**Most of the aircraft that will be in service in the year 2000 are on the ramp today. It's no longer possible to upgrade combat capability through new acquisitions alone.**

# Modernization Through Modification

**BY BRIG. GEN. (MAJ. GEN. SELECTEE) RICHARD D. SMITH, USAF**
**DEPUTY CHIEF OF STAFF FOR MATERIEL MANAGEMENT, AIR FORCE LOGISTICS COMMAND**

BETWEEN eighty and eighty-five percent of the weapon systems that will be in Air Force service beyond the year 2000 are already on the ramp today.

New military aircraft are no longer introduced with the frequency they once were, and the number of aircraft produced annually has been declining steadily for some time. When a system does enter the force, it will have to handle its share of the threat for quite a while because there will probably be a considerable wait before the follow-on system rolls out.

One consequence of this pattern is that the Air Force cannot achieve through acquisition of new systems alone the updated combat capabilities it needs to keep abreast of the threat. This, in turn, has led to greater reliance on modernization through modification of existing systems.

Lt. Col. Vince Lewis, Chief of AFLC's Modification Policy and Financial Management Branch and a former B-52 bomber pilot, cites the seemingly ageless B-52 as the prime example of modernization through modification. Gen. James P. Mullins, a former AFLC Commander, recently stated that "about all a current B-52 has in common with one from the 1950s is the silhouette on the skyline." Further, it contains one of the best and most tangible success stories in Logistics Command—the Offensive Avionics System (OAS). The vacuum-tube technology of the bombing/navigation system rarely flew more than one sortie without a significant failure or degradation. This system suffered immensely from low reliability and high support costs. Historically, the "BUFF" always finished last in the SAC bombing competitions. But last year, with the OAS in place, the B-52 took the first seven places. And still, this aged craft remains the most powerful single air-breathing weapon system on the face of the earth.

Modernization, however, has its price. The total bill for B-52 Class IV and Class V modifications and associated costs reaches just over $8.6 billion. And how does this compare to purchasing a new weapon system? A few years ago, the Boeing Military Airplane Co. estimated B-52 replacement costs at around $100 million per equivalent aircraft with few of the enhancements listed above. If the B-52 were to be replaced one for one with B-1Bs, the costs for the aircraft and associated new support equipment would soar to $250 million per copy. Even using the lower $100 million figure, the cost to modify compared to acquiring a new weapon system yields at least a three to one advantage.

## New Discipline Emerges

As the modification program becomes more important, a new discipline is emerging in the way modifications are developed and executed. Traditionally, modifications have tended to fall into separate and specific categories, such as safety, performance, or reliability and maintainability (R&M). These distinctions—driven largely by financial planning and programming schemes to allow an organized means of conveying requirements

—Photo by William A. Ford

***The venerable Boeing B-52 Stratofortress has been modernized numerous times throughout its lengthy career to keep abreast of technology and ahead of the threat. By 1984, the B-52Gs (such as the one shown here at Griffiss AFB, N. Y.) had been modified to carry air-launched cruise missiles; by 1986, the much more accurate, much more compact, digitally based Offensive Avionics System (OAS) had replaced this collection of analog avionics boxes (below) in the nearly thirty-year-old B-52Gs and Hs.***

to the Air Staff, DoD, and Congress—have often led to missed opportunities. From a technical perspective, there is no reason why safety, performance, and R&M modifications cannot complement each other. Opportunities to increase combat capability at dramatic reductions in support costs are there for the taking, and the potential synergism is too strong to ignore. We also know that modifications can be done much quicker by employment of "form, fit, and function" spare parts.

The vehicle for the new modification discipline is the Weapon System Master Plan (WSMP) process, with Logistics Command, Systems Command, and the operating commands all in the loop. Conceived by AFLC and now a recognized Air Force program, WSMP is a long-term "contract" between the combat commands and Logistics Command. It starts with a view of what Air Force planners expect each weapon system to do for the next ten years. System program managers specify the current capabilities of the system. In between these two points is a "delta"—a void that must be filled. Defining the technology, performance, and R&M options to fill the voids will set modification requirements in the years ahead. WSMP further lets the commands involved express their requirements credibly, with a single voice.

Modifications originate from many different sources. The most common of these are accident investigations, materiel-deficiency reports, inspections, new technology applications, R&M opportunities, and even the Air Force Suggestion program. External to the materiel sys-

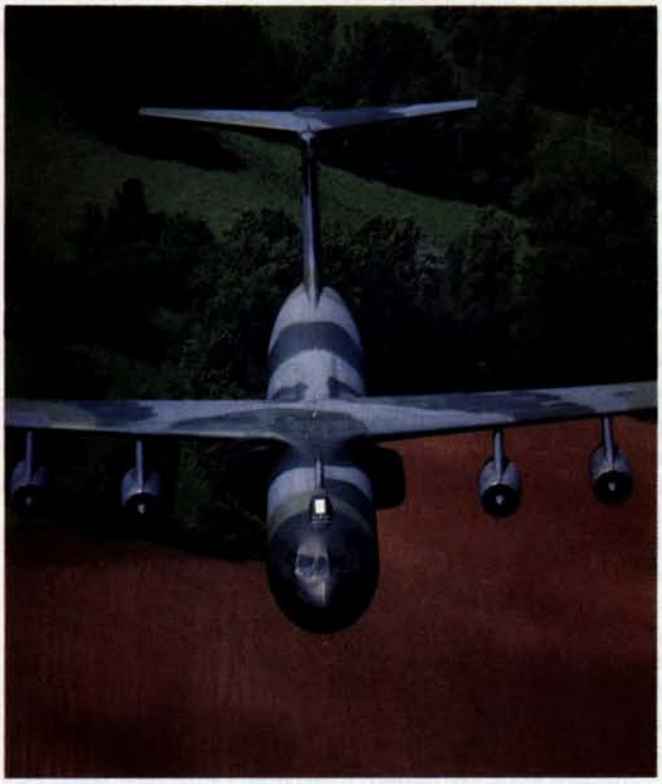
tem are modifications generated by mission area analysis or enemy threat changes, which may demand a whole new capability.

Each need, whether generated by the system's users, such as Military Airlift Command, Tactical Air Command, Strategic Air Command, and Air Force Communications Command, or by supporting commands (AFLC or AFSC), follows a dual track for approval and funding. Sooner or later, every modification must pass both a technical evaluation and a funding authorization/appropriation process. The technical evaluation assesses the adequacy of the fix through a formal process known as the Configuration Control Board. However, funds are obtained through the completely separate Air Force Planning, Programming, and Budgeting System, where modifications compete with each other and against the total needs of the service for limited financial resources. Successfully passing these milestones, which usually takes two to three years, results in official Program Management Direction from Hq. USAF to execute the modification.

### The Results of Modification

The B-52 example cited earlier demonstrates how the bomber force has been modernized through modification. The process has also been applied to upgrade airlifters, trainers, and fighters.

While the C-5, C-130, and C-141 constitute the majority of our airlift capability and the C-130 consumes the most resources at $1.99 billion, the C-141 probably provides the best example of why modifications are done. In the Fall 1986 issue of the *Air Force Journal of Logistics,* Dr. William Head, Deputy Chief, Office of History, Warner Robins Air Logistics Center, says that "the inability of its primary cargo transport to refuel while in flight nearly cost America her foremost Middle East ally." During the 1973 Yom Kippur War between Israel and several Arab states, our Western European allies initially refused to grant landing rights to US supply flights destined for Israel. Dr. Head asserts that "the time and expense of producing a new cargo plane, as well as training new crews, made the development of a new series of transports prohibitive."



***A real force-multiplier was the modification program done to the Air Force's fleet of Lockheed C-141 StarLifters. Adding twenty-three feet to the fuselage of the planes provided a thirty percent increase in volumetric capacity, and an in-flight refueling capacity gave the "StarLizards" global range.***

Stretching the C-141 fuselage and adding an air-refueling capability became the optimum solution. In the end, the Air Force gained a thirty percent increase in volumetric capacity in the 270 C-141s for approximately $500 million and in less than half the time it would have taken to develop and acquire a new transport. Furthermore, the modified aircraft could be flown by the same crews and picked up an added force-multiplier in the new air-refueling capability. The increased cargo space added an equivalent volume of ninety additional aircraft!

While much smaller in size, the T-38 trainer is just as critical to this nation's military might because it is the sole aircraft used to teach advanced jet flying to virtually all the USAF fixed-wing pilots. Twenty-five years of use have taken their toll. Cracks and other signs of fatigue began showing up in early 1970s, and eighty-nine of the aircraft had to be grounded. A program to replace the T-38's thin-skinned wings gave the aircraft new life, but by the end of that decade, fatigue problems began to show up in the main fuselage structural components on all the T-38s. By then it was recognized that the T-38 would be an excellent candidate for a complete Service Life Extension Program (SLEP). Nicknamed "Pacer Classic," the T-38 SLEP integrated ten modifications into one program.

Pacer Classic literally helps to double the service life of the 851 T-38s, projecting their use beyond the year 2010. At a modification cost of $359.2 million, the price pales in comparison to that of purchasing a new aircraft.

Age, however, is not the primary reason to modify a weapon system. This nation's top-of-the-line fighter, the F-15 Eagle, consumes $2.7 billion from the overall modification account. Unlike other aircraft, eighty percent of the F-15 modification money goes for Class V mods to make the world's best fighter aircraft even better. A relatively new concept, known as the multistage improvement program (MSIP), has been allotted $1.8 billion worth of the F-15 modification program. The MSIP is a preplanned, logically grouped, and integrated set of phased improvements to incorporate new capabilities and technologies after production and deployment.

### Age Less Important Now

MSIP reverses the traditional thinking of managers who have tended to treat modifications as a "fix after failure" solution. Now, during the design and full-scale-development phases of acquisition, space provisions and interface components are designed into the production aircraft for modifications that may not even be available for years. For the first time in military aviation history, MSIP causes the age of a weapon system to lose some of its significance as a measure of capability. The vast performance and capability differences between


—USAF photo by SSgt. Fernando Serna

***The Boeing KC-135 Stratotanker first flew in 1956, and—with modification programs such as those being done in the KC-135R reengining program—the KC-135s will still be pumping gas well into the twenty-first century. This KC-135R has just topped off an F-16C (an excellent example of evolutionary modernization while still in production) from the 50th Tactical Fighter Wing at Hahn AB, West Germany.***

first production models and the latest C/D series of the F-15 are prime examples of how modifications contribute to our fighter superiority.

The air-refueling mission may not have the glamour of fighters, but it does have the single most expensive modification in the Air Force. The $10 billion reengining program provides such enhancement for the KC-135 Stratotanker that it can be likened to buying new aircraft for the price of the engines. In fact, the KC-135R makes up much of the Air Force air-refueling shortfall generated by termination of the KC-10 procurement. Refitting the KC-135 with commercial CFM56-2 (F108-CF-100) engines provides for an up to fifty percent increase in fuel-offload potential, shorter takeoff distances, and twenty-seven percent lower fuel consumption—yet it meets or exceeds all noise and pollution standards. Aside from increased capabilities, fuel savings alone on the 640 KC-135s to be modified will go a long way toward defraying the total cost. This, together with the reliability and maintainability benefits, distinguishes the KC-135R program as a model of fiscal responsibility, performance enhancements, and R&M synergism.

The CFM56 engine reliability and maintainability track record has allowed SAC to advance to a centralized intermediate maintenance concept. This will enable SAC to redistribute ninety manpower positions to meet other critical command requirements. In effect, this modification has internally generated a net increase in available SAC manpower. It should not be any mystery why SAC has taken this action, since the McConnell AFB, Kan., unit flew all of its aircraft for more than a year and never changed an engine.

The KC-135R is just one of more than 800 ongoing modifications in various stages of planning and execution throughout the command. In all, this year's Air Force budget alone contains $3.2 billion for aircraft, missile, and ground communications and electronics modifications. In constant dollars, there has been a quadrupling of the modification account in the last ten years. The President's budget for FY '88 projects Air Force spending of $36.8 billion between FY '85 and FY '94 for the modernization of aircraft through modifications. Given the real growth in the modification account, the unchanging number of systems in the inventory, and the increasing age of military aircraft, it can be seen that a definite pattern has developed.

### One Fighter in Two Decades

During the 1940s and 1950s, the Air Force developed at least six new fighter systems per decade—the P-47, P-51, P-59, P-61, F-80, F-82, F-84, F-86, F-89, and F-94 in the '40s and the F-100, F-101, F-102, F-104, F-105, and F-106 in the '50s. During the 1960s and 1970s, two new systems per decade were acquired in quantity—the F-4 and F-111 in the '60s and the F-15 and F-16 in the '70s. It appears that in the 1980s and 1990s only one new fighter will be developed—the Advanced Tactical Fighter. This means that older systems will be kept in the

inventory longer, and they will have to be upgraded with new technology modifications to meet the threat.

Throwing billions of dollars at costly new replacement aircraft in order to counter the threat is simply not a viable alternative in today's defense-spending plan. Keeping aircraft in the inventory for thirty years or more is becoming the rule rather than the exception. Such workhorses as the F-4, B-52, KC-135, C-130, C-141, and F-15 are stable design types that will carry the load for many years to come. Despite their ages, each of these aircraft has been and continues to be a significant part of this country's powerful arsenal because of their ability to accept modifications. Given this importance, newer aircraft designs have incorporated space for preplanned—and in some cases as yet unknown—product improvements and new technology modifications that could alter the course of a battle.

At the heart of these modifications is the reliability and maintainability factor. Its contribution to the military power of this country is aptly cited by Gen. Robert D. Russ, Commander of Tactical Air Command: "It doesn't do any good to have a superior airplane that can only fly once if the enemy's got one that flies three times unopposed. To match the Soviet threat, we need to fly sortie after sortie, again and again." Further, Gen. John T. Chain, Jr., Commander in Chief of Strategic Air Command, says that "combat capability on the ground doesn't do me any good if I can't get it in the air—each time, every time."

### Leaps in Reliability

In the Air Force Logistics Command, a program called "R&M 2000" is putting new emphasis on the importance of reliability and maintainability in modifications. No longer are planners limited to fractional advances. An educational process, just beginning, will demonstrate the availability of quantum leaps in both reliability and maintainability. Just a few examples will illustrate how the aggressive goal of 2,000 hours' mean time between failures (MTBF) is an achievable task with some surprising cost paybacks.

***Preplanned modernization programs—such as the F-15 Multistage Improvement Plan, where internal space and interface components are built in to allow for future systems or upgrades—make incorporation of new capabilities much easier and more economical than previously.***

An item as small as the oil-quantity-indicating system on the A-7 costs $11,000 and has a 200-hour mean time between maintenance (MTBM). It is unrepairable when it breaks, and it produces hazardous waste. More than 100 aborted missions per year are attributed to this item. A modification can now be purchased for $2,500–$3,000. It produces no hazardous waste and has an 18,000-hour MTBM. Cost avoidance over five years is estimated to be $7 million.

The new ring-laser-gyro inertial navigation unit (INU) on the F-15 boasts a mean time between failures of 2,000 hours. It replaces an INU that has failed, on an average, at 100 hours and that costs $39,000 more than the new INU. Based on its reliability, the savings in spares alone amounts to $94.2 million.

The Central Air Data Computer (CADC) used on the A-7, C-5, C-141, F-4, and F-111 fails at 200 hours and exists in nineteen different configurations. Spares for the CADC are calculated at 872 units for the C-141 alone. Its replacement, the standard CADC, has a guaranteed MTBF of 1,200 to 2,100 hours and uses eighty percent common modules in all the above aircraft. In addition, the standard CADC costs $31,900 compared to $56,900 for the older versions. The lower costs and reduced spares requirement (187) lead to an investment avoidance of $43.6 million in spares for the C-141 alone. Add the other aircraft, and the investment avoidance is staggering.

In theory, sufficiently high R&M levels can negate the need for much of the maintenance work that both AFLC and field units do today. This opportunity prompted Gen. Earl T. O'Loughlin, then AFLC Commander, to challenge corporate executives in May 1987 to "put AFLC out of business if you possibly can."

Modernization through modification is a logical means of countering a growing threat while living with shifting national priorities along with manpower and funding constraints. Force structure growth will occur only when ways are discovered internally to finance the people and resources required. One of the prime means of developing and fielding additional combat capability will be the modification program. In the stark reality of today's world, modernization through modification may very well be the single most viable alternative in creating a force structure that can win, if called on to fight. ■

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*Brig. Gen. (Maj. Gen. selectee) Richard D. Smith, DCS for Materiel Management at Hq. AFLC, Wright-Patterson AFB, Ohio, is responsible for wholesale support of all USAF aircraft and missile systems, ground vehicles, and communications, electronic, and meteorological equipment. An Oklahoma native, General Smith graduated from the Air Force Academy in 1961 and holds advanced degrees from both Texas Tech and the University of Oklahoma.*