army and navy air units.

General Genda promptly reactivated himself as a pilot, even though he was in his fifties and had not flown in more than ten years. His airplane of choice was the F-86, at that time being made under license by Mitsubishi in Nagoya. Genda, however, would have nothing to do with a Mitsubishi airplane. Instead, he insisted on the genuine article from Inglewood, Calif. One of our captains customarily flew Genda's wing, although Genda flew the captain's wing when the weather was really sour, his instrument technique being a bit rusty.

Mitsubishi—regardless of General Genda's prejudice—produced fine F-86s, with careful attention paid to the detail work. When that production run was finished, the Nagoya plant made F-104s, then F-4s, and finally F-15s, adding local touches as their expertise increased. All of which makes the current hassle over the FSX difficult to understand. It is doubtful that we have much left to show the Japanese.

The 1950s saw Japan reemerge as an Asian power. It was a very cautious reemergence, what with the pacifist constitution we had provided for them and fresh memories of Japan's brutal militarism, but the Japanese were back in uniform, even though the services masqueraded under the innocuous titles of Ground, Maritime, and Air Self-Defense Forces. They rearmed at our urging.

Military service was not a popular vocation in the Japan of the 1950s, nor does it seem to be so now. The senior officers who were retreaded to lead the new Self-Defense Forces were looked down on by the new entrepreneurs. Golf club membership, then as now a supreme status symbol, was not granted to these senior officers. Even a proud and aristocratic man like Genda found more agreeable companionship in our ranks than he did among Japanese civilians. One relaxed evening after dinner, he told a few of us of his Pearl Harbor regrets. If his plan had been followed, he said, we would still be trying to pry the Japanese out of the Rockies.

Our military connection with Japan is a curious one when viewed against our arrangement with the other old foe. NATO provides both the mechanism and the excuse for a rearmed Germany. Japan has no ally save the United States and no incentive to rearm except for our prodding. Unlike the West Germans, the Japanese keep foreigners at a distance. It is a rare American who is truly absorbed into Japanese culture. The Japanese language itself, with its many nuances related to sex, social position, and hierarchical status, is an almost impossible barrier for an outsider to penetrate.

Because of Pearl Harbor and World War II in general, there is undeniably a lot of residual US hostility toward Japan. Perhaps because the Pacific War was more directly our war, the hostility has lingered, while, toward Germany, it has virtually disappeared. Japan's commercial triumph has stirred up further resentment, as has the widespread feeling that the Japanese are getting a free defense ride.

True enough, Japan spends only about one percent of its GNP on defense, but that still amounts to $30 billion, all of which goes to that end. Retirement pensions are in a separate account, which makes Japan's outlay compare favorably with that of any European ally. The question is, how much farther do we want the Japanese to go?

Old memories would stir uneasily throughout Asia if Japan's defense budget began to take a more sizable percentage of its GNP. In any case, however far Japan does go, it would seem imperative that it be hand-in-hand with the United States.

It may be that we have reached a crossroads in our relationship with Japan. Given its own head in the FSX affair, Mitsubishi would doubtless have gone it alone. The US preference, naturally enough, would have been the outright sale or joint production of the F-16. The compromise—to use the F-16 as the basic design and proceed from there—isn't perfect, but more is at stake than an airplane sale.

Perhaps there are good reasons to oppose the FSX consortium, including the fear that we will provide systems integration knowledge that will make Japan an aerospace power. But there is also a strong emotional bias for much of the opposition, one that is rooted in old prejudices and modern concern about Japan's economic success and the inroads it is making in the US.

We need Japan as a close ally if we are to remain a Pacific power. Now that we have brought that nation out of its postwar shell and back into the world of mutual security, it would seem important to strengthen our defense partnership. The public argument over the FSX hasn't done anything toward that purpose. ■

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"Valor at Its Highest"

Two young lieutenants laid their lives on the line for a wounded comrade.

BY JOHN L. FRISBEE

FOUR months after the Allies landed in Normandy on June 6, 1944, the Germans had been driven from most of northern France. Then one sector of the advance stalled in front of massive fortifications at and near Metz in northeastern France, about thirty miles from the German border. After a month of preparation, the US Third Army crossed the Moselle River on November 9 in an offensive aimed at taking Metz. Eighth Air Force B-17s of the 452d Bombardment Group based at Deopham Green, England, were called on to support the offensive by blasting forts at Metz and Thionville.

One of the group's bombers, a B-17G named *Lady Janet,* was piloted by twenty-one-year-old 1st Lt. Donald Gott, flying his twenty-seventh mission since joining the 452d in early August. His copilot, 2d Lt. William Metzger, a year older than Gott, had been with the group about a month.

That day, as was often the case, weather in the UK was foul and was even worse over the target area. Unable to bomb its primary targets, the 452d was diverted to a secondary—the marshaling yards at Saarbrücken, Germany, some forty miles east of Metz. Shortly before reaching that city, the group was hammered by a barrage of flak.

Two B-17s went down, and three of *Lady Janet's* engines took direct hits. Number 1 caught fire; its propeller couldn't be feathered. Number 2 was smoking heavily and losing power. Number 4 was sheathed in flame that streamed back to the tail. The intercom was knocked out, flares had been ignited, hydraulic fluid was gushing from damaged lines, the flight engineer was wounded in the leg, and one of the radio operator's arms had been severed below the elbow.

While Don Gott fought to control the crippled B-17, copilot Metzger left his seat to apply a tourniquet to the unconscious radio operator's arm. Returning to the cockpit, he told Gott that the man probably could not survive a bailout over enemy country, where medical aid might be long in coming. In any event, they had no static line that would pull the ripcord if he were dropped from the doomed aircraft.

They decided to jettison their bombs, turn back toward friendly territory only a few miles to the west, and there order the able members of the crew to bail out. Rather than abandon the gravely wounded radio operator, Gott and Metzger would attempt a crash landing.

With two engines afire and a third running intermittently at reduced power, keeping *Lady Janet* airborne for the few minutes needed to reach the Allied lines was a dicey proposition. Their worst worry, however, was an explosion. The right wing was engulfed in flame, and hydraulic fluid had been ignited in the fuselage by the burning flares. Nevertheless, Gott and Metzger had agreed not to abandon the radio operator, and they were prepared to live or die with that decision.

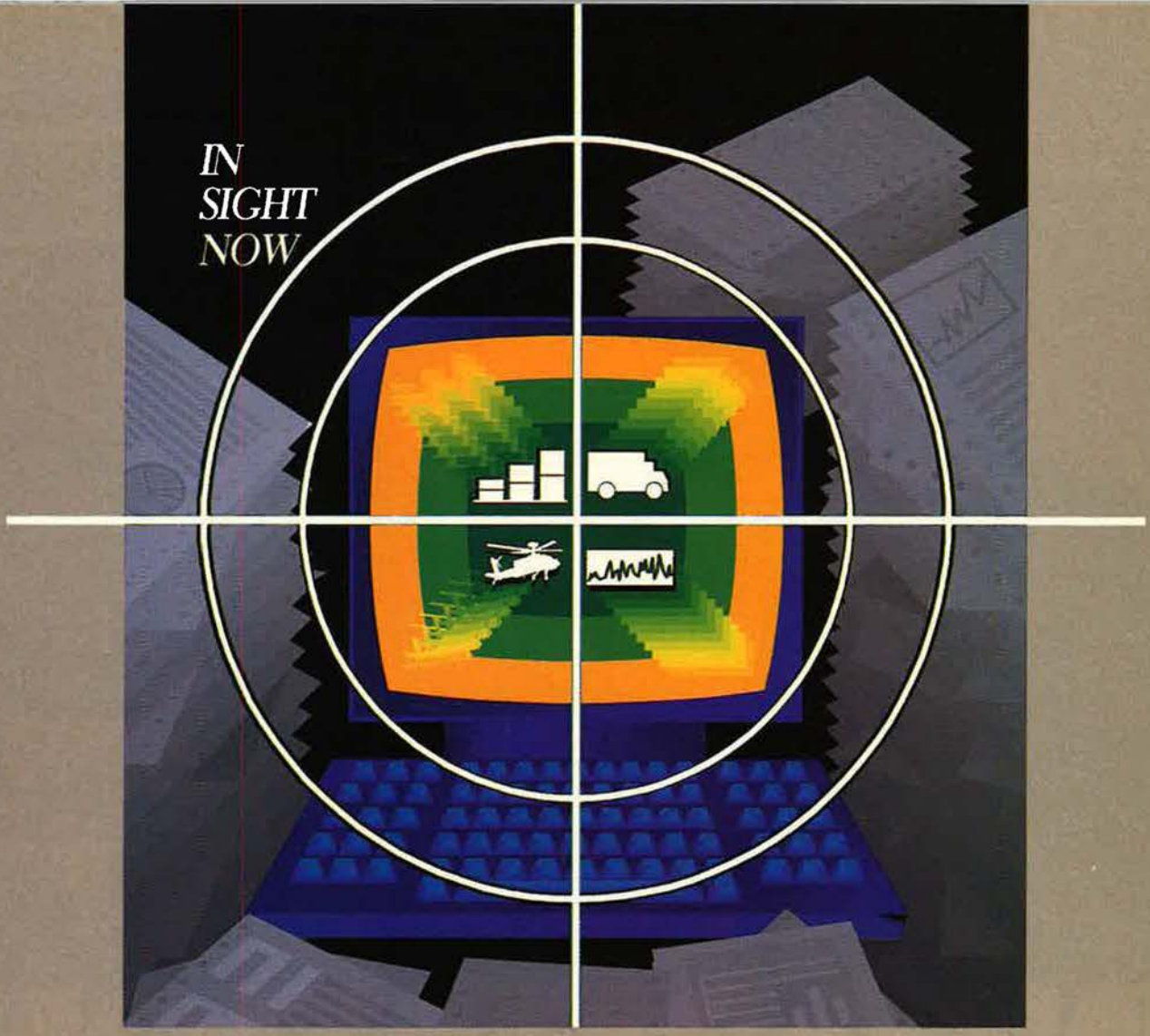
Despite the beating it had taken, the tough Boeing Fortress held together until they were over liberated France once more. Gott told Metzger to go through the aircraft and tell each crew member to bail out. Two had already jumped. The others were ready to go except one gunner, whose chute had been torn by flak. Metzger gave the man his own chute and joined Gott on the flight deck.

As they broke through the clouds, Gott saw an open field and turned into it. There was no time to search for an ideal crash site. With only one engine operating normally, he and Metzger started their approach. Both men knew that the impact of a crash landing would likely rupture the overstressed tanks in the flame-enshrouded right wing with the result totally predictable. But the war had seen many miracles. Maybe this was their day.

It was not. Witnesses said that at about 100 feet the bomber exploded. There were no survivors.

Donald Gott and Bill Metzger were awarded the Medal of Honor posthumously. The citations for both ended with these words: "[His] loyalty to his crew . . . and his deed of knowingly performing what may have been his last service to his country were an example of valor at its highest." By their self-sacrifice for a fellow airman, two heroic young pilots added another strand to the seamless web of Air Force tradition. ■

Posthumous Medals of Honor went to B-17 pilot Donald Gott (left) and his copilot, Bill Metzger, for their heroism and self-sacrifice after their aircraft took direct flak hits during a mission against the marshaling yards at Saarbrücken, Germany. Gott and Metzger died attempting a crash landing rather than leave their gravely wounded radio operator.



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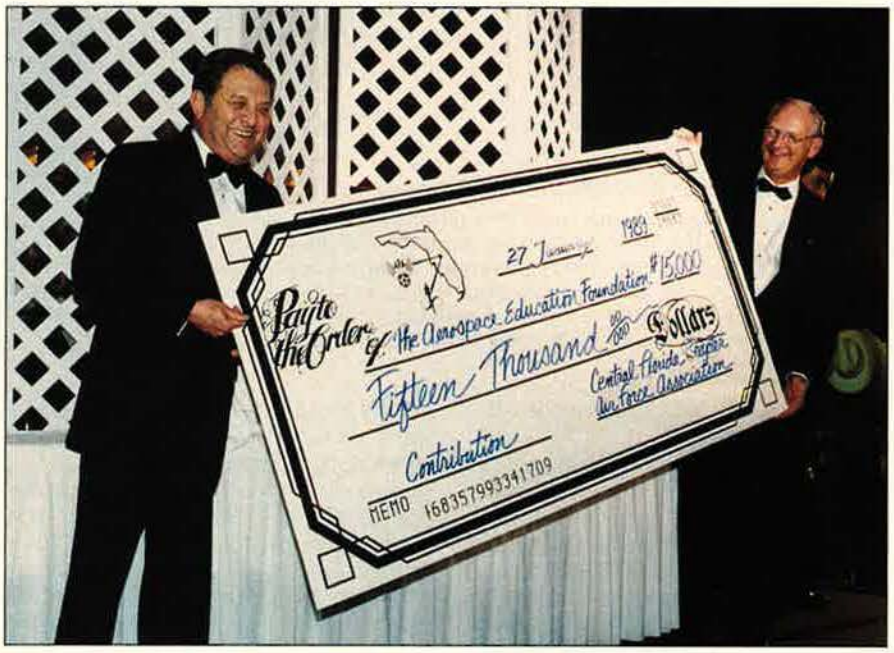
By J. R. "Doc" McCauslin, CHIEF, FIELD ORGANIZATION DIVISION

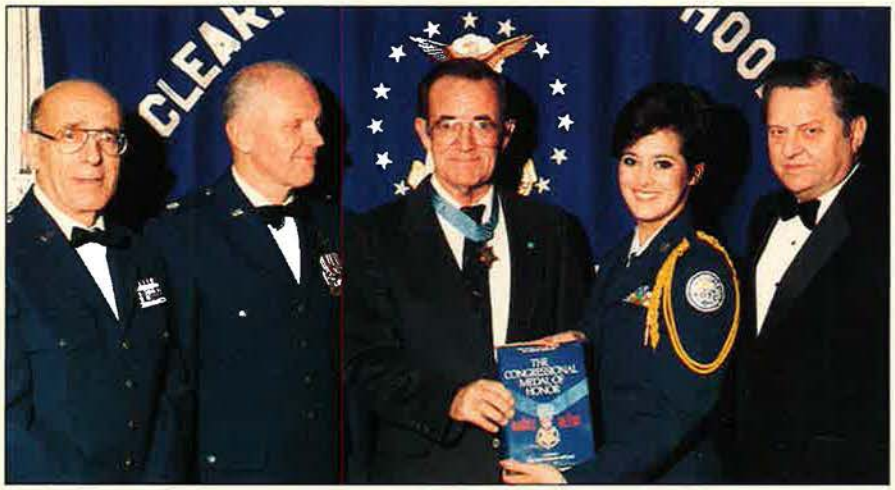
New Chapters and New Names

Congratulations to the newest AFA chapter overseas. The **Spangdahlem (Germany) Chapter** has been chartered with Lt. Col. Charles H. Matthewson as President. There are now 361 AFA chapters worldwide, formed to "address the defense responsibilities of our nation imposed by the dramatic advance of aerospace technology; to educate the members and the public at large in what that technology can contribute to the security of free people and the betterment of mankind; and to advocate military preparedness of the United States and its allies adequate to maintain the security of the United States and the free world."

The **Air Capital (Kan.) Chapter** has been renamed the **Lt. Erwin R. Bleckley Chapter.** The chapter was renamed to honor the Medal of Honor recipient and his efforts to deliver supplies to the front line in World War I. Lieutenant Bleckley (1894–1918) was born in Wichita, Kan., and enlisted in that state's National Guard. He was attached to the 50th Aero Squadron and sent to France. While making a second trip to drop supplies to a battalion cut off by the enemy in the Argonne Forest on October 6, 1918, his plane was brought down by enemy rifle and machine-gun fire. Lieutenant Bleckley was posthumously awarded the Medal of Honor for the "highest possible contempt of personal danger, devotion to duty, courage, and valor." *(For more on Lieutenant Bleckley and his last mission, see "Valor," AIR FORCE Magazine, December '84 issue.)*



The Central Florida Chapter recently held its fifth annual Tactical Air Forces gala and presented thirty-five percent of the proceeds to the Aerospace Education Foundation. Shown above, AFA National President Jack C. Price (left) beams as he accepts the $15,000 check from Central Florida Chapter President Tommy Harrison during the evening festivities.



Honored guest at Utah AFA's sixteenth annual AFJROTC dining-in at Clearfield High School was George E. Wahlen II (center), a World War II US Navy pharmacist's mate who won the Medal of Honor for valor on Iwo Jima on March 3, 1945, while serving with the 5th Marine Division. Others shown from left are CMSgt. John Deroian, USAF (Ret.), Ass't Aerospace Science Instructor; Lt. Col. Jay C. Hess, USAF (Ret.), Aerospace Science Instructor; AFJROTC Squadron Commander Cadet Lt. Col. Carolyn Smith; and AFA National President Jack C. Price.

Chapter Activities

The (then) **Air Capital Chapter** supported the Eighth Annual Knuckle-Busters Dining Out to honor the outstanding performers of the 384th Bomb Wing maintenance units at nearby McConnell AFB, Kan. More than 450 military and civilian guests from the Wichita area participated. The Dining Out program has con-

The Birmingham Chapter (Ala.) held its quarterly luncheon meeting with CMSgt. Wayne L. Fisk, Director of USAF Enlisted Heritage Hall, Gunter AFB, Ala., as guest speaker. Chief Fisk described his involvement in pararescue activities for the Apollo 8, Apollo 9, and Apollo 10 missions and his experiences in the raid on Son Tay POW camp in Vietnam and during the Mayaguez rescue. An AFA member and ardent supporter, Chief Fisk was recently assigned to duty at the US Embassy in Ottawa, Canada.

tinued to grow since the chapter established it in 1981.

The **General Doolittle/Los Angeles Area (Calif.) Chapter** donated funds to support AFROTC Detachment 060 at the University of Southern California and the two-day ROTC Drill Units Competition in Anaheim. This year's invitational drill competition was commanded by Cadet Maj. Marci Townsend, a USC student. Thirteen units from across the nation participated in inspection, regulation drill, exhibition drill—including an exciting exhibition drill presented by the USAF Honor Guard from Washington, D. C.—and a colorful awards banquet. The keynote speaker at the banquet was Maj. Gen. Robert R. Rankine, USAF Space Division Vice Commander.

The **Cape Canaveral (Fla.) Chapter** held its annual Astronaut Tribute Night to honor a USAF astronaut; this year's honoree is Col. Dick Covey, pilot of Mission 51-I and Mission STS-26, the *Discovery* flight that was launched on September 29, 1988, and landed October 3. As part of the tribute, the chapter presents the honoree with a $1,000 Doolittle Fellowship in support of the Aerospace Education Foundation. Previous honorees are Edwin E. "Buzz" Aldrin, Tom Stafford, Roy Bridges, and Jim McDivitt. Colonel Bridges and Dr. James "Ox" van Hoften, another former astronaut, were on hand for this year's festivities. The guest speaker was Glynn Lunney, Vice President and General Manager of the Houston Operations of Rockwell International Corp.'s Space Transport Systems Division.

The recently chartered **Roanoke Valley (N. C.) Chapter** has hit the ground running with strong programs such as its January 1989 meeting with Brig. Gen. Graham Shirley speaking on the April 1986 Libyan raid. At the time of that mission, General (then Colonel) Shirley was Commander of the F-111 unit at RAF Upper Heyford, UK. Another chapter meeting featured Col. Hubert J. Callahan, Commander of the 6th Airborne Command and Control Squadron at Langley AFB, Va., who discussed his unit's continuous alert mission and ongoing efforts to extend the life of the remaining EC-135 aircraft. Colonel Callahan also discussed pilot retention, maintenance retention, operational readiness, and effects of budget cuts on TAC acquisition of advanced aircraft.

The **Antelope Valley (Calif.) Chapter** held its dinner meeting and salute to the USAF Test Pilot School with the school's Commandant, Col. Michael C. Kostelnik, as guest speaker. His address outlined the school's forty-five-year history, its curriculum, and its flying and academic programs. Chapter President Sam Kilanowski presented Colonel Kostelnik with an AFA plaque and a special greeting to be included in the authoritative history of the USAF Test Pilot School now being prepared.

The **Brooklyn Key (N. Y.) Chapter** coordinated efforts with the Parkway East Kiwanis Club to gather more than 5,000 pounds of canned and packaged food, along with 142 turkeys, for distribution to local VA medical facilities and several churches and synagogues. Following that project, President Gene Festa and chapter volunteers gathered and distributed clothing and food to needy families in the area.

AFA regrets the formal deactivation of the **Central Washington Chapter**. AFA members in the Yakima, Wash., area are being reaffiliated with other chapters within that state.

The Midwest Regional Workshop in Kansas City, Mo., drew chapter, state, and national officials from Kansas, Missouri, Nebraska, and Iowa. Shown among the workshop participants are National Director Charles Church (second from left, front row, partly behind uniformed man); National Director Earl Clark (third from left, front row); Midwest Region National Vice President Don Adams (fourth from left, front row); and National Director James McCoy (seventh from left, front row).

Regional AFA

AFAers of the **Great Lakes Region** held a Regional Workshop in South Bend, Ind., with a large turnout of dedicated chapter and state volunteers. Despite freezing rain that closed roads and caused flights to be canceled, the workshop, hosted by the **South Bend (Ind.) Chapter,** was a success. Representatives from Illinois, Indiana, Ohio, Michigan, and Wisconsin participated. AFA National Vice President Walter G. Vartan moderated the workshop; South Bend Chapter Secretary John R. Kagel managed the arrangements. The workshop culminated with an indoor poolside banquet with entertainment by the AFLC Band under the direction of Lt. Col. Richard A. Shelton (an AFA member since 1981). Special patriotic numbers were offered by SrA. David Nokes and A1C Tracey McKenna.

The **Central East Region** recently met at National Headquarters with the Arnold Air Society Regional Council to develop closer ties among AAS squadrons, AFROTC detachments, and AFA chapters. AFA National Vice President Charles G. Durazo conducted the meeting with chapter officers from the five metropolitan Washington, D. C., chapters and Arnold Air Society members from Howard University and the University of Maryland. Among the joint objectives established was an AFA/AAS program to develop AFA activities in local AAS communities; it is hoped that these activities will lead to the creation of new AFA chapters in college and university areas.

National Director and former AFA National President Judge John G. Brosky of the Pennsylvania Superior Court joined AFAers from **Ohio and Pennsylvania** in a visit to Louisiana as guests of the Commander of the Eighth Air Force, Lt. Gen. E. G. Shuler (an AFA Life Member). During their visit, Judge Brosky and AFA member George F. Cahill (President of the National Flag Foundation) presented General Shuler with a personalized Flags of America chart.

How to Support AEF

The Aerospace Education Foundation has begun a fund-raising challenge in cooperation with Time, Inc., to provide the Foundation with a substantial endowment for scholarships. In the March and May 1989 issues of AIR FORCE Magazine, Time, Inc., offered discount subscription rates for a limited time to AFA members, patrons, Industrial Associates, subscribers, and Community Partners. Specific magazines discounted up to half off the cover price are *Fortune, McCalls, People, Life, Sports Illustrated, Money,* and *Time.* For a limited time, the magazine company will donate $5.00 to the AEF scholarship program for every paid subscription. This tremendous educational support offer also applies to renewal orders of the aforementioned magazines. Further information may be obtained by calling (800) 289-1850.

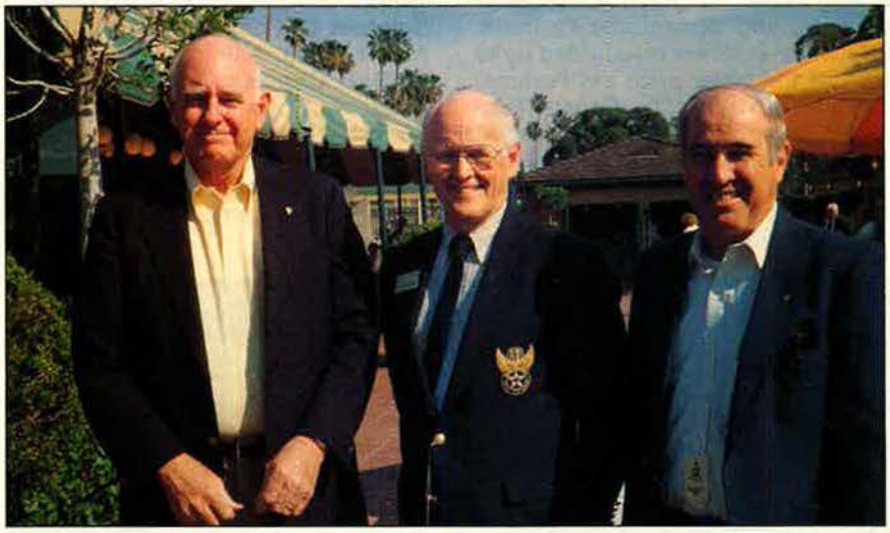
Another way to support the Aerospace Education Foundation is through the purchase of the new sixty-four-minute video (VHS only) "Jimmy Doolittle—An American Hero," narrated by Robert Stack. Proceeds from sales of the video will benefit the AEF. At $59.95, this tape is an excellent choice for showing at AFA and other defense- or history-related functions. Orders can be placed by calling (800) 727-3337, extension 5818.

New Senior Enlisted Advisors

Congratulations to these new Senior Enlisted Advisors: **CMSgt. Eugene L. Bergin,** 501st Tactical Missile Wing, RAF Greenham Common, UK; **CMSgt. Ronald W. Brodeur,** 42d Bomb Wing, Loring AFB, Me.; **CMSgt. Bobby W. Butler,** 6th Strategic Wing, Eielson AFB, Alaska; **CMSgt. Leslie H. Corbin,** 90th Strategic Missile Wing, F. E. Warren AFB, Wyo.; **CMSgt. Stephen C. Pachman,** 63d Military Airlift Wing, Norton AFB, Calif.; **CMSgt. Charles C. Porter,** USAF Academy, Colorado Springs, Colo.; **CMSgt. Thomas Snodgrass,** 384th Bomb Wing, McConnell AFB, Kan.; and **CMSgt. Jack R. Tycer,** 50th Tactical Fighter Wing, Hahn AB, Germany.

In Las Vegas, Nev., to meet with the AFA Board of Directors, National President Jack C. Price (front row, center) poses with the other AFA National Officers and the National Vice Presidents. From left, front row, are: Jack Powell (Rocky Mountain Region); Charles Durazo (Central East); Gerald S. Chapman (Far West); Mr. Price; James E. "Red" Smith (Southeast); John E. Kittelson (North Central); and Walter G. Vartan (Great Lakes). Second row: National Secretary Thomas McKee; Ollie R. Crawford (Southwest Region); Board Chairman Sam E. Keith, Jr.; Donald D. Adams (Midwest); Kenneth Thayer (Northeast); Joseph Zaranka (New England); Everett E. Stevenson (South Central); Ed Monaghan (Northwest); and National Treasurer Bill Webb.

More than 200 attended the Llano Estacado Chapter (N. M.) meeting at Cannon AFB to hear Lt. Gen. Michael J. Dugan, then DCS/Plans and Operations (now, with his fourth star, USAFE Commander in Chief). From left to right: New Mexico State AFA President Louie Evers; Col. Donald L. Peterson, Commander, 27th Tactical Fighter Wing; General Dugan; Ollie R. Crawford, AFA National Vice President for the Southwest Region; Col. David E. Benson, Commander, 27th Combat Support Group; and Llano Estacado Chapter President Jim Cook.



During AFA Day at the Santa Anita, Calif., racetrack, California State AFA President John Lynch (left) poses with Bud Chamberlain, General Doolittle/Los Angeles Area Chapter President (center), and George Estrella, California (South) Vice President. Eighty California AFAers attended the event; the fourth race was named for and dedicated to AFA.

Coming Events

June 2–4, **Georgia State Convention,** Warner Robins; June 16–17, **Louisiana State Convention,** Bossier City; June 16–18, **New Jersey State Convention,** Cape May; June 16–18, **Ohio State Convention,** Newark; June 22–25, **National Aerospace Symposium for Educators,** Arlington, Va.; June 23–24, **Maine State Convention,** Bangor; June 23–24, **Missouri State Covention,** Whiteman AFB; June 24, **Massachusetts State Convention,** Auburn; June 30, **Alaska State Convention,** Fairbanks; July 7–8, **Montana State Convention,** Bozeman; July 14–15, **Arkansas State Convention,** Blytheville; July 14–15, **Colorado State Convention,** Colorado Springs; July 21–23, **Pennsylvania State Convention,** State College; July 21–23, **Texas State Convention,** South Padre Island; July 22–23, **North Carolina State Convention,** Seymour Johnson AFB; July 29 **Michigan State Convention,** Lansing; July 29–30, **Florida State Convention,** Daytona Beach; August 4–6, **North Dakota State Convention,** Grand Forks; August 11–12, **Utah State Convention,** Wendover; August 11–13, **Arizona State Convention,** Sedona; August 12, **Indiana State Convention,** West Lafayette; August 12–13, **Delaware State Convention,** Dover AFB; August 18–19, **Wisconsin State Convention,** Milwaukee; August 24–26, **California State Convention,** San Francisco; August 26, **Illinois State Convention,** Chanute AFB; September 18–21, **AFA National Convention and Aerospace Development Briefings and Displays,** Washington, D. C.; October 20–21, **25th Annual Orientation of AFA State Presidents and New Directors,** Washington, D. C.; October 27–29, **North Central Regional Workshop,** Sioux Falls, S. D.; November 17–18, **Southeast Regional Workshop,** Savannah, Ga.

Outstanding Chapters

AFA Chapters that have been named Medium-Sized AFA Chapter of the Year are: 1983—Cleveland (Ohio); 1984 and 1985—Charles A. Lindbergh (Conn.); 1986 and 1987—Paul Revere (Mass.); 1988—Major John S. Southrey (Mass.)

How to Have Your Say

Contributions to "Intercom" should be sent to J. R. "Doc" McCauslin, AFA Headquarters, 1501 Lee Highway, Arlington, Va. 22209-1198. ■

Unit Reunions

Air Commandos/Special Operations Squadron
Air Commandos and Special Operations Squadron personnel are planning to hold a reunion in conjunction with the Kokomo, Ind., annual Vietnam veterans reunion on September 15–17, 1989. **Contacts:** Jim Otto, 10657 St. Veronica Ct., St. Ann, Mo. 63074. Phone: (314) 429-0391. Harry Carver, RR 2, Galveston, Ind. 46932. Phone: (219) 699-6542.

Air Force Security Police
The Air Force Security Police Association will hold a reunion on August 3–5, 1989, at the Omni Hotel in Orlando, Fla. **Contact:**

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B-compact	~~$30~~	$29	~~$150~~	$145
C-midsize	~~$34~~	$32	~~$170~~	$160
D-2-door full size	~~$36~~	$34	~~$180~~	$170
F-4-door full size	~~$36~~	$34	~~$180~~	$170

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Col. Jerry M. Bullock, USAF (Ret.), 28 Willow Creek Circle, San Marco, Tex. 78668. Phone: (512) 396-5444.

Eagle Squadrons
The Eagle Squadrons of the Royal Air Force will hold their annual reunion September 21–24, 1989, at the Hilton Hotel in Colorado Springs, Colo. **Contact:** James A. Gray, 7283 Kolb Pl., Dublin, Calif. 94568. Phone: (415) 828-0227.

Missile Warning and Space Surveillance
The US Space Command Missile Warning and Space Surveillance (all units and ranks) special oral-history reunion will be held September 1–4, 1989. **Contact:** Col. Terry D. Miller, USAF, AFSPACECOM/ADO, Peterson AFB, Colo. 80914-5001. Phone: (719) 554-3795.

RAAF/WAFB Veterans Ass'n
Military and civilian personnel stationed at Roswell AAF or Walker AFB, N. M., from 1941 to 1947 will hold a reunion September 29–October 1, 1989, at the Roswell Inn in Roswell, N. M. **Contact:** TSgt. Lott W. Porter, USAF (Ret.), P. O. Box 8092 (Linda Vista Station), Roswell, N. M. 88201.

Search and Rescue Squadron
A reunion will be held October 13–14, 1989, in Marshall, Tex., for Search and Rescue Squadron members who served during World War II in China-Burma-India and members of the 1352d Base Unit who served at Chabua or Mohanbari, India. **Contact:** LeRoy D. "Smitty" Smith, 1402 S. Cage, Box 41, Pharr, Tex. 78577. Phone: (512) 781-9541.

Tow Target Det.
Members of Tow Target Detachment, 72d Observation Group, who served in Panama between 1942 and 1944 will hold a reunion September 22–24, 1989, in Dayton, Ohio. **Contact:** "Bus" Bonucchi, 534 N. 10th St., Clinton, Ind. 47842. Phone: (317) 832-8514.

USAF SAM Flight Section
Personnel from US Air Force SAM Flight Section, School of Aviation Medicine, stationed at Randolph AFB, Tex., between 1948 and 1960, will hold a reunion October 6–8, 1989, in San Antonio, Tex. **Contact:** Eugene H. Sabelman, 2100 Grace Dr., Santa Rosa, Calif. 95404. Phone: (707) 545-8783.

Wheeler Field
Personnel and attached units who were stationed at Wheeler Field, Oahu, Hawaii (circa 1941), will hold a reunion November 9–11, 1989, at the Airport Holiday Inn in Fort Myers, Fla. **Contact:** Paul F. Bemis, 9693 Baycrest Terrace, Lehigh Acres, Fla. 33936. Phone: (813) 369-9234.

2d Bomb Group/2d Bomb Wing
Members of the 2d Bomb Group (World War II) and 2d Bomb Wing (SAC) will hold a reunion November 1–5, 1989, in Tucson, Ariz. **Contact:** Maj. Gen. John W. Collens, USAF (Ret.), P. O. Box 735, El Dorado, Calif. 95623.

4th Tow Target Squadron
The 4th Tow Target Squadron (1941–46) will hold a reunion October 5–8, 1989, in Nashville, Tenn. **Contact:** Edward R. Zaino, 212 Garrett Dr., Nashville, Tenn. 37211. Phone: (615) 832-0568.

8th Photo Recon Squadron
The 8th Photo Reconnaissance Squadron (World War II and Korean War) will hold its reunion September 13–17, 1989, at the Marriott Hotel in Dayton, Ohio. **Contacts:** Andy Kappel, 6406 Walnut, Kansas City, Mo. 64113. Phone: (816) 363-0261. Jack Carmen, 4485 Bath Rd., Dayton, Ohio 45424. Phone: (513) 233-7145.

15th Air Force
Veterans of the 15th Air Force will hold a reunion August 13–17, 1989, at the Riviera Hotel in Las Vegas, Nev. **Contact:** Lt. Col. C. E. Ben Franklin, USAF (Ret.), P. O. Box 6325, March AFB, Calif. 92518.

19th Bomb Group
Members of the 19th Bomb Group (B-17s and B-29s) will hold their reunion August 3–5, 1989, in Dayton, Ohio. **Contacts:** James A. Kiracofe, 274 Quinn Rd., West Alexandria, Ohio 45381. Phone: (513) 839-4441. Robert E. Ley, 3574 Wellston Ct., Simi Valley, Calif. 93063. Phone: (818) 703-7717.

20th Tactical Fighter Wing
The 20th Tactical Fighter Wing will hold its reunion September 7–10, 1989, at the Holiday Inn (Embarcadero) in San Diego, Calif. **Contact:** Col. Donald C. "Army" Armstrong, Jr., USAF (Ret.), 3909 Summer Way, Escondido, Calif. 92025. Phone: (619) 489-9266.

23d Tactical Fighter Squadron
Members of the 23d Tactical Fighter Squadron will hold a fiftieth anniversary reunion on September 27–30, 1989, at Spangdahlem AB, Germany. **Contact:** Capt. Paul Lockhart, USAF, 23d TFS/52d TFW, PSC Box 851, APO New York 09123. Phone: 011-49-6-575-4712.

27th Troop Carrier Squadron
The 27th Troop Carrier Squadron will hold a reunion October 25–28, 1989, at the Quality Inn in Tucson, Ariz. **Contact:** Lester J. "Rip" Van Winkle, 126 Riojas Dr., Kerrville, Tex. 78028. Phone: (512) 995-2558.

29th Bomb Group
The 29th Bomb Group Association will hold a reunion October 6–8, 1989, at the Marriott Hotel in Nashville, Tenn. **Contact:** Dr. Jack Burton, 1211 Loma Alta Pl., Cleburne, Tex. 76031. Phone: (817) 645-6743.

33d Air Depot Group
Members of the 33d Air Depot Group will hold a reunion September 8–9, 1989, in Fort Mitchell, Ky. **Contacts:** Herbert L. Cooper, 643 Reynosa Ct., Berea, Ohio 44017. Phone: (216) 234-9007. Robert W. Gocholl, 10280 Pendery Dr., Cincinnati, Ohio 45242. Phone: (513) 891-7742.

34th Bomb Group
The 34th Bomb Group will hold its reunion September 14–17, 1989, in Shreveport, La. **Contact:** Ray L. Summa, 2910 Bittersweet Lane, Anderson, Ind. 46011. Phone: (317) 644-6027.

39th Fighter Squadron
The 39th Fighter Squadron, 35th Fighter Group, 5th Air Force (World War II, Korea, or Vietnam), will hold a reunion October 12–15, 1989, in Oklahoma City, Okla. **Contact:** CMSgt. Nelson C. Thompson, USAF (Ret.), 9170 E. 8th St., Tucson, Ariz. 85710. Phone: (602) 885-9782.

46th/72d Recon Squadrons
Members of the 46th and 72d Reconnaissance Squadrons who were stationed at Ladd Field, Alaska (1946–48), are planning to hold a reunion October 9–11, 1989, in San Diego, Calif. **Contacts:** Allan Chapman, P. O. Box 2653, Santa Rosa, Calif. 95405. Phone: (209) 948-6343 (Henry D. Humbert).

51st Troop Carrier Wing
Members of the 51st Troop Carrier Wing will hold their reunion November 3–5, 1989, in Raleigh, N. C. **Contact:** James W. Klibbe, 3113 Merrianne Dr., Raleigh, N. C. 27607.

Class 61-Delta
Members of Class 61-Delta, both graduates and nongraduates, will hold a reunion September 21–24, 1989. **Contact:** Lt. Col. James D. Freebairn, USAF (Ret.), 2901 Coral Shores Dr., Fort Lauderdale, Fla. 33306. Phone: (305) 563-4517.

61st FIS Squadron
The 61st Fighter-Interceptor Squadron and the 61st Fighter Squadron will hold a reunion October 20–22, 1989, at the Ramada Inn in Fort Walton Beach, Fla. **Contact:** Ed Slown, 297 S. Bayshore Dr., Valparaiso, Fla. 32580. Phone: (904) 678-7284.

81st Troop Carrier Squadron
Members of the 81st Troop Carrier Squadron, 436th Troop Carrier Group (World War II), will hold a reunion October 24–26, 1989, in Orlando, Fla. **Contact:** T. W. Bonecutter, 620 Randolph St., Wilmington, Ohio 45177. Phone: (513) 382-4351.

82d Fighter Group
The 82d Fighter Group will hold its reunion October 4–8, 1989, at the Queen Mary Hotel in Long Beach, Calif. **Contact:** John C. Hendrix, 14708 Bouger Ave., Hawthorne, Calif. 90205. Phone: (213) 676-4794.

90th Bomb Group
Members of the 90th Bomb Group (H) will hold their reunion October 5–7, 1989, in Chattanooga, Tenn. **Contact:** Wiley O. Woods, Jr., 630 S. Crest Rd., Chattanooga, Tenn. 37404. Phone: (615) 622-9487.

91st Bomb Group
The 91st Bomb Group will hold a "rally-round" to rededicate the Priory Garden Royston Memorial and will also revisit its

former station July 14–15, 1989, in Royston, England. **Contact:** Paul Chryst, 1494 N. Adams St., Pottstown, Pa. 19464.

100th Bomb Group
Members of the 100th Bomb Group and supporting units (World War II) will hold a reunion November 2–5, 1989, in Tampa, Fla. **Contact:** Tom Hughes, 220 Mockingbird Lane, Englewood, Fla. 34223.

303d Bomb Group
The 303d Bomb Group (H) (World War II), 8th Air Force, will hold a reunion September 27–October 1, 1989, at the Omni International Hotel in Norfolk, Va. **Contact:** Hal Susskind, 2602 Deerfoot Trail, Austin, Tex. 78704. Phone: (512) 441-6475.

305th Bomb Group
The 305th Bomb Group (World War II), 8th Air Force, will hold a reunion October 6–9, 1989, in Portland, Ore. **Contact:** Abe Millar, P. O. Box 757, Sanger, Tex. 76266. Phone: (817) 458-3516.

306th Bomb Wing
Members of the 306th Bomb Wing (McCoy AFB, Fla.) will hold their reunion October 19–21, 1989, at the Ramada Oceanside Hotel in Satellite Beach, Fla. **Contacts:** Joe Demes, 1585 Mercury St., Merritt Island, Fla. 32953. Phone: (407) 452-4417. R. E. "Bud" Grierson, 6616 Beret Dr., Orlando, Fla. 32809. Phone: (407) 855-0120.

312th Bomb Group
Members of the 312th Bomb Group "Roarin' '20s" will hold their reunion September 21–24, 1989, at the Marines Memorial Club in San Francisco, Calif. **Contact:** Bob Spencer, 17250 High Rd., Mission Highlands, Sonoma, Calif. 95476. Phone: (707) 938-8165.

339th Fighter Group
The 339th Fighter Group, 8th Air Force (World War II), will hold its reunion on November 1–5, 1989, at the Wyndham Hotel in San Antonio, Tex. **Contacts:** Chester Malarz, 2405 Kings Point Dr., Atlanta, Ga. 30338. James R. Starnes, P. O. Box 251, Lutz, Fla. 33549.

351st Bomb Group
The 351st Bomb Group (H), 8th Air Force (World War II), will hold a reunion July 6–9, 1989, at the Hilton Towers in Huntsville, Ala. **Contact:** Ben Schohan, 398 Catawba Ave., Westville, Ohio 43081. Phone: (614) 882-8410.

362d Fighter Group
The 362d Fighter Group will hold a reunion October 9–14, 1989, at the Holiday Inn in Hampton, Va. **Contact:** G. W. Askew, Jr., 71 Wheatland Dr., Hampton, Va. 23666.

363d Fighter Group
The 363d Fighter Group (World War II) will hold a reunion October 5–7, 1989, in Fort Walton Beach, Fla. **Contact:** Charles H. Shiff, 710 Melanie Lane, Fort Walton Beach, Fla. 32548. Phone: (904) 863-1514.

367th Fighter Group
Members of the 367th Fighter Group, 9th Air Force (World War II), will hold a reunion September 21–24, 1989, in Niagara Falls, N. Y. **Contact:** Col. Allen J. Diefendorf, USAF (Ret.), 25985 Holly Vista, San Bernardino, Calif. 92404.

386th Bomb Group
Members of the 386th Bomb Group will hold their reunion September 7–10, 1989, in Colorado Springs, Colo. **Contact:** Emmett Curran, 624 Crestridge Ave., Colorado Springs, Colo. 80906. Phone: (719) 576-9133.

390th Bomb Group
The 390th Bomb Group, 8th Air Force, will hold a reunion October 11–14, 1989, at the Clarion Hotel in Colorado Springs, Colo. **Contact:** O. Dean Settles, P. O. Box 252, Woodland Park, Colo. 80866. Phone: (719) 687-2909.

390th Service Squadron
The 390th Service Squadron, 74th Service Group, 9th Air Force, will hold a reunion in October 1989 in Baton Rouge, La. **Contact:** Glenn Bock, P. O. Box 11, Sherman, N. Y. 14781. Phone: (716) 761-6587.

404th Fighter Group
Members of the 404th Fighter Group will hold a reunion September 7–10, 1989, in Savannah, Ga. **Contact:** John E. Hartshorn, 18 Rookery Rd., Savannah, Ga. 31411. Phone: (912) 598-1333.

449th Bomb Group
The 449th Bomb Group "Flying Horsemen" will hold a reunion October 31–November 3, 1989. **Contact:** Richard F. Downey, 4859 Stanhope Dr., St. Louis, Mo. 63128. Phone: (314) 892-4597.

449th/452d Bomb Squadrons
Members of the 449th and 452d Bomb Squadrons of the 322d Bomb Group will hold a reunion September 25–29, 1989, aboard the *Queen Mary* in Long Beach, Calif. **Contact:** Robert F. Wittling, 240 N. Edison Ave., South Bend, Ind. 46619. Phone: (219) 287-0264.

454th Bomb Group
The 454th Bomb Group stationed in Italy during World War II will hold a reunion October 1989 in Charleston, S. C. **Contact:** Ralph Branstetter, P. O. Box 678, Wheat Ridge, Colo. 80034. Phone: (303) 422-6740.

457th Bomb Group
Members of the 457th Bomb Group and attached units stationed in Glatton, England, during World War II will hold a reunion November 2–5, 1989, in San Diego, Calif. A minireunion of the 457th will be held on October 4–9, 1989, in Denver, Colo., in conjunction with the 8th Air Force Historical Society. **Contact:** Homer Briggs, 811 N. W. B St., Bentonville, Ark. 72712. Phone: (501) 273-3908.

459th Bomb Group
Members of the 459th Bomb Group (H) stationed in Italy during World War II will hold a reunion October 12–15, 1989, in Niagara Falls, N. Y. **Contact:** John Devney, 90 Kimbark Rd., Rochester, N. Y. 14610-2738. Phone: (716) 381-6174.

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Unit Reunions

505th Bomb Group
Veterans of the 505th Bomb Group, 313th Bomb Wing, will hold a reunion August 24–27, 1989, at the Marriott Hotel in San Antonio, Tex. 20th Air Force Association members are also invited. **Contacts:** Bob O. Bowens, 13004 Trent St., San Antonio, Tex. 78232. Phone: (512) 491-0533. Elbert Smith, 7811 Compass Lake Dr., San Diego, Calif. 92119. Phone: (619) 697-6123.

582d Air Resupply Group
The 582d Air Resupply Group will hold a reunion September 28–October 1, 1989, at the Ramada Beach Resort in Fort Walton Beach, Fla. **Contact:** Lt. Col. F. W. Mittelstadt, USAF (Ret.), 805 Jack St., Rothschild, Wis. 54474. Phone: (715) 359-8428.

585th Bomb Squadron
Members of the 585th Bomb Squadron (World War II) will hold their reunion September 12–16, 1989, in Billings, Mont. **Contact:** Thomas J. O'Brien, 1907 Rio Vista Dr., Fort Pierce, Fla. 34949. Phone: (407) 465-7974.

7531st Air Base Squadron
Members of the 7531st Air Base Squadron and attached units will hold a reunion in Hemel Hempstead, England, September 22–24, 1989. **Contact:** MSgt. John W. Hill, USAF (Ret.), 3101 S. Nichols Dr., Sierra Vista, Ariz. 85635.

Air Refueling Squadrons
For the purpose of compiling a roster and organizing a reunion, I would like to hear from members of the 70th Air Refueling Squadron (Little Rock AFB, Ark.), which includes KC-97 crew members, maintenance, staff, and support personnel.

I would also like to hear from members of the 907th Air Refueling Squadron (Glasgow AFB, Mont.), including B-52, KC-135, and F-101 personnel.

Please contact the address below.

Lt. Col. David L. Roberts, USAFR (Ret.)
1055 N. Shore Dr.
Roswell, Ga. 30076-2841
Phone: (404) 992-9516

5th Communications Group
For the purpose of organizing a reunion this fall, I would like to hear from former members of the 5th Communications Group who served in Korea between the years 1951 and 1953.

Please contact the address below.

Charles Crank
9854 Glen Wood
Overland Park, Kan. 66212

19th Troop Carrier Squadron
I am seeking former members of the 19th Troop Carrier Squadron who served from Pearl Harbor through the Berlin Airlift.

Please contact the address below.

Donald Jacobs
Box 61
Monument Beach, Mass. 02553
Phone: (508) 759-4215

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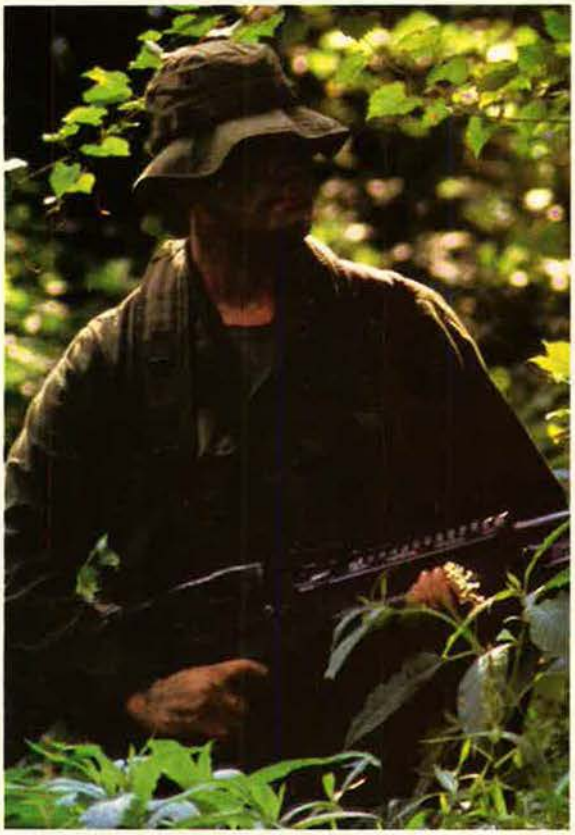

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Reunion Notices

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to "Unit Reunions," AIR FORCE Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Please designate the unit holding the reunion, a time and location, and a contact for more information.

23d Bomb Squadron/5th Bomb Group

Members of the 23d Bomb Squadron and the 5th Bomb Group are seeking current and former members (all ranks) for the purpose of obtaining information for future reunions.

Please contact the address below.

J. W. McClosky
2727 Asbury Ave.
Evanston, Ill. 60201

39th Bomb Group

For the purpose of organizing a reunion, I would like to hear from former personnel (support, ground, and administrative) of the 60th, 61st, and 62d Bomb Squadrons assigned to the 39th Bomb Group who trained at Smokey Hill AAB, Kan.

Please contact the address below.

James W. Wyckoff
2714 E. Hayts Corners Rd.
Ovid, N. Y. 14521
Phone: (607) 869-2574

Class 42-H

Class 42-H pilots are planning a fiftieth anniversary reunion and would like to hear from former members.

Former graduates should send name, address, and name of flying school to the address below.

Reginald L. Robinson
4009 Ranier Ct.
Fort Worth, Tex. 76109
Phone: (817) 923-2791

Class 44-B

For the purpose of organizing a reunion, I would like to hear from Class 44-B members who graduated from Freeman Field, Ind.

Please contact the address below.

Lt. Col. Robert L. Brown, USAF (Ret.)
4424 Beechwood Lake Dr.
Naples, Fla. 33962
Phone: (813) 775-4226

Class 52-G

I am attempting to locate former members of Class 52-G for the purpose of organizing a reunion.

Please contact the address below.

Jack Gilliland
1232 Redwood Lane
Gulf Breeze, Fla. 32561
Phone: (904) 932-5472

Class 53-B

I would like to hear from members of Class 53-B (Hondo AB, Tex./Williams AFB, Ariz.) who would be interested in holding a reunion this fall in the Langley area.

Please contact the address below.

Lt. Col. Frank J. O'Brien, USAF (Ret.)
16 Van Dr.
Bordentown, N. J. 08505
Phone: (609) 298-3075

Class 55-K

I am working on a directory and planning a reunion for Pilot Class 55-K and would like to obtain the names and addresses of former members.

Please contact the address below.

R. Thomas Roe
750 N. Branch Rd.
Maple Plain, Minn. 55359
Phone: (612) 591-1111

325th Air Service Group

For the purpose of organizing a reunion this fall, I would like to hear from members of the 328th and 343d Air Service Squadrons of the 325th Air Service Group.

Please contact the addresses below.

John Watts
2029 N. B
Wellington, Kan. 67152
or
Lawrence Cole
1202 N. Washington
Wellington, Kan. 67152
Phone: (316) 326-2148 (Watts)
(316) 326-6354 (Cole)

The von Kármán Scholarships Need You

The Aerospace Education Foundation will begin a new von Kármán scholarship program in 1990 with ten awards to AFROTC graduates working toward advanced degrees.

The first group of scholarship recipients will be chosen from the body of AFROTC cadets graduating in 1990. The grants will apply to graduate work they pursue before beginning active duty with the Air Force.

In subsequent years, the number of scholarships could increase. The Foundation has placed an initial sum of money in a special scholarship fund. It will now seek to build the endowment with contributions from AFA chapters and corporate support.

Gerald V. Hasler, Chairman of the Foundation's Scholarship Committee, explained the two plans by which donations can be made. Each "share" contribution of $200 will be held in the scholarship account until it can be combined with twenty-four other "share" donations to create one of the ten basic scholarships each year.

A contribution of $5,000, however, will add an additional scholarship to the number awarded. While donors may not designate the individual recipient of a scholarship thus created, they will be able to designate the state or the school from which the recipient is to be selected.

AEF President James M. Keck and Mr. Hasler emphasized that one hundred percent of the donations to the fund will be awarded in scholarships. None of the money will be used for administrative or fund-raising purposes.

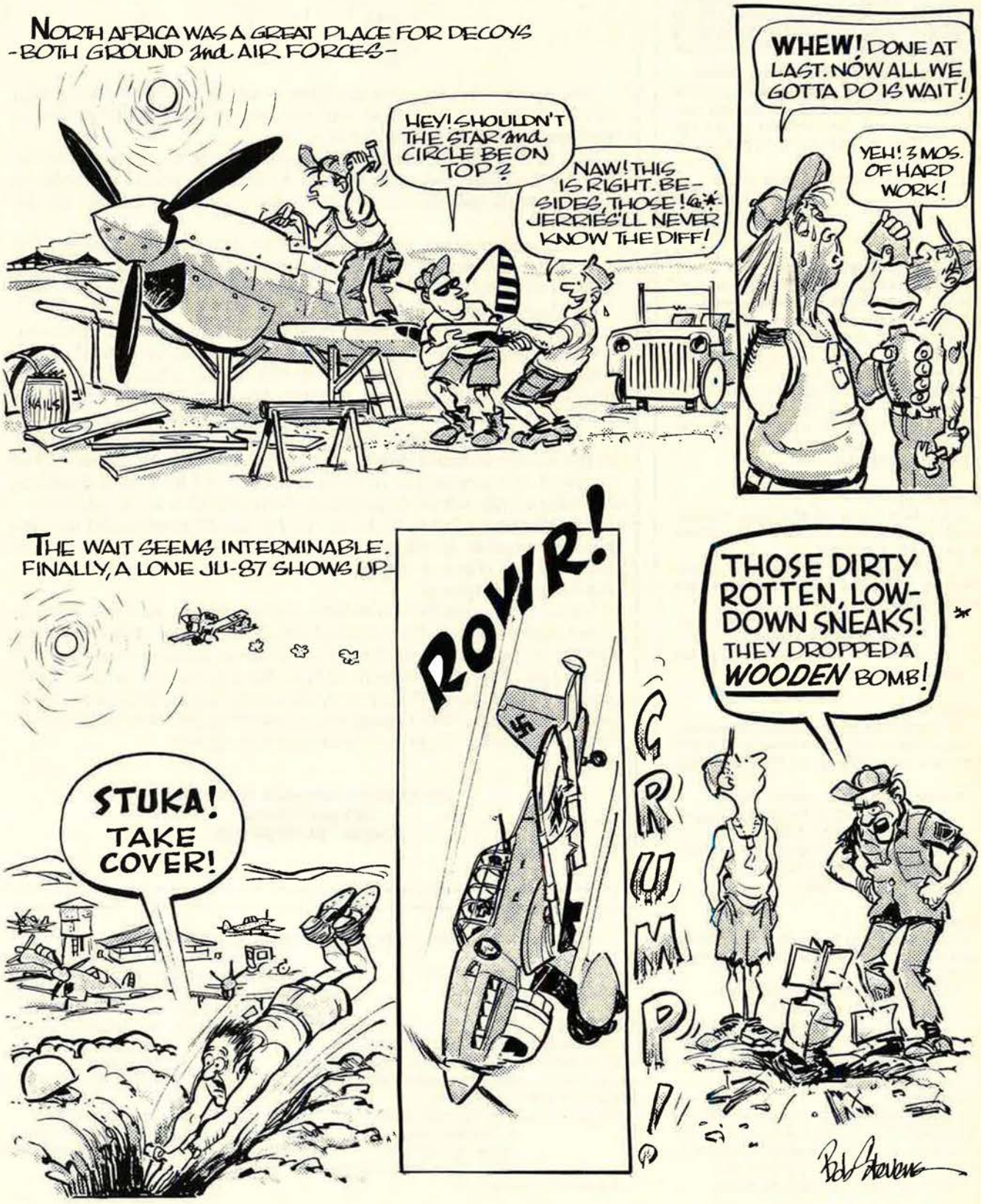
Time, Inc., is our first corporate sponsor for the new von Kármán scholarship program. For a limited period, Time, Inc., will donate five dollars ($5.00) to the program for every new or renewal subscription to *Time*, *Life*, *Sports Illustrated*, *People*, *Money*, *Fortune*, and *McCall's* magazines at special AEF subscription rates. See the Time insert in the May issue of AIR FORCE Magazine or call (800) 289-1850 for details on how to subscribe to the aforementioned magazines.

The Aerospace Education Foundation
1501 Lee Highway
Arlington, VA 22209-1198

Bob Stevens'

"There I was..."

DECOYS HAVE ALWAYS BEEN PART OF MILITARY STRATEGY, e.g., THE TROJAN HORSE. MAKING THE ENEMY EXPEND COSTLY ORDNANCE ON FAKES IS PARTICULARLY GRATIFYING BECAUSE IT DEMONSTRATES OUR SUPERIOR INTELLECT OVER OUR "STUPID" FOES...



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Satellite communications are essential for keeping some U.S. military forces connected to their chain of command. If those communications were ever cut off, some of our forces would be impaired.

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Milstar's design puts special emphasis on survivability. Now ready for Low Rate Initial Production, the system uses extremely high frequency (EHF) and other state-of-the-art technologies to withstand electronic warfare and attack.

It's as simple as this. Our forces can't be effective if they can't communicate. By providing secure and survivable communications, Milstar will help ensure that a breakdown like this never takes place. That's why America needs Milstar. Few other programs are so vital to our national defense.

For more information contact: Collins Defense Communications, 3200 East Renner Road, Richardson, Texas 75081, (214) 705-3950.

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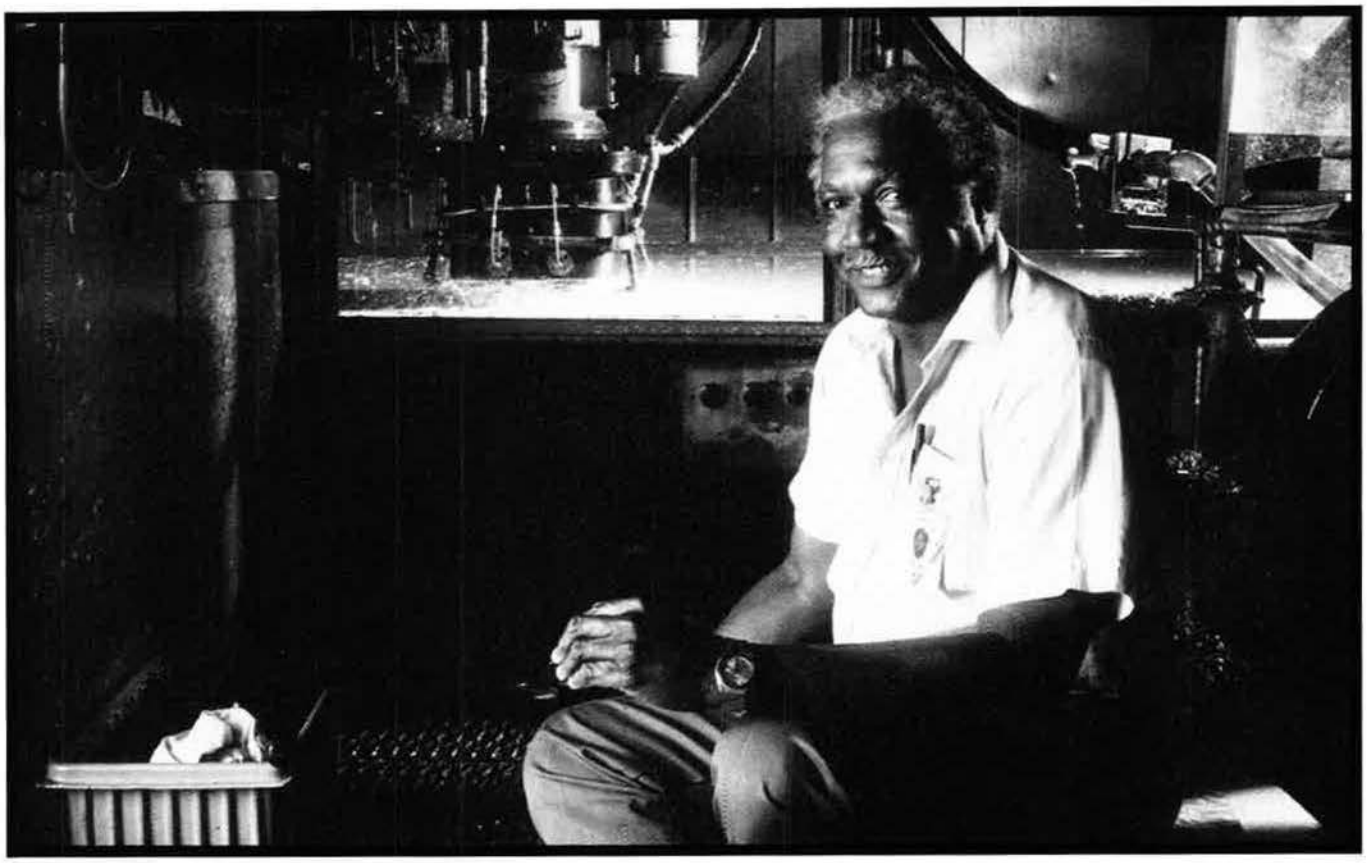

"We call it a skin, this big sheet of aluminum that lines the inside of the Delta rocket.

The specifications say I've got five thousandths of an inch leeway in cutting out these triangular pockets on its surface. But I like to get closer than that.

So before I load the skin onto my machine, I go over the whole table with a polishing stone. Then I check the numbers after every cut and make adjustments as I go. That way I hold my tolerances tighter—to plus or minus three instead of five.

There's a guy down the line that has to do his job with the skin I make. I'm just making sure he can rely on me. He's doing his job the same way. That's the best way—maybe the only way—to build reliability into our rockets." *—Joe Hall, Delta Rocket, Numerical Control Machine Operator*

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