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Transitioning Technology to the Fighting Force

Aviation Digest

Professional Bulletin

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Cover: 50th Anniversary of the Aviation Applied Technology Directorate: Transitioning Technology to the Fighting Force (1944–94). AATD conducts vital technology research for worldwide rotorcraft application. By developing effective and affordable technology for current and future systems, AATD improves Army Aviation's warfighting capability. Cover illustration by Ms. Ethel Long, Graphics Department, AATD, Fort Eustis, Va.

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Major General Ronald E. Adams

Aviation Applied Technology Directorate—Congratulations on 50 Years of Excellence

We live in an ever–changing world in which technology continues to accelerate and, as a consequence, the battlefield too has changed. In 1944, commanders communicated by line–of–site radio systems requiring manual transcriptions. Tankers closed with and fought the enemy with the M–4A3 Sherman tank. The infantryman was armed with an M–1 rifle. The regimental commander could acquire targets within a 12 by 5 kilometer box with direct and indirect fire weapons. Today, the brigade commander has tactical satellite communications systems and is seeing real–time combat information digitally transmitted from reconnaissance assets out forward and from higher headquarters. The brigade commander can engage targets at distances in excess of several hundred kilometers with the Army Tactical Missile System and attack helicopters. The brigade closes, and destroys the enemy, with the M–1 Abrams tank, the AH–64 Apache attack helicopter, and the infantryman armed with advanced devices coupled with the M–16 rifle. Since 1944, the battlespace has expanded; it is far more complex and far more lethal.

Global tensions, the speed of competition, the proliferation of high–tech weaponry are associated with that more complex, more lethal battlefield and have forced us to relook at how we do business. To lead us in this change, the Army has established a vision for the future called Force XXI—an information age force for the 21st century. It will encompass reconceptualization and redesign of the force at all levels with the focus on connectivity—how we put the force together. Aviation is an important player in the Force XXI team. We are replacing technologically aged aircraft with modern, technically superior aircraft, but in fewer numbers. We will, in fact, have to do more with less. We will have to be more modular, even more tailorable and

more versatile to remain relevant.

The Aviation Applied Technology Directorate (AATD), Fort Eustis, Va., will play a key role in ensuing that relevance. The past 50 years of Army aviation have been a period of great growth and technical development. The advances in Army aviation can be directly attributed to the outstanding efforts of the soldiers and civilians of the AATD. Improvements to aircrew survivability and safety, powerplant reliability, weapons systems integration, and maintenance are due, in great part, to their efforts. In turn, these new technical developments have helped to advance the role that aviation occupies in the conduct of operations across the spectrum of war.

The mission of AATD is to improve the warfighting capability of Army aviation by developing the technology to take the Army aviator into the 21st century. The 250 members of the AATD team, both military and civilian, work to meet this requirement on a daily basis.

As Army aviation continues to move into the 21st century, certain requirements are placed upon us; we must protect the force, operate at an increased tempo for longer periods of time, strike the enemy throughout the expanded battlespace, fight with constrained resources, and win decisively. We have a great force assembled now, but in the future our forces must be given an extra edge that will allow them to operate in this new environment. Technology provides that edge. AATD is the proponent of these technical changes and the improvements needed to fight and win under the requirements of Force XXI.

In the future, we will see the results of AATD's continuing efforts. The powerplants that are being tested now will greatly increase the range and performance of the engine but at lower weight with increased reliability and greater efficiency. Sustaining the force will be made easier by putting laptop computer technology in the aircraft and in the hands of the crewchief. These systems monitor aircraft performance and diagnose problems that will allow aircraft to operate safely for longer periods of time. Maintenance will be made easier by digitally accessing maintenance support systems from anywhere on the battlefield.

Twenty–first century aircraft, like the RAH–66 Comanche, will incorporate a broad spectrum of advanced technologies such as stealthy radar–absorbing materials, ballistic hardening, and visual and electro–optic detection avoidance systems. These technologies are a direct result of the vulnerability reduction technologies developed by the AATD.

One of AATD's most promising developments is the Rotorcraft Pilot's Associate (RPA). The RPA is an additional "electronic" crewmember which is designed to manage the cockpit data that will allow the crew to more effectively prosecute the battle. This system will assist the aircrew in classifying, prioritizing, and managing aircraft and battlefield information to maximize the aviation warriors' ability to fight and win in the digitized battlefield of the future.

Since 1944, the growth of Army aviation has been fueled by the developments of available technology. Through the efforts of AATD, aviation history is full of achievements that have facilitated the accomplishment of the aviation mission. AATD continues to focus on the capability that gives us the greatest return, while providing synergistic qualities rather than simple system effectiveness. The soldiers and civilians of the AATD can stand proud of their achievements of the past 50 years. It is in large part through their dedication and hard work that Army aviation is leading the way for our Army into the 21st century. Army Aviation... Vanguard of Change!

Improve military aircraft safety

Author's note: This was written before the tragic 23 March F–16D Fighting Falcon accident at Pope Air Force Base, N.C., which killed 23 U.S. Army paratroopers when aircraft debris set fire to the C–141B Starlifter they were boarding. An additional 56 were seriously burned, ranging from 10 to 90 percent of their bodies. Had they been in effect, the safety changes described in this article could have reduced the severity of this accident. Let's not wait another day.

It is 1993. An aging C–141B full of 153 paratroopers takes off from Pope Air Force Base. As it climbs to flight altitude, a fuel line snaps in the starboard #4 engine and fire breaks out. The pilot declares an in–flight emergency and the paratroopers buckle up because they are too low to jump. The Starlifter slams back onto the runway, the landing gears collapse, and the stretched fuselage breaks. The fire spreads as thick, toxic black smoke floods the aircraft interior.[1]

If the soldiers and airmen try to exit the burning plane, many will collapse from the toxic smoke before they reach the exit doors. This is what happened to civilian passengers during a 1985 crash when an engine fire created blinding, dense smoke that caused them to collapse before they could get out—55 people died. Many studies have concluded that smoke kills people long before fire does in survivable aircraft accidents. Thus, many aircraft safety organizations are pressing for smokehoods to be provided to every passenger, even though the airlines are reluctant to pay for them. Most airliners have lights on the floor to guide people to the exit doors if smoke forces them to their knees.[2]

Hoods will not stop carbon monoxide gas but will stop the more immediate threat from toxic soot. The good news is that every airman/soldier doesn't have to buy smokehoods; they already have a M17A2/M40 field protective mask (FPM) that can provide the few minutes of smoke protection needed to exit a burning plane.[3] All we have to do is require that servicemembers take their FPM on–board when they fly on military aircraft (or any aircraft during military duty). Before take–off, the FPMs would be donned as part of the aircrew's safety/emergency exit briefing. In an actual in–flight emergency in which bailout is not possible because of low altitude or lack of parachutes, all passengers would don their FPMs as standard "prepare to crash–land" procedure. A simple directive by both the Departments of the Army and Air Force could accomplish this overnight *before* a troop–laden aircraft crashes, which could occur anytime—even as the reader considers these no–cost measures. With United States Air Force (USAF) Air Mobility Command and Army aviation assets stretched thin to meet worldwide commitments, the chance of an accident increases especially if key, aging aircraft—such as the C–141B—are not replaced by new aircraft such as the C–17 long–range, heavy–lift transport. It is even more critical that all servicemembers bring their FPM on–board Civil Reserve Air Fleet (CRAF) and chartered aircraft because they have an even greater risk of fire because they lack military aircraft safety features (such as self–sealing fuel tanks) and their individualized bench seats slow mass movement to emergency exits.

The paratroopers and aircrew donned their FPMs and, shortly after impact, make their way to safety outside the plane. Unfortunately, some of the men have broken legs, arms, and backs from the impact and were unable to move themselves to safety. The fire spreads through the fuselage, melting parachutes and nylon web gear.

If the men on–board are wearing standard cotton/nylon battle dress uniforms (BDUs) or, worse yet, polypropylene underwear

and GORE–TEX extended cold–weather–clothing–system parkas/pants, they will be severely burned and possibly perish in the fire, as these items will melt to the skin. It is standard practice for all military flight crews to wear fire–resistant Nomex clothing to provide fire protection to escape from a burning aircraft. These come in the form of expensive flight suits and gloves.

The good news is that we don't have to outfit our soldiers with Nomex flight suits to get this fire protection; they already have the personal armor system for ground troops (PASGT) Kevlar helmets and flak jackets that can provide a high degree of fire protection.[4]

We need a directive that all servicemembers will wear these items during tactical exercises/deployments or have them accessible for quick donning before a crash–landing. PASGT will also provide trauma and puncture protection from aircraft interior furnishings that could break free on impact.

For nontactical deployments, the U.S. Army Natick Research, Development, and Evaluation (RD & E) Laboratories, Natick, Mass., have developed a BDU made of Nomex.[5] It is in woodland camouflage and looks almost exactly like the regular BDU. It is already in the supply system. Soldiers could sew on their proper insignia, and they would look just like all the other soldiers in BDUs. The International Tactical Studies Group (ITSG) has field tested the "aircrew BDU" and finds that it is comfortable; it is actually cooler than the regular BDU. This BDU is also abrasion– and tear–resistant, making it a practical field uniform. At 2.5 pounds, it is lighter than the hot–weather BDU!

One set of Nomex BDUs needs to be obtained for every soldier engaged in hazardous duty in which fire may be possible—flying in aircraft (assault zone airlanding/parachute jumping) and helicopters (rappelling/fast roping, airlanding) and riding in armored fighting vehicles. This can be done with no cost to the government by having these BDUs on sale at every military clothing sales outlet. Cost is only $90, only slightly higher than regular BDUs—but worth it. All paratroopers, aviators, and contingency force personnel of the XVIII Airborne Corps, for example, would be directed to have at least one set for qualification jumps and actual combat. During actual combat, this Nomex BDU would offer increased protection from enemy fires—be they shell/grenade explosion or land–mine blast. Another beneficial side effect would be reducing injury severity so that troops can live and return to duty sooner to contribute to battle victory. Recent combat has shown that wars will be highly violent and last short periods of time—a battle decision will be reached within hours or days. Troops would wear regular BDUs for garrison/low–hazardous training and don their Nomex BDUs before the battle, which should last them for the length of a short high–intensity campaign. A last benefit of Nomex BDUs is that they provide a beneficial wicking of perspiration and dry quickly, unlike the cotton/nylon BDU, which soaks water like a sponge but retains this moisture.

When the fire spreads, the seriously wounded are given a respite by the Kevlar body armor and Nomex BDUs they are wearing. Their able–bodied comrades pull them to safety, enabled by their FPMs to negate the smoke and by their Nomex BDUs to fire protect long enough to concentrate and effect rescue.

All servicemen exit safely from the C–141B, which is completely engulfed in flames. The plane is a complete loss, but our men are alive to train or fight another day.

If we want to save lives and strengthen our chance for victory on the next, distant battlefield, we need U.S. military aircraft safety improved *now* using the no–/low– cost changes described above. You could help by passing these ideas on to the necessary officials in our military to get the job done.

Airborne!

Notes

1. Even wearing a parachute will not help if your plane crashes before jump altitude; on 24 September 1961, a USAF C–123 crashed before its passengers (U.S. Army Golden Knights) could jump, killing one and injuring two others. ***Golden Knights***, R.C. Murray, Daring Books, Canton, Ohio, pages 66–68.
2. ***The Final Call***, Stephen Barlay, Pantheon Books, Division of Random House, New York, New York, 1990, pages 161–181.
3. Author's personal observations using M17A2/M40s during field training exercises.
4. According to the manufacturer's (Dupont) brochure, Kevlar is used to make ejection seat parachutes to guard against fire.
5. National Stock Number (NSN) Aviator's BDU 8415–01–345–5211 Jacket Medium–Regular and NSN 8415–01–345–5226 Trousers.

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ALSE—train and maintain for survival

The twentieth–century battlefield is history. Army aviation, as it approaches the twenty–first century, faces a new battlefield—complex, integrated, and technically advanced—a battlefield no longer restricted to a forward line. Army aviation will strike deep into opposing forces' territory, destroying designated targets and inserting complete divisions of men and equipment to create instant forward lines of troops.

Active Army, Reserve, and National Guard units are no longer

aligned to one specific capstone. Crew members will find themselves in a variety of environments—cold weather, desert, overwater, and tropical jungle. Aviation life support equipment (ALSE) must no longer be restricted to what is commensurate with a unit's peacetime mission and environment. Crew members must not merely be familiarized with the variety of ALSE but must be trained to use this equipment and trained to survive in all climates.

Sophisticated air defense weaponry compromises the survivability of aviation assets, greatly increasing the probability of crew members facing the difficult and dangerous task of search–escape–evasion–rescue (SEER). Army aviation is making every effort to counter this threat with one–step–ahead technology and realistic combat training. The March/April 1994 ***Aviation Digest*** epitomizes this effort with the entire issue dedicated to high–tech simulation training. Realistic training will provide confidence and practical experience. Crew members, however, inevitably will find themselves on the ground and on the run.

An article in the July/August 1993 ***Aviation Digest***, pages 33 through 37, focused on the 377th Medical Company (Air Assault), Republic of Korea (ROK). One section of the article dealt with training: "The ROK is unforgiving to the unsafe and ill–trained air crewmember—especially aircrews charged with the difficult and complex mission of aeromedical evacuation . . . . The unit conducts monthly combat search and rescue (CSAR) exercises . . . . This is the type of training that may possibly keep DUSTOFF aircrews alive and available to perform their important mission in the event of hostilities."

The ROK is not the only such environment, and medical evacuation (MEDEVAC) isn't the only aviation asset likely to find itself in a CSAR situation. Saudi Arabia was a very unforgiving environment. Sand dunes claimed more than one aircrew. A downed AH–64 Apache jock was captured when Iraqi soldiers homed in on his PRC–90 radio beacon. Unit training cannot consist of just mission training; there must be an integration of the ominous "what if." What if the aircraft is downed during a mission? How well–trained are aircrews to survive the many environments that they may encounter; and how well–maintained is the equipment that they will depend upon? A brief look back through past ***FlightFax*** articles provides the answer.

FlightFax, 16 July 1986, Volume 14, Number 40: "Although they knew they would be flying over water, neither pilot was wearing a personal flotation device (PFD) as required by AR [Army Regulation] 95–17, the unit SOP [standing operating procedures], and the commander's flight briefing.

"After they reached the surface, they climbed onto the aircraft's skids, which were about 18 inches under the water . . . . (The aircraft was inverted), and tried, without success, to make contact with their AN/PRC–90 radios. There was a civilian airport about 7 nautical miles away, and in line of sight. . . ." These pilots remained in the water for four hours before rescue and suffered severe hypothermia and skin irritation from fuel leaking from the aircraft.

FlightFax, 22 April 1987, Volume 15, Number 28: "The copilot was unable to communicate with the search aircraft by using the AN/PRC–90 survival radio and attempts to attract attention with penlight flares were unsuccessful." This accident took place at 1200 hours—under clear skies. The aircraft crashed into 60–foot–high hardwood trees. How visible are the penlight flares in the SRU 21–P survival vest? In the daylight—not very. In this situation, purple smoke grenades were popped to attract search and rescue aircraft, not the orange smoke illumination signal devices contained in the aircraft survival kits. The burn time for these devices is short, and insufficient smoke is produced to penetrate thick foliage.

FlightFax, 27 May 1987, Volume 15, Number 33: "Sometimes machines break . . . . When it happens, a pilot's training and skills may avert an accident . . . . If you survive the crash you may need help and . . . . You're going to need some way to get that help . . . . Although both pilots survived the crash, several factors could have meant life or death after the accident—limited availability of survival radios in the unit had led to a restriction of one radio per aircraft.

"On this aircraft, however, there were no survival radios. Only pilots in command (PICs) were authorized by flight operations to sign for survival radios, and the PIC on this mission had originally deployed as a copilot and, therefore, had no radio. No cold–weather survival kits were on the aircraft. The pilot had problems getting the first–aid kit open. The safety wire attachment on the kit's zipper required an excessive amount of force to break."

FlightFax, 4 November 1987, Volume 16, Number 7. "The IP [instructor pilot] . . . . tried to use a survival radio to summon help, but he was unsuccessful . . . When the crew . . . Attempted to use the flares from their aircraft, only two of them worked."

FlightFax, 5 April 1989, Volume 17, Number 12: "Although search and rescue aircraft were immediately launched, it was 1 hour and 40 minutes before the survivors were found. The pilots' attempt to contact search aircraft with the downed

aircraft's radios was unsuccessful, and the survival radio was inoperative due to corrosion of the battery cap. There was no ELT [emergency locator transmitter] on the aircraft." Corrosion on the battery springs is a common occurrence and can happen between scheduled inspections. However, crew member preflight of ALSE would have called attention to this inoperative condition. With proper training, a simple troubleshooting procedure would have remedied the problem. Simply using the eraser of a pencil to clean the battery springs could have made the survival radio serviceable.

FlightFax, August 1993, Volume 21, Number 11. ". . . an MH–60 [Black Hawk] struck water at a velocity in excess of 120 knots. All of the helmets . . . came off the wearers' heads. USAARL [U.S. Army Aeromedical Research Laboratory, Fort Rucker, Ala.] evaluated the helmets and found that all of the chinstraps were fastened . . . . it is suspected that improper fit resulted in the helmets coming off." One aviator "who had an average–size head, was wearing an extra–large shell with the retention system placed at the largest setting. In addition, the tiedown strap for the yoke assembly at the rear of the helmet was tucked up into the helmet rather than holding onto the nape strap as designed." Losing a helmet during a crash sequence greatly reduces the chance of survival. Trained and experienced ALSE personnel should be the only people fitting crew–member helmets in the unit. Crew members should bring their helmets with them to the flight surgeon annually for fitting during flight physicals. The next time you're preparing to fly, check the chinstraps and nape straps of your crew. Both straps should be snug. The more hazardous the flight environment, the tighter the straps.

FlightFax, February 1994, Volume 22, Number 5: "Following a recent OH–58 [Kiowa] accident, the crew's SRU–21P survival vests were inspected and many items were either expired, missing, or unserviceable. There was no standardization concerning the placement of items within the vests. Had the need arisen for the use of any of these missing or unserviceable components, the crewmembers could have been in a serious situation."

Circumstance and situation dictate action; action is a result of training and practical experience. The success of our action depends on the serviceability of our equipment and how proficiently we are using it. Proper training and proper equipment for crew members are lacking. This is not a revelation. Eleven years ago, a DARCOM [U.S. Army Materiel Development and Readiness Command] project manager generated a letter, 3 January 1983, to all aircrew personnel informing them of the results of a survey of 1,200 Army aircrew members: among the current problems at the time—"a major problem in the management of ALSE is that there is no ALSE technician specialist MOS [military occupational specialty]. Individuals with the Q2 designator added to their MOS felt strongly towards an ALSE MOS due to the fact that the care and maintenance is a full–time job and those with the Q2 designator already have a primary duty . . . [and] are responsible for maintaining proficiency in their assigned MOS."

A recent article in the April 1994 ***FlightFax***, Volume 22, Number 7, written by MSG Keith A. Gallion, asks, "*Where are all the ALSE maintenance personnel?*" MSG Gallion teaches the Aviation Accident Prevention Course (AAPC) for noncommissioned officers and travels throughout the aviation community. In addition to teaching, MSG Gallion conducts safety surveys. He says, "I find a problem that is prevalent in most units. There appears to be a lack of aviation life support equipment (ALSE) maintenance or there is an insufficient number of qualified personnel to properly maintain the unit's assigned equipment.

"All units surveyed within the past year did have personnel maintaining the ALSE; however in most cases, these personnel were not properly trained . . . . About 400 ALSE maintenance personnel are trained per year. Based on findings during unit safety surveys, these highly trained personnel are not in the unit ALSE shops where they are most needed. Where do they go after graduation, and why are they not being utilized?"

In 11 years, how much progress has ALSE made? Actually, ALSE has come a long way. Despite some ongoing problems, a lot has changed—thanks to the unselfish, untiring efforts of many people including dedicated and committed ALSE technicians and officers. They sacrifice a lot of time and energy to see that crews are properly equipped and trained and ensure that crews have every advantage for "making it out" when things don't go as planned. Attitudes have changed. The "it–won't–happen–to–me" way of thinking is being replaced with the realistic "what–if" approach. Improvements in the flight helmet, survival vest, and survival kits are improving the odds that crew members will survive.

But we can make improvements. I suggest the following:

- Qualified personnel must be on hand to properly maintain ALSE.
- Experienced personnel must be on hand to teach survival to aircrews.
- An ALSE training program must be incorporated into unit mission training that provides the hands–on

testing of crew–member proficiency in the proper use of all ALSE—not just ALSE commensurate with a unit's peacetime mission and climate.
• We must seek a greater exchange of ALSE and SEER information.
• We need an ALSE MOS. The major problems hindering ALSE will never be remedied until there is an ALSE MOS.

If your unit was activated, mobilized, and deployed to a combat environment, would your aircrews enter the game trained, equipped, and ready to play? Would crew members have their helmets rotate off during a crash sequence? Would crew members have the knowledge, training, and experience necessary to survive an over–water ditching? Would survival items in their vests and survival kits be on hand and serviceable? Would your aircrews' knowledge, training, and experience of search–escape–evasion–rescue provide them with every opportunity to survive on the ground and return to friendly lines?

An enormous amount of talent is available throughout Army aviation. Share your knowledge, experiences, viewpoints, and ideas. Sit down today and submit ALSE, SEER, and CSAR articles to Army aviation publications (especially the ***Aviation Digest***). We need a greater exchange of information.

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Military history competition

Colonel Kavin Coughenour, acting commander of the U.S. Army Center of Military History (CMH), has announced the Department of the Army's 1994 Military History Writing Contest.

CPT Nathan K. Wantanabe won first prize and a cash award of $500 in the 1993 annual competition for an essay he wrote while attending the Aviation Officer Advanced Course at Fort Rucker, Ala. CPT Wantanabe's winning essay was titled "*A Fight for Freedom, A Fight for Justice: An overview of the 442d Regimental Combat Team.*" His article will be published in a forthcoming issue of ***ARMY HISTORY***, the Army's professional bulletin of military history.

Eligibility: All students who are attending officer advanced courses or the Sergeants Major Academy during calendar year 1994 are eligible to enter the competition (only once). Be sure to include your course title, number, dates attended, current and forwarding address, and telephone number.

Entries: Submit two copies of previously unpublished manuscripts, typed, double–spaced. Maximum length of papers is 2,500 words (about 10 double–spaced pages). Papers that exceed this length will not be accepted. Documentation is required, but footnotes and endnotes do not count in length. Submit graphics, illustrations, or photographs as if for publication.

Topics: Essays should develop a limited theme related to the history of the U.S. Army. Possible topic areas are—
• Civil War, World War I, Korean War, etc.
• World War II (50th anniversary period).
• Minority soldiers.
• Leadership.
• Training.
• Unit cohesion and stress in combat.
• Fighting outnumbered and winning.
• Logistics.

Deadline: Entries must be postmarked before midnight, 31 December.

Submission: Send two copies of the manuscript—along with all accompanying photographs, maps, or other graphics—to U.S. Army Center of Military History, ATTN: Writing Contest (Mr. Billy Arthur), 1099 14th St., N.W., Washington, D.C. 20005–3402. Point of contact is Mr. Billy Arthur, DSN 285–5368 or 202–504–5368.

Judging and prizes: A panel of military historians will judge each entry based on the following criteria: historical accuracy, originality, writing style, and rhetoric. First place: $500 and publication in ***ARMY HISTORY*** (CMH's quarterly professional bulletin); second, $250; third, $100, or as the judges direct. Winners should be announced by 30 April 1995.

Extraordinary promotions

In a recently released Department of the Army promotion list for sergeant first class, 29 staff sergeants of 129 soldiers assigned were selected for promotion to sergeant first class from the Advanced Attack Helicopter Division, Department of Attack Helicopter Training, U.S. Army Aviation Logistics School, Fort Eustis, Va. This is most noteworthy as it represents only two military occupational specialties, 67R, AH–64 (Apache) Attack Helicopter Repairer, and 68X, AH–64 Armament/Electrical Systems Repairer. This could be an unprecedented promotion first—for such a small organization to have received so many promotions.

CW5 Graham T. Stevens
Chief, Advanced Attack Helicopter Division
SGM Earl Hildebran
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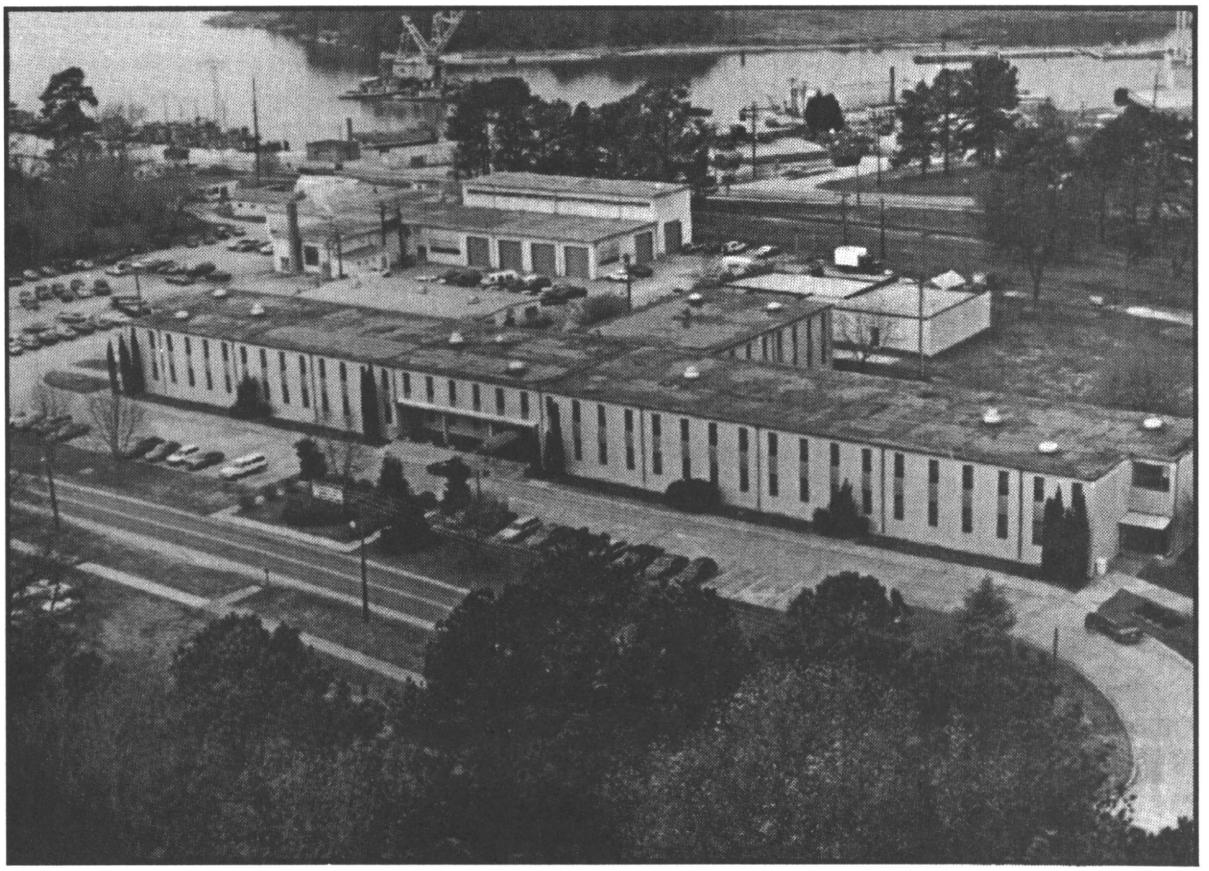

50th Anniversary of the Aviation Applied Technology Directorate

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U.S. Army Aviation and Troop Command
Fort Eustis, Virginia

On 16 December 1944, as Adolph Hitler began the Battle of the Bulge, his final offensive of World War II, the U.S. Army Transportation Board, the predecessor organization of the Aviation Applied Technology Directorate (AATD), was established at Fort Monroe, Va. Through the years there have been numerous changes resulting in the current organization. Located at Fort Eustis, Va., AATD is an element of the Aviation Research, Development, and Engineering Center, U.S. Army Aviation and Troop Command, St. Louis, Mo.

The war in Europe ended within 5 months of this famous battle and by this time the groundwork had been laid for an organization that would become the U.S. Army's principal aviation research and development (R&D) activity.

The Transportation Corps Board was activated with a mission to develop and execute an R&D program for the youngest of the Army's technical services, the Transportation Corps. The mission included R&D on all transportation equipment to include marine, rail, highway, terminal and material handling, and aviation.

SOME EARLY ACCOMPLISHMENTS

Following a brief move to Brooklyn Army Base, Brooklyn, N.Y., in 1946, the Board relocated to Fort Eustis, in 1950.

In May 1965, the organization was designated as the U.S. Army Aviation Materiel Laboratories (AVLABS),

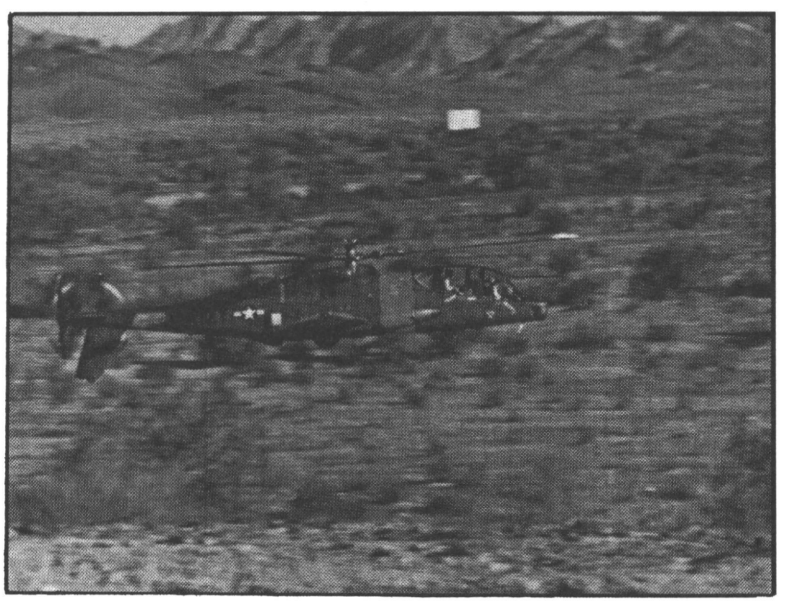
This Bell UH–1B was extensively modified for a major research program that investigated the high speed flight characteristics of rotary–wing aircraft. On 15 April 1969, this helicopter flew 274 knots (316 mph), unofficially breaking the world record held by a Russian helicopter.

and became totally oriented on Army aviation R&D. As AVLABS, it was the only aviation R&D activity within the Department of the Army dedicated to the mission of air mobility R&D.

As aviation expanded into its current role in the Army, responsibilities for activities outside of aviation R&D were transferred to other agencies. AVLABS then focused its pioneering efforts on vertical/short take–off landing and rotary–wing aircraft. Included among many significant demonstrator programs were the Bell UH–1B Huey (above), the XC–142 Tilt–wing aircraft, the AH–56A Cheyenne (predecessor to the AH–64 Apache) (below), the XH–51A Advancing Blade Concept demonstrator, and the heavy lift helicopter.

Organizationally, five technical divisions, a Rotorcraft Pilot's Associate (RPA) Office, two support divisions, a contracting division, and an office of the counsel make up the Directorate "team" of over 250 civilian and military personnel. Because of the technical nature of the work performed by AATD, over two–thirds of the team are engineers, technicians, and other professionals associated directly with research activities.

AATD is organized to handle a large, varied, and continuous workload, while maintaining a high degree of flex-



Lockheed produced 11 AH–56 Cheyenne compound helicopters for the Army. This advanced gunship flew at 215 knots in level flight, 245 knots in a dive. It demonstrated high maneuverability and excellent first–hit accuracy with its weapon systems.

ibility to meet unprogrammed projects. A unique in-house capability exists for structural and ballistics testing as well as signature measurements on helicopter engines. Facilities also are available to modify and fabricate aircraft components and to conduct various other investigations of aeronautical systems. Major technical areas of effort include: propulsion; materials and structures; systems integration and weaponization; reliability, maintainability, and mission technology; and safety and survivability.

MISSION

Since 1965, the organization's mission has remained basically the same—to improve Army aviation's warfighting capability by developing effective and affordable technology for current and future aviation systems. More recently, the mission has been expanded to meet the requirements of the Aviation Program Executive Officer, program managers, and special mission users.

Technology development. Besides its rich history of demonstration programs, AATD has sustained a strong technology development activity. The current modernized fleet owes much of its demonstrated capabilities to those technological advancements. The T–700 engine in the UH–60 Black Hawk and Apache helicopters evolved from two engine demonstrator programs managed by AATD. Individual components such as elastomeric bearings, reparable main rotor blades, infrared suppression, crashworthy designs for landing gear, airframe, seats, and fuel systems were available for fielding because of AATD's developmental efforts.

The Kiowa Warrior (armed OH–58D) was originally integrated, tested, and fielded by a joint AATD/industry team. AATD developed and demonstrated the Longbow Apache concept.

The Comanche helicopter, which incorporates even more sophisticated technologies, also was developed through AATD's technology base program.

AATD's efforts have helped Army aviation to achieve phenomenal successes in Panama, the Persian Gulf, and more recently, in Somalia. Not content to rest on past achievements, AATD continues to develop and integrate relevant and affordable technology for their aviation customers.

The first phase of a major turbine engine improvement program has demonstrated tremendous improvements in engine component technologies that will result in improved fuel efficiency and increased power from the next generation of turbine engines. The second phase of this program was initiated this past summer.

A lighter, easier-to-operate Advanced Boresight Technology was demonstrated successfully recently on an Air technology's commonality by moving from one aircraft to the other and performing an accurate boresight on each aircraft in a matter of minutes. Future demonstrations are planned for adaptation to armor systems (M1A1).

The potential application of automobile air bag technology and inflatable restraint systems to helicopter cockpits was demonstrated during recent fuselage impact tests at the National Aeronautics and Space Administration–Langley Research Center, Hampton, Va.

A major study to reduce vibrations on CH–47D Chinook cargo helicopters, through the application of onboard vibration measurement and diagnostic equipment, is currently underway at Fort Hood, Tex., and Fort Lewis, Wash.

AATD also has initiated an advanced technology demonstration (ATD) program known as the RPA. This ATD program is focusing on technology that will assist future pilots in managing the vast quantity of available information on the modern battlefield and to use that data to increase their combat effectiveness.

NAME CHANGE

The Directorate has undergone nine name changes and survived numerous threats of disestablishment and relocation (left). Its story is a record of past accomplishments documented in various test reports and also on display at the local transportation museum. Although these are proud contributions of this and our predecessor organizations, the history of tomorrow's Army aviation is being shaped today at the Aviation Applied Technology Directorate.

1944 Transportation Corps Board (TC Board)
1950 Transportation Development and Experimental Station (TDES)
1950 Transportation Research and Development Station (TRADS)
1953 Transportation Research and Development Command (TRADCOM)
1956 Transportation and Engineering Command (TRECOM)
1957 U.S. Army Transportation and Engineering Command (USATRECOM)
1965 U.S. Army Aviation Materiel Laboratories (USAAVLABS)
1970 Eustis Directorate, U.S. Army Air Mobility Research and Development Laboratory (USAAMRDL)
1977 Applied Technology Laboratory (ATL)
1985 Aviation Applied Technology Directorate (AATD)

AATD Name Changes (1944—85)

50 AATD

MANAGEMENT SERVICES DIVISION

Mr. Joseph J. Silvent
Chief, Management and Administrative Branch

The Management Services Division is a cohesive administrative unit comprised of diverse functions through which all essential administrative operational support are provided to the Directorate. It provides human resource, financial, and supply/logistics management. The division is the focal point for all administrative activities within these areas that support both the Directorate's workforce and its research and development (R&D) programs.

The division employs highly talented and skilled personnel in a variety of support service functions. These functions range from program–budget/management analysis to facilities operations. The division's personnel combine talent and skill with professionalism and dedication. As the key ingredient within the established administrative infrastructure, they provide continued operational success in management services support.

The present challenges of moving into the 21st century are increased when coupled with today's rapid growth in communication and automation technologies. These challenges require creative and innovative responses by the division to continually meet the administrative support needs of the Directorate. The human resource element of the division has been vitually important in coordinating and securing both in-house promotional and career developmental opportunities for the workforce. Career advancement and development are geared to providing the necessary leadership and technical and administrative knowledge and skills to ready the workforce to face new organizational and mission demands. Future Army aviation R&D programs will continue to require the support of this crucial element of the division.

Astute financial planning and program execution by the program budget element enable the Directorate to maximize available funding in support of science and technology program efforts, in–house R&D, and customer programs. A flexible and comprehensive automated financial management program has been developed internally. It is a key tool used in the effective and efficient management of the Directorate's financial resources.

An aggressive equipment management program ensures the Directorate's industrial and plant equipment, as well as other general purpose equipment, is maintained in good working order. This equipment is used to support in–house and customer R&D programs. It is continually evaluated for modernization. Accountability of all Directorate property also is assured under the program's umbrella. In addition, the equipment management function serves as the source of requisition for all general operating items of supply.

The mission supply and logistics element of the division supports procurement and acquisition of all test items and materials required for R&D programs. This ready source of supply is instrumental in expeditiously obtaining such items and materials and enables the establishment of aggressive program schedules and facilitates timely completion of program efforts.

The division also excels in handling all types of general administrative initiatives for the Directorate.The division's recent award for having the best recycling program on the installation is an example of the excellence achieved in implementing such administrative initiatives. The Directorate's program established by the division has been cited as a model for all other installation activities to follow.

The division is constantly training its workforce on new concepts such as 6 Sigma manufacturability (engineering course) and Integrated Product Process Development. It continues to educate its staff in engineering, technical, and administrative disciplines including Total Army Quality. It also constantly maintains its focus on support of customers.

50 AATD

TECHNICAL SUPPORT SERVICES DIVISION

Colonel Randall G. Oliver
Commander/Director, AATD

The Technical Services Division is the cornerstone of Aviation Applied Techology Directorate's (AATD's) research and development (R&D) program. This small, skilled group is highly responsive to the needs of Army aviation in terms of program support for research, development, test, and evaluation projects and, increasingly, in terms of high–priority operational matters.

This division has a wide array of instrumentation and fabrication talents. These talents can be quickly formed into support teams for flight test programs, crash testing, infrared testing, ballistic testing, special aircraft modifications, structural integrity tests, and a gamut of other subjects. Add to these functions, several basic ongoing functions—computer operations, technical library, technical illustration, technical editing, and photo lab—and you round out a strong and integrated capability.

During Operations Desert Shield and Desert Storm, this group offered invaluable support. They fabricated covers, developed training aids, manufactured needed devices, and provided the technical expertise across the broad spectrum of needs the harsh environment of Southwest Asia created.

The best example of the group's capability can be summed up in the armed OH–58D Kiowa Warrior aircraft for the U.S. Army Helicopter Improvement Program (AHIP) supporting the U.S. Forces in the Middle East.

The AATD and the AHIP Project Office, St. Louis, Mo., undertook the AHIP Program as a joint, rapid–deployment effort. In less than 6 months, the team designed, fabricated, and installed HELLFIRE missile systems on 15 OH–58Ds for use in the Persian Gulf.

Despite tight budgets, limited equipment availability, and conflicting priorities for badly needed resources, the division met a drastically short deployment schedule. While performing a critical mission, it helped to field an aircraft that exceeded all readiness projections.

Given time and materials, the talented model makers, machinists, sheet metal mechanics, welders, and other specialists of the Experimental Fabrication Branch can handle just about anything assigned to them. They are creative, experienced, and totally oriented toward getting the job done. While the shops are not rich in state–of–the–art production equipment, the specialists make their impact through their individual abilities and adequate machinery.

Projects have varied over the 50–year history of this organization. For example, the shops have built air-cushioned vehicles, paragliders, full-scale helicopters, wind–tunnel models, shallow draft boats, and the first armor kits used in Vietnam. In addition, branch specialists have fabricated the following: test facilities, displays, major test rigs, and fixtures; mockups and working models of aviation equipment; aviation intermediate maintenance (AVIM) systems toolsets; armor kits for the UH-60 Black Hawk; full–scale visual modification kits for the National Training Center, Fort Irwin, Calif.; and an endless list of other items.

Today, AATD prepares to celebrate its golden anniversary. The men and women of the Technical Services Division, faced with shrinking resources, will continue their mission to support Army aviation R&D programs. They will do so with the motivation, skill, and versatility that has consistently marked the previous endeavors of their predecessors.

50 AATD

Assessing the Mission and Warfighting Impact of the Intelligent Cockpit:

The Rotorcraft Pilot's Associate (RPA) Evaluation Approach

Mr. Keith Arthur
Lead Engineer, System Evaluation
Rotorcraft Pilot's Associate
Aviation Applied Technology Directorate
U.S. Army Aviation and Troop Command
Fort Eustis, Virginia

Army aviation has a big job: finding the enemy without being seen, destroying threat air defense sites, supporting the battle commander's coordinated activities, delivering swift decisive strikes across enemy lines, and performing numerous other duties—all in the dark at tree–top level. And as battlefield complexity steadily increases, technology within the cockpit continues to advance, demanding more and more of the crew's time, attention, and mental resources. New sensors are being developed, and existing ones are being given more capabilities. New and upgraded weapon systems have demanding interface and control requirements. Digital interconnectivity[1] means more complex and capable communications suites and the ability to tap into large quantities of battlefield situational data. All of these "technological innovations . . . are giving rise to what is being called a 'military–technical revolution.'"[2]

This revolution means that Army aviators are being inundated with information while trying to fight the battle. The aviator must "assimilate and determine the significance of all available mission information [and] manage the capabilities and performance of the mission equipment"[3] in addition to flying the aircraft. The goal of the Rotorcraft Pilot's Associate (RPA) is to significantly enhance the Army aviator's mission effectiveness by—

- Containing and managing this explosion of information in the rotorcraft cockpit.
- Using that information to provide timely and pertinent aid to the crew.

Rotorcraft Pilot's Associate

RPA will be a selective–authority electronic "associate" to the combat helicopter crew, much like an additional crew member. It will manage the myriad significant and insignificant data available in the cockpit, freeing the crew to more effectively prosecute the battle. RPA will also reason about the current mission situation, develop plans, and take authorized action to assist the crew in executing the mission.[4]

As shown in Figure 1, RPA consists of two basic parts: the system architecture and the Cognitive Decision Aiding Subsystem (CDAS). The system architecture performs two functions: data distribution and data fusion. Data is distributed to and from the mission equipment and the CDAS as needed. Also, data from multiple sources, both on–board and off–board, are correlated and fused to eliminate redundant data and to increase confidence in the useful data. For example, in–flight intelligence updates may warn of an SA–15 air defense system operating in a certain sector. As the helicopter team skirts the sector, Radio Frequency Interferometers (RFIs) on two ships pick up an air defense radar in search mode. Using advanced secure communications and triangulation, each helicopter's RPA can pinpoint the position of the air defense radar and, using the intelligence data, positively identify the threat as an SA–15.

The CDAS lies at the heart of RPA. CDAS is composed of five interdependent modules: external situation assessment (SA), internal situation assessment, proactive planning, reactive planning, and cockpit information management. As the names indicate, the first two modules

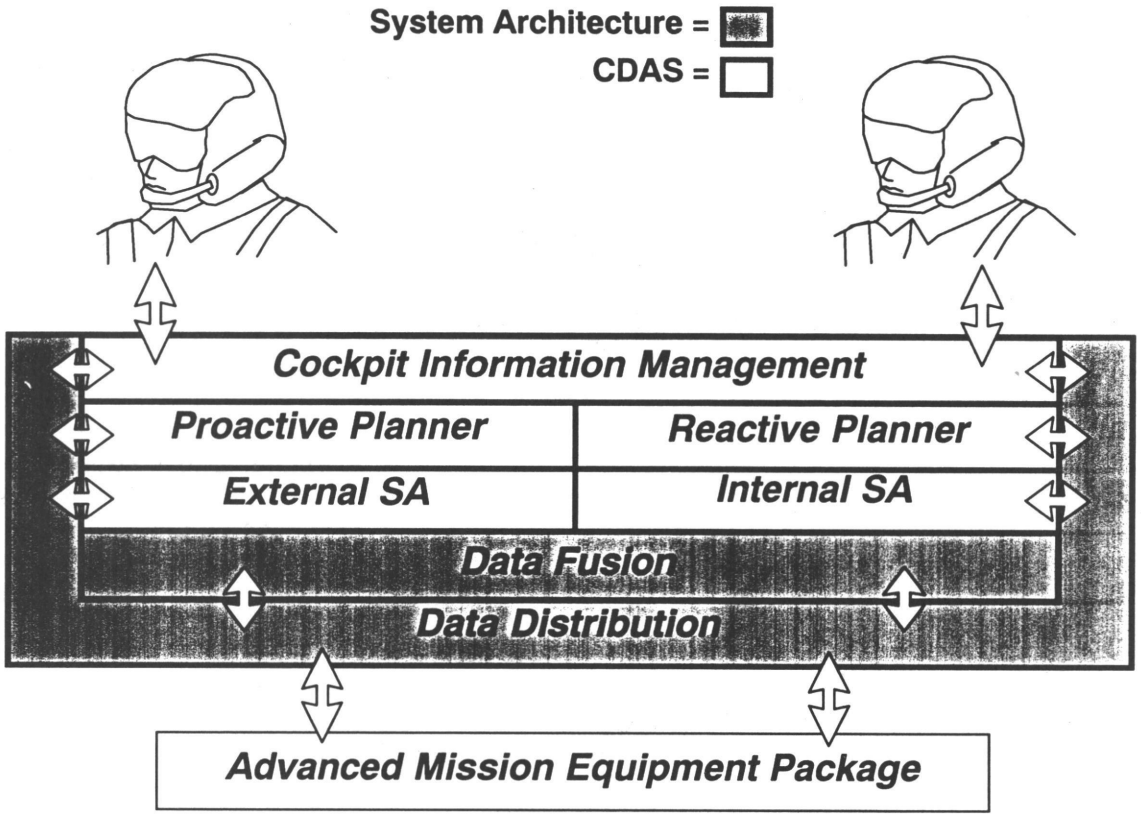


Figure 1

keep track of the battlefield situation and the status of all aircraft systems. The planning modules perform real–time, four–dimensional (x, y, z, and time) mission, countermeasures, weapons, sensor, attack, and defensive planning before and during the mission, as well as in response to unexpected threatening situations. The Cockpit Information Manager transfers the right information to the crew—at the right time using the right channels—and takes commands from the crew through an intelligent and tailorable interface. By taking advantage of emerging advanced computing technologies, RPA "will enable expanded use of the crew's perceptual, judgmental, and creative skills to capitalize on their [sic] own strengths and exploit adversary weaknesses."[5]

Predecessor programs

Two programs in particular paved the way for RPA. First was the U.S. Air Force (USAF)/Defense Advanced Research Projects Agency (DARPA) Pilot's Associate (PA) program, which investigated "the feasibility of applying expert systems and advanced computing technologies to the cockpits of advanced tactical fighters of the next decade in order to improve combat effectiveness and survivability."[6] RPA took much more than just two–thirds of its name from the PA program; RPA built upon the technological, programmatic, and philosophical successes of PA, for example, by adopting a pilot–centered approach to designing RPA functionality. Second was the Army Day/Night Adverse Weather Pilotage System (D/NAPS) program. The objectives of D/NAPS were to "demonstrate enhanced mission effectiveness . . . through the innovative integration of advanced technology" and to "speed the application of artificial intelligence (AI) and cockpit automation."[7] Along with PA, D/NAPS did much of the foundational work of integrating and coordinating disparate systems: mission equipment software and hardware, as well as expert systems such as mission and tactics planners and situation assessors.

Although these two programs operated in completely different regimes (high and fast for PA and nap of the earth for D/NAPS), both had similar goals. RPA has therefore taken full advantage of their experience. Particularly in the area

of system evaluation, RPA has learned and applied many lessons from both PA and D/NAPS.

Previous evaluations (lessons learned)

Both PA and D/NAPS were evaluated against a baseline aircraft using high–fidelity manned simulators. Each was evaluated in the context of a specific mission scenario. The test matrix was fully exercised by varying the appropriate test conditions of test subject, aircraft configuration, mission condition, and environmental condition. Each test subject pilot flew both the baseline and advanced configurations under each mission condition (for example, high–, medium–, or low–density threat laydown) and each environmental condition (for example, day or night).

PA's baseline was an advanced conceptual fighter based on the YF–22, the USAF Advanced Tactical Fighter. Its mission was an advanced precursor sweep in which the crew's job was to attack and neutralize three enemy combat air patrol stations (ground sites). D/NAPS's baseline was an advanced UH–60 Black Hawk. Its mission was a covert, cross–FLOT (forward line of own troops) troop insertion mission.

Lessons learned about evaluation from these two programs fall into two categories: technical and methodological. Briefly, three types of technical issues were encountered: subsystem and system integration problems, which caused test schedule compression and worst–case testing using rudimentary substitutes for key software modules; lack of simulation maturity, which caused some unrealistic and erratic behavior; and pilot–vehicle interface problems, which led to ineffective information transfer between the system and crew, a crucial function in an intelligent cockpit.

Methodological issues were more numerous. Training was probably insufficient to effectively use the aiding provided by the two new systems. The scenarios, as implemented in the simulation evaluations, were somewhat insensitive to the benefits of the new systems. Insufficient time was planned for the process of integrating the new systems into the simulation environment and for the evaluations themselves. Development of the evaluation measures was not synchronized with the development of system functionality (in other words, measures were decided upon up front without a full understanding of the potential operational benefits of the system). Finally, the evaluations tended to focus on system–level performance measurement, somewhat to the exclusion of ensuring proper subsystem performance and measuring mission–context effectiveness.

RPA's evaluation—the approach

Because an intelligent cockpit has so much potential on the battlefield, RPA will be evaluated at several levels, by several methods, and by a multiagency, multidisciplinary evaluation team. As RPA is developed, testing will proceed through organizational levels from subsystem to system to individual aircraft to combined arms team. All three simulation methods will be used: constructive (analytical modeling), virtual (man–in–the–loop), and live (flight test).[8] Both the prime contractor, McDonnell Douglas Helicopter Systems (MDHS), and the Army's Crew Station Research and Development Facility (CSRDF) will provide facilities and techniques to evaluate RPA. Figure 2 graphically shows relationships among all three elements, level, method, and evaluation team member.

Subsystem– and system–level testing are done in most development programs. But RPA will also be evaluated beyond the system level. One of the premises upon which RPA's evaluation is based is that an intelligent cockpit in the scout/attack helicopter improves not only the individual helicopter's mission effectiveness, but it also produces benefits that higher organizational levels will reap. For example, RPA's real–time data fusion and enhanced secure communications capabilities will make the individual helicopter a more effective reconnaissance asset. More effective reconnaissance will increase the battlefield situational awareness of all involved: the individual aviator, his aviation teammates, his combined arms teammates, and several levels of commanders. As another example, RPA's ability to plan all aspects of the mission en route to the battlefield will make Army aviation more responsive to battle commanders. They, in turn, can plan and depend on tighter cohesion and coordination among all their assets. Therefore, to truly assess the mission and warfighting impact of the intelligent cockpit, RPA's evaluation must identify and claim those benefits reaped at all levels—individual aircraft, team leader, and aviation and ground commander—because of RPA's use at the lowest level.

Such a broad evaluation demands a similarly broad use of methods. Early in the program, newly developed functionality will be tested on the Rapid Prototyping Mission Simulator (RPMS), a low–to–medium–fidelity manned simulator. As subsystem and system functionality matures, a domed, high–fidelity manned simulator will be used. Subsequently, a high–fidelity simulator will be networked with other simulators over the Defense Simulation Internet to increase the number of aviation and nonaviation players and thereby extend the scope of the evaluation. A constructive simulation will also be used to

RPA Evaluation Relationships

Venn Diagram

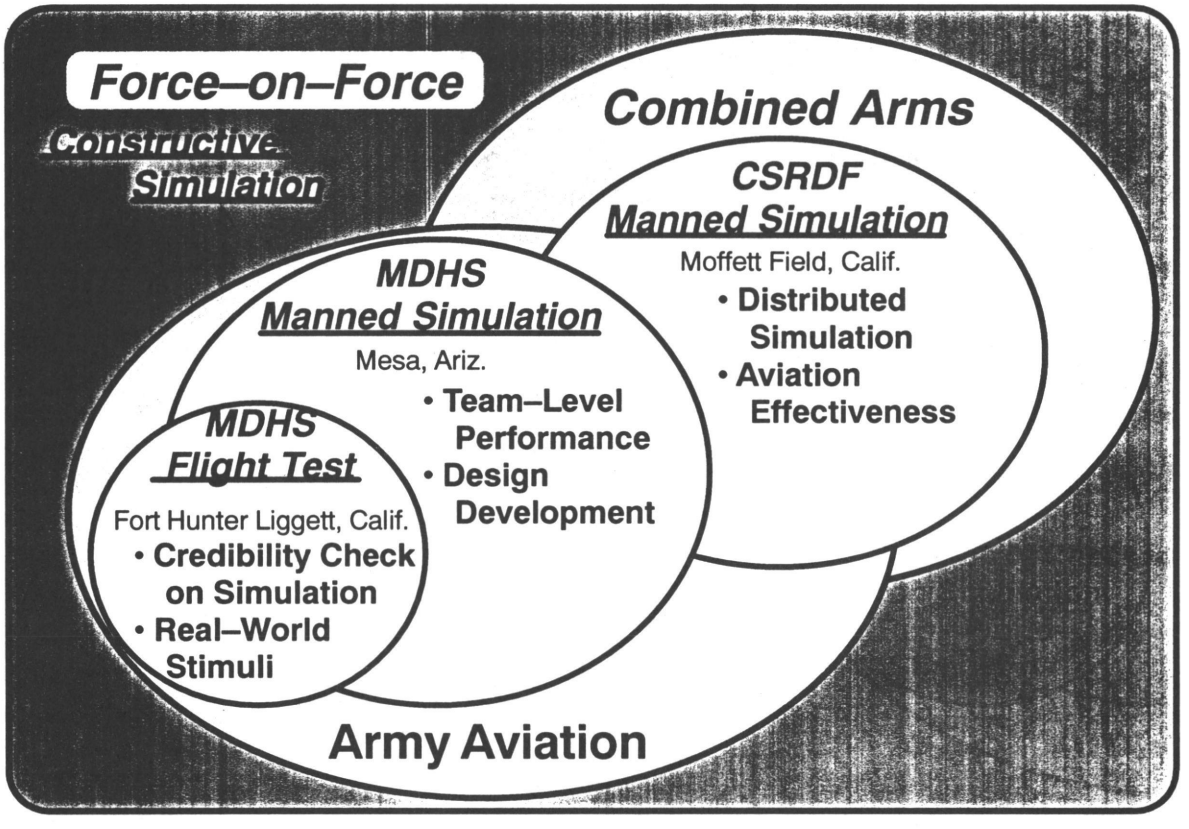


Figure 2

extend the scope further and allow a multiday battle evaluation. Finally, a live simulation (or flight test) will be conducted to evaluate the effect of real–world stimuli and as a credibility check on the virtual (or manned) simulations.

RPA's evaluation—the structure (lessons applied)

To make such a broad evaluation happen, the RPA program has been structured to apply those lessons learned in PA and D/NAPS and countless other technology development programs. Technical issues are addressed through program structure. The RPA program will integrate the developed software and hardware into the simulation environment incrementally. Six software builds and two simulation environment builds, as well as a "sufficient time" commitment by management, ensure that all developed functionality will be present, the simulation environment will be mature, and there will be sufficient time for the final evaluation. Also, information transfer is a separate major contract task, which along with feedback from the incremental build assessments, will ensure an effective pilot–vehicle interface. Also integral to the program structure is the Evaluation Methodology Subgroup (EMS). This small working group of experts advises RPA's evaluators by reviewing the evaluation methodology as it matures and by identifying both problems and, most importantly, solutions.

As well as through program structure, methodological issues are addressed through procedure. To be useful, new systems, especially complex ones, demand some minimum level of operator proficiency. Therefore, test subject training will be structured to achieve high proficiency levels and will focus on understanding system behavior so

that the crew can take advantage of the aiding provided by the system. And to ensure that the system's operational benefits are taken advantage of, realistic and doctrinally correct mission situations will be implemented, which will allow RPA's benefits to be observed and measured and will cause realistic consequences. Feedback from the incremental build assessments will help ensure that, during a simulated mission, consequences of pilot or system action or inaction are not artificially negated. Additionally, RPA will be evaluated in six missions, not just one. CSRDF and other Government evaluation and combat development experts are working closely with the MDHS throughout the program to properly implement the mission situations.

In the past, probably every evaluation has run short on time. To help ease the effects of this universal risk, RPA relies on two strategies: incremental builds and their assessments and a commitment by program management to preserve the planned evaluation time. As mentioned above, these two strategies will help ensure that the evaluation time is not shortened by integration problems and program pressures. The RPA program is also structured so that system functionality and the methodology to measure that functionality are concurrently developed and synchronized. Evaluation methodology is a separate task paralleling the main development tasks. It uses the results of the incremental build assessments as well as communication between the system designers and evaluators to ensure that the measurement scheme is appropriate.

The job of assessing the mission and warfighting effectiveness of an intelligent cockpit requires more than just system–level performance measurement. RPA is structured to assess subsystem, system, and team performance—as well as the effectiveness of the man–machine system as a member of the combined arms team.

All of these will ensure proper assessment of the Rotorcraft Pilot's Associate: multiple assessments of incremental builds, thoughtful and realistic mission situation implementation, and evaluation over six missions by multiple organizational levels and multiple methods.

Summary

Evaluating an intelligent cockpit requires an innovative and carefully thought–out evaluation methodology. By learning and applying lessons from predecessor programs and infusing innovative thought, the RPA program is formulating the right methodology to evaluate tomorrow's cockpit.

Army Chief of Staff GEN Gordon Sullivan stresses the importance of winning the Information War.[9] One of the most potentially dangerous fronts in the Information War is in the cockpit of the combat helicopter. On this front, the intelligent cockpit of RPA will be a potent ally to the Army aviator, and Army aviation will be an even more potent ally to the Joint Forces.

Notes

1. George T. Singley III, *Why RPA is Important Now*, ***Inside the Vision***, Volume I, Number 1, p. 2. Mr. Singley is the Deputy Assistant Secretary for Research and Technology and the Chief Scientist for the Office of the Assistant Secretary of the Army (Research, Development, and Acquisition). ***Inside the Vision*** is RPA's quarterly newsletter.
2. GEN Gordon R. Sullivan and LTC James M. Dubik, ***Land Warfare in the 21st Century***, Strategic Studies Institute, U.S. Army War College, p. 12. GEN Sullivan is Chief of Staff of the Army. LTC Dubik serves on the general's personal staff.
3. Singley, p. 2.
4. Bruce S. Tenney, *RPA Executive Briefing Outline Script*, (draft), p. 2. Mr. Tenney is the manager of the Rotorcraft Pilot's Associate program.
5. Rotorcraft Pilot's Associate (RPA) Advanced Technology Demonstration (ATD) Technology Development Plan (TDP), Revision 2, 25 April 1994, p. 1.
6. Thomas D. Aldern et al., ***Phase I Final Report of the Pilot's Associate Program***, report number WRDCTR–90–7007, Cockpit Integration Directorate, Wright Research and Development Center, Air Force Systems Command, Wright–Patterson Air Force Base, Ohio, p. i.
7. Kenneth A. Wroblewski et al., ***Day/Night Adverse Weather Pilotage System (D/NAPS)***, USAATCOM Technical Report 92–D–16, Aviation Applied Technology Directorate, ATCOM, Fort Eustis, Va., p. 1.
8. Models and simulations are divided into three general types, differing in realism and required resources. The lowest cost, least realistic is *constructive*, which consists of analytical tools (usually war games and battlefield models, such as CASTFOREM and JANUS; in the broadest sense, this type also includes other tools such as program management and computer–aided design tools). Next in realism and cost is *virtual*, which consists of manned simulators in synthetic environments (such as a flight training simulator or the Aviation Test Bed at Fort Rucker, Ala.). Highest in cost and realism is *live*, which refers to real soldiers and real (or prototyped) equipment in a field exercise (such as at the National Training Center, Fort Irwin, Calif.).
9. Singley, p. 2.

50 AATD

RELIABILITY, MAINTAINABILITY, AND MISSION TECHNOLOGY DIVISION

Mr. Eugene Birocco
Chief

"Where the Rubber Meets the Road"

PROGRAMS/STAFF

The Reliability, Maintainability, and Mission Technology (RM&MT) Division is, in fact, "where the rubber meets the road" in terms of Army aviation research and development (R&D) programs. It also might aptly be called the collateral duty division because of the wide range of programs it tackles. Since the "One Stop Shopping Concept" of the U.S. Army Aviation Research, Development, and Engineering Center (AVRDEC), St. Louis, Mo., was initiated, the division has been challenged to support a diverse range of customer order work. Projects come from the Aviation Program Managers, the Weapons Systems Manager (WSM) for Aviation Ground Support Equipment (AGSE), and other services. The division also executes a wide variety of tech-base, mission–funded programs. This article touches on a dozen of our current programs.

The division consists of the Reliability and Maintainability and Subsystem (R&M&S) Team and the Mission Support Equipment (MSE) Team. Each team is staffed with electrical, mechanical, and aerospace engineers to ensure expertise is available for the broad range of programs worked within the division. Senior aviation maintenance soldiers also work in the R&M&S Team to provide user inputs and expertise.

In addition, the Mission Technology (MT) Team has an equipment specialist and two aviation sheetmetal mechanics who have the knowledge and experience to prototype new systems and build mock–ups of critical components and assemblies. With these essential people–skills onboard, the RM&MT Division has the innate capability to perform a myriad of widely diverse aviation and aviation support programs.

CUSTOMER ORDER PROGRAMS

The Flexible Engine Test System (FEDS) and the Onboard System for Evaluation of Rotors, Vibration, and Engines (OBSERVE), discussed below, are good examples of two typical customer order programs being worked at this time. These programs are being performed for the AGSE WSM and the CH–47 Chinook Modernization Program, Product Manager, respectively.

o Flexible Engine Test System (FEDS) (Figure 1): The FEDS program is an Army adaptation of the U.S. Navy's A/E37T–24 Turboshaft Engine Test System. It is managed and funded by the AGSE WSM. Aviation Allied Technology Directorate's mission, at the direction of the AGSE WSM, was to manufacture two pre-production FEDSs and assemble a technical data package for future FEDS production.

The FEDS is capable of testing the Army's T700, T53, T55, and T63 family of engines. It has growth potential for future engines such as the T800. The multiple engine capability is a unique feature of the Army's configuration. The system is designed to provide easy access to the engine for quick installation and repairs. Instrumentation is automatically configured by the system for each family of engines. A data acquisition

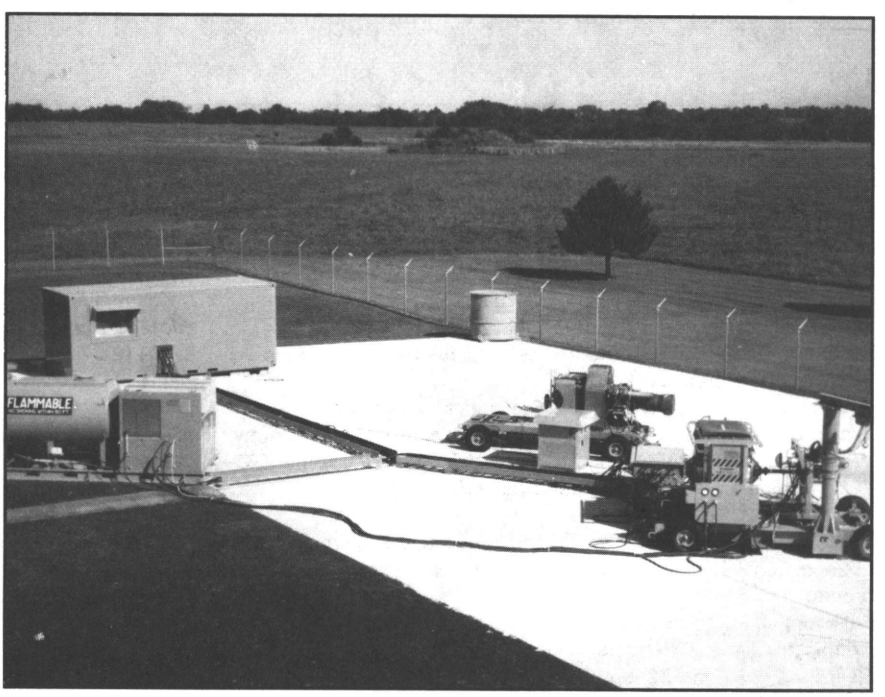


Figure 1

system was added to the FEDS to automatically record engine data, evaluate engine performance, and prompt the operator with test procedures. The pre–production units have been in operation at the Missouri Aviation Classification and Repair Activity Depot in Springfield, Mo., since April 1992, and at the Aircraft Engine Test Facility at Fort Campbell, Ky., since February 1993.

The FEDS has proven to be reliable, easy to maintain, and transportable to meet the Army's worldwide requirements. It provides the maintainer with the test capabilities to keep Army aircraft flying for years to come.

o Onboard System for Evaluation of Rotors, Vibration, and Engines (OBSERVE): This system is an onboard diagnostic and monitoring system for helicopter rotors, drive trains, and engines. OBSERVE uses a standard Army aviation vibration analyzer (AVA), which is operated from the cockpit of a CH–47D Chinook helicopter. It monitors inputs from rotor track and balance, and other rotating component sensors. The AVA, known commercially as the RADS-AT, currently is being fielded within the U.S. Army as a piece of AGSE. OBSERVE is used by maintainers to adjust rotor track and balance to reduce aircraft vibrations.

The system is currently under evaluation on 10 aircraft: 5 at Fort Lewis, Wash., and 5 at Fort Hood, Tex. This test will assess the ability of OBSERVE hardware to perform rotor track and balance, and measure vibration of the oil cooler combiner fan, aft transmission fan, and engines. Maintenance on these aircraft is being tracked and compared to aircraft without the system to determine cost benefits.

BASIC RESEARCH AND SYSTEM–SPECIFIC PROGRAMS

The Reliability and Maintenance (R&M) Team performs both basic research and system specific programs for aircraft subsystem development and enhancements. Some of its ongoing projects of are the Intelligent Fault Locator (IFL), Smart Integrated Microsensors (SIMSs), the Turbine Engine Diagnostic System (TEDS), Fiber Optics Battle Damage Repair (BDR) kits, and the Nondestructive Test and Evaluation (NDTE) Program discussed below.

o Intelligent Fault Locator (IFL) (Figure 2): The IFL is an off–aircraft, currently nonintrusive, comprehensive diagnostic expert system. It is housed in laptop computers for operation in a DOS [disk operating system] environment.

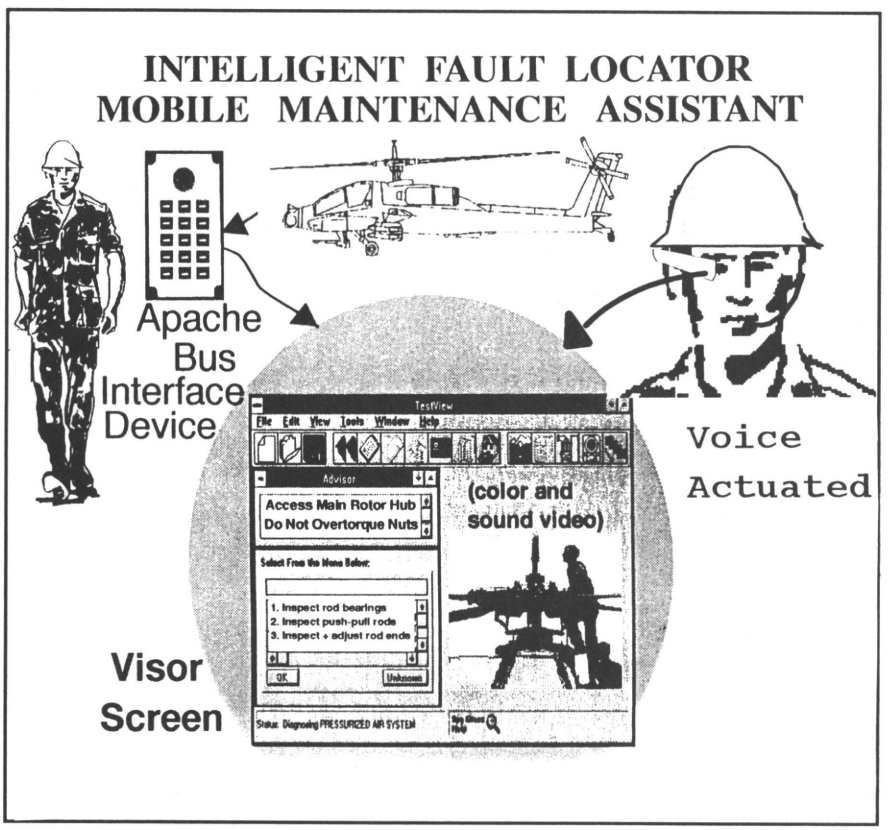


Figure 2

This portable maintenance aid (PMA) currently is configured for 22 AH–64A Apache subsystems. It provides troubleshooting steps with appropriate schematics and diagrams; includes diagnostic information from engineers and field service soldiers and civilians, as well as technical manuals; and places all the information required to perform diagnostic maintenance at the aviation unit maintenance (AVUM) level at the hands of soldiers/technicians.

The IFL is an in–house development effort. Currently, it is undergoing field assessment at seven Army sites and has undergone limited validation by DynCorp at Fort Rucker, Ala.

The development procedure involved the following steps: analyzing AH–64A subsystems, developing diagnostic information/schematics into knowledge engineering formats, building knowledge and graphics databases, verifying accurate knowledge transfer, and downloading the IFL into PMAs.

The soldier/technician is led through a series of steps, schematics, wire checks, read codes, instructions, etc., to a successful diagnosis and resolution of maintenance problems. A problem analysis may reveal the malfunction is not traceable to the initially selected subsystem like the engine, but, in fact, is attributed to another interfacing subsystem such as the fuel system. If so, the diagnostic logic transfers the user to that part of the IFL concerned with those problems. Besides laptop computers, the IFL operates on the Portable Operations Maintenance Aid, Mobile Assistant, which is a head–mounted, video–voice, belt–mounted computer, hands–free device. Future developments include video, remove and replace procedures, and Apache bus electronic interface device.

o Smart Integrated Microsensors (SIMSs): The current method of replacing flight–critical components with finite fatigue lives is based on operating hours; it must assume a projected usage and take into account uncertainties in the actual usage by increasing the loads or modifying the starts and number–of–cycle curves or both. This provides clearly inefficient part replacement criteria. It is still possible for a component to see more severe usage than originally anticipated, which would cause it to fail before the operating time limit has expired. It is more likely that most components will not see the loading originally predicted. Since the nature of fatigue is such that damage increases exponentially with load, these components will, therefore, be replaced long before they need to be. Many are replaced with little or no damage accumulated at all. There is no way of inspecting for damage short of destroying the part; therefore, the parts must be discarded. A significant amount of maintenance downtime is spent replacing these parts. Microelectronics and new stress/strain analysis techniques make possible a microelectronics system that monitors, analyzes, and displays the remaining fatigue life in real time. This provides an optimal means of attaining good life data and maximizes the performance life of the helicopter.

The SIMS design concept provides a more accurate knowledge of the fatigue damage than current techniques. This knowledge is presented to the maintainer in a clear, easy to understand read out of the real–time percentage of fatigue life remaining. This concept will increase overall system safety and reduce both parts usage and maintenance downtime.

o Turbine Engine Diagnostic System (TEDS): The TEDS program will develop improved diagnostics and fault isolation techniques for the T700 family of turboshaft engines. Its goal is to reduce the false removal rate of expensive components, minimize maintenance time, and decrease operating and support costs. Using data from a maintenance survey and engine testing, various concepts for improved engine diagnostics will be evaluated. Concepts to be considered include automated manuals with improved procedures, ground test sets, and airborne flight recorders for monitoring systems. The most effective, cost–efficient concept will be prototyped and demonstrated on an engine test stand. This contract was awarded to General Electric Aircraft Engines in September 1993. The prototype demonstration will be conducted in May 1995.

o Fiber Optics Battle Damage Repair (BDR): Fiber optic systems are being incorporated in major modifications and new aircraft such as the RAH–66 Comanche. Although fiber optics have been used extensively in telecommunication systems over the past 10 years, military aircraft fiber optic systems will require peculiar repairs because of the unique operational and maintenance environment. An R&D contract was initiated to develop BDR procedures for aircraft fiber optic systems. The optical component repair procedures program will analyze the damage modes of, and effects on, optical components (i.e., optical fibers, connectors, transducers, sources, detectors, databusses, etc.); it will develop combat damage criteria and damage inspection and repair tools/techniques for optical component repair. The damage inspection, assessment, and repair procedures and criteria developed will be incorporated into a fiber optics BDR kit and damage assessment and repair guide.

o Nondestructive Test and Evaluation Program (NDTE): The NDTE program is developing a versatile, multimode, Army aviation, field–level, nondestructive inspection capability; it is making this capability as user–friendly as possible with minimal operator training needed. With the dramatic increase in composite structures on rotorcraft, damage to composite structures in service also has increased. These complex structural components can be fixed forward in the field. Thus, they must be subjected to nondestructive inspection before repair, and again after repair, before release for flight. Detailed development of the system has been completed and incorporates these inspection methods: ultrasonics or "pulse–echo time–of–flight," resonance, and eddy current. The system is being tailored to function in the Army maintenance environment and to reduce operator training and experience requirements. A working prototype has been available for several months. Under a follow–on phase of the program, expert systems and artificial intelligence will be used to improve the usability of the system and further reduce the training and experience needed for the operator. At the completion of this phase, field–demonstrations will be conducted with representative user soldiers.

LOGISTIC MANAGEMENT TECHNOLOGY

The MSE Team performs basic research in logistic management technology focusing on programs that define new logistic aircraft design and support concepts for improved efficiency, including battlefield reconstitution and resupply. System–specific programs are worked in the areas of common aviation ground support equipment (AGSE) and aircraft cargo handling systems. Some of the programs being worked are the Advanced Unit Maintenance Aerial Recovery Kit (A–UMARK), 30mm Loader Program, Shop Equipment-Combat Maintenance (SECM), Advanced Boresight Equipment (ABE), and Advanced Cargo Handling System (ACHS) Demonstration Program.

o Advanced Unit Maintenance Aerial Recovery Kit (A–UMARK) (Figure 3): We developed the A–UMARK for aerial recovery of disabled helicopters by other helicopters. The A–UMARK will replace the old Aerial Recovery Kit (ARK) currently in the system and the Interim UMARK (I–UMARK) developed for Desert Storm. The A–UMARK is about 425 pounds lighter than the ARK and 275 pounds lighter than the I–UMARK. It has fewer kit components and is much more versatile and easier to use than either predecessor. The A–UMARK incorporates a universal spreader bar for recovery of the OH–58D Kiowa Warrior and the AH–64D Longbow. The CH–47 Chinook also is included in the list of recoverable aircraft; it requires the use of

Figure 3

two kits. Lightly to heavily damaged aircraft in any configuration may be recovered in multiple rigging configurations in 15 minutes or less. The kit is contained in three ruggedized cases, each weighing less than 100 pounds; it is organized so that only the case or cases needed for a specific aircraft recovery are used.

o 30mm LOADER (Figure 4): The Improved 30mm Loader, called the Sideloader, is an integral aircraft system used for loading 30mm ammunition on the Apache. It was developed to solve persistent problems with the current Uploader/Downloader (UL/DL) external system.

The problems arise from the location where the UL/DL connects to the Apache M230 gun. When the UL/DL is attached to the gun, the ammunition handlers are forced to sit or lie on the ground to work. At times it is impossible for them to load ammunition because of uneven, overgrown, soft, or muddy ground. This location not only slows their performance but also creates a safety hazard since the loading operation cannot be seen by the pilots.

The new Sideloader design corrects these deficiencies. The prototype Sideloader was installed on an AH–64A Apache and evaluated by soldiers from Fort Campbell, Ky., in December 1993. The demonstration clearly established the fact that the Sideloader can load 330 rounds of ammunition in 3 minutes compared to 10 minutes for the current method. During the evaluation, the Sideloader loaded more than 25,000 rounds of ammunition without a failure. The soldiers said the Sideloader was a significant improvement because it was simple to operate and reduced workload.

The evaluation demonstrated many advantages for the Apache battalion commander: one–man operation, functions in any environment, improved access and safety of ammunition handler, reduced loading time by 75 percent, reduced forward rearming and refueling point (FARP) turn–around time by 50 percent, and eliminated the UL/DL external system. A follow–on Sideloader program is planned that will focus on reducing weight, enhancing components, and fabricating a second prototype.

o Shop Equipment-Combat Maintenance (SECM) (Figure 5): The contact maintenance mission has been an approved Army doctrine for many years. However, equipment required to perform contact maintenance does not currently exist for the aviation mission. The mission consists of a team of aviation mechanics, with the tools and parts required for a specific aircraft repair, who move to the site of a disabled aircraft as far forward as the tactical situation allows. Aircraft repairs are made that return it either to fully mission capable or mission capable status. If this is not possible, the aircraft will be pre-

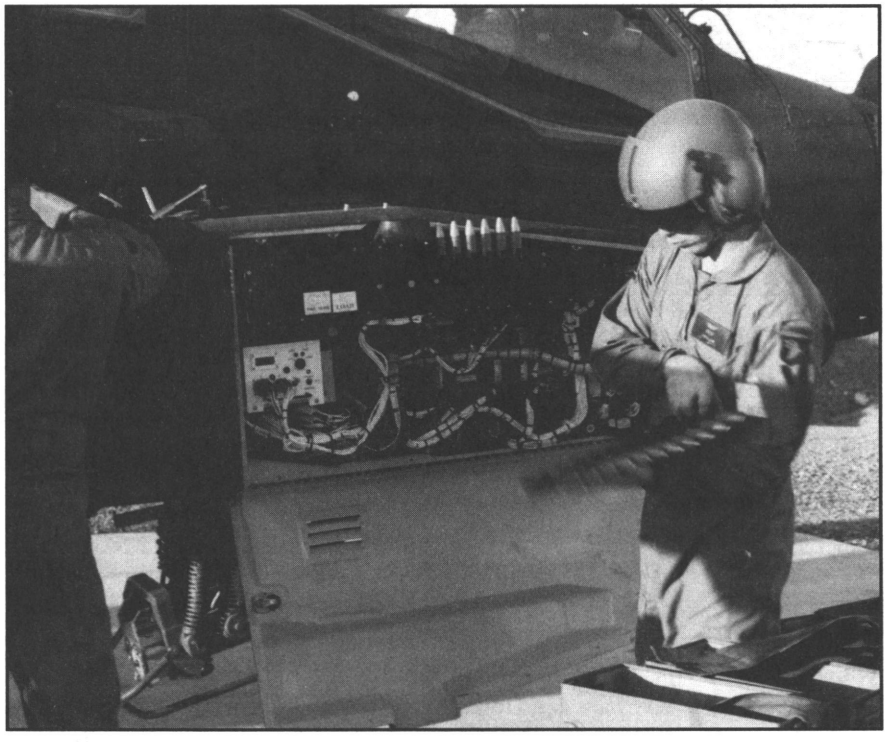


Figure 4

Figure 5

pared for aerial or ground recovery. This equipment was prototyped by the division's aviation sheetmetal mechanics under the tutelage of our equipment specialist and SECM project engineer.

The program will define a self–contained tool and equipment shelter system that mounts on a high mobility multipurpose wheeled vehicle (HMMWV), heavy variant, to form a contact maintenance truck. The photo shows a SECM with the 24th Infantry Division under operational user testing at the National Training Center (NTC) last year. The users liked the system so well they requested permission to deploy it with the unit for Operation Bright Star 94 in Egypt, followed by a second rotation to the NTC.

o Advanced Boresight Equipment (ABE) (Figure 6): The ABE program is a tri–service funded demonstration/validation (DEM/VAL) effort initiated with a Joint Aeronautical Commanders Group (JACG) Memorandum of Agreement (MOA) in May 1989. According to the MOA, the program intends "to develop a prototype ABE unit applicable for use on Army, Navy, and Air Force weapon systems and conduct sufficient technical and operational tests and evaluations to determine the ABE's capabilities, the degree of tri–service application, and support a production decision."

Given the logistics burden associated with boresighting combat aircraft, the degree of commonality of boresight requirements among the three services, and the nonweapon system specific nature of the current boresight equipment being developed by the Army, it was determined that a joint service development and evaluation of ABE should be undertaken.

The goal of the program is to develop compact, lightweight, quick, and easy–to–use ABE, which applies to multiple Army, Navy, and Air Force weapon systems. ABE intends to reduce the logistics burden associated with boresighting weapon systems, thus resulting in increased readiness. A system prototype of the ABE has been developed by the AAI Corporation, under contract to AATD, and has successfully completed demonstrations at AAI; McDonnell Douglas Helicopter Systems, Mesa, Az.; Langley Air Force Base, Hampton, Va.; Cazaux Flight Test Center, France; Fligerhorst Kaserne, Hanau, Germany; and RAF Lakenheath, United Kingdom, on AH–64 Apache

Figure 6

helicopters, F–15C/E fighter aircraft, and a Gazelle helicopter.

Even in its prototype form, the ABE has proven to be an extremely accurate piece of ground support equipment that has been well received by its users. The DEM/VAL program is scheduled to be completed in 1996 with developmental and operational testing. It is possible to enter production at the end of this phase of development, complete the logistics package during initial production, and field ABE in 1997.

o Advanced Cargo Handling System (ACHS) Demonstration Program: The CH–47D Chinook is the Army's primary cargo aircraft. However, its cargo handling capabilities are limited and do not reflect "state–of–the–art" capabilities. The objective of the ACHS Demonstration is to prototype cargo handling systems previously conceptualized under the Advanced Cargo Handling Technology Analysis Program. This demonstration effort will include dual winchable hooks, flip–over rollers/restraints, cordless intercom headset, night vision goggle compatible floor/ramp lights, and stowage provisions for loose gear.

These systems will be demonstrated on an Army CH–47D with flight tests and hands–on user cargo handling evaluations. The effort will be conducted in three phases: technology identification and preliminary design, detail design and test planning, and fabrication assembly and demonstration. Results of the ACHS Demonstration will identify benefits of the ACHS concepts. It will include a definition of a production configuration and an assessment of the predicted effects on a CH–47D. Proven advanced cargo handling concepts may then be used as technology inserts on the existing aircraft or incorporated into advanced platforms like an Improved Cargo Helicopter or the National Transport Rotorcraft.

This year, and in years to come, the focus will be even greater on affordable technology to provide and maintain a lethal, highly mobile, and responsive Army aviation capability. The AATD will accomplish this through implementing the above programs, which both individually and collectively reduce operating and support costs while improving readiness and efficiency. Dual use technologies developed by our division will play an important roll in developing the next logistic support aircraft, whether it is an improved CH–47, or a new airframe common with the commercial short haul air carriers.

The key to tomorrow's force projection Army will be its air mobility assets, many of which will be developed by AATD's RM&MT Division.

50 AATD

SAFETY AND SURVIVABILITY DIVISION

Mr. Harold K. Reddick Jr.
Chief
Helicopter Battlefield Survivability

Definition/Factors

Helicopter survivability, as defined by Robert Ball in his classic book on the subject, is the "*capability of an aircraft to avoid and/or withstand a man–made hostile environment.*" Two factors dictate **survivability—susceptibility**, the vehicle's ability to avoid being hit; and **vulnerability,** the vehicle's ability to withstand damage, given that it is hit.

Contained within each of these two factors are specific technologies: signature control; active countermeasures, and hardening against ballistic, biological/chemical, and directed energy weapons; and operational considerations including mission planning, situational awareness, and tactics.

Figure 1 illustrates the analysis task flow for each of these factors.

Aircraft Survivability Features

Survivability, as we know it today, has been both threat and technology driven. During the Vietnam War, the U.S. Army employed helicopters as never before in both tactical and nontactical situations. The helicopters initially employed had few survivability features, notwithstanding a level of inherent ballistic hardening augmented over time with parasitic armor to protect crewmembers and flight critical components.

The first fielded application of infrared (IR) signature suppression for countering heat–seeking missiles was through engine exhaust IR suppressors installed on the UH–1 Hueys and AH–1 Cobras during this war. The Safety and Survivability Division developed and tested these suppressors.

As a result of the Vietnam war and future threat postulations, the helicopter's **survivability** to hostile threats became a focused priority. Government and industry worked to reduce the vehicle's susceptibility to being fired on and hit and its vulnerability to debilitating damage, given that it was hit.

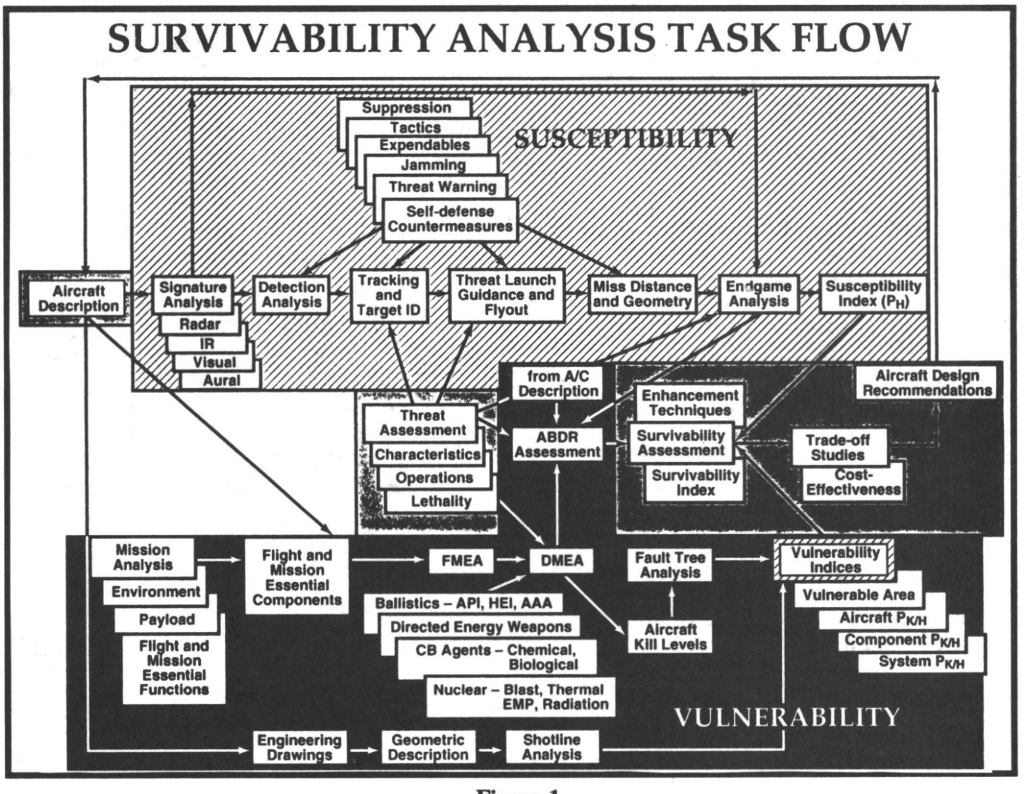


Figure 1

Clear evidence of this focus was in the UH–60 Black Hawk and AH–64 Apache helicopter developments that included very strong emphasis in select **survivability** areas such as ballistic hardening and engine exhaust IR suppression, and resulted in excellent survivability against these threats.

The four–bladed main and tail rotors of these helicopters produced passive acoustical signature improvements over Vietnam era helicopters. These helicopters also contained significant technology advancements in crashworthiness for reduced occupant fatalities and injuries, and loss in materiel.

Figure 2 illustrates testimony to this technology being implemented and "working as advertised." In this situation, a UH–60 Black Hawk helicopter was impacted ballistically in 29 locations during the Grenada invasion, including flight critical components such as the rotor system, flight controls, and fuel cell; it was able to successfully complete its mission. The Army's RAH–66 Comanche is designed to an extremely high level of survivability against a spectrum of advanced technology threats.

Recent Technology Developments

Figure 3 shows the division's recent technology developments that contribute to the Comanche's **survivability** effectiveness.

The division has been integral to this "**survivability** evolution." It has a long tradition of formulating technology programs to specific developer and user technology needs

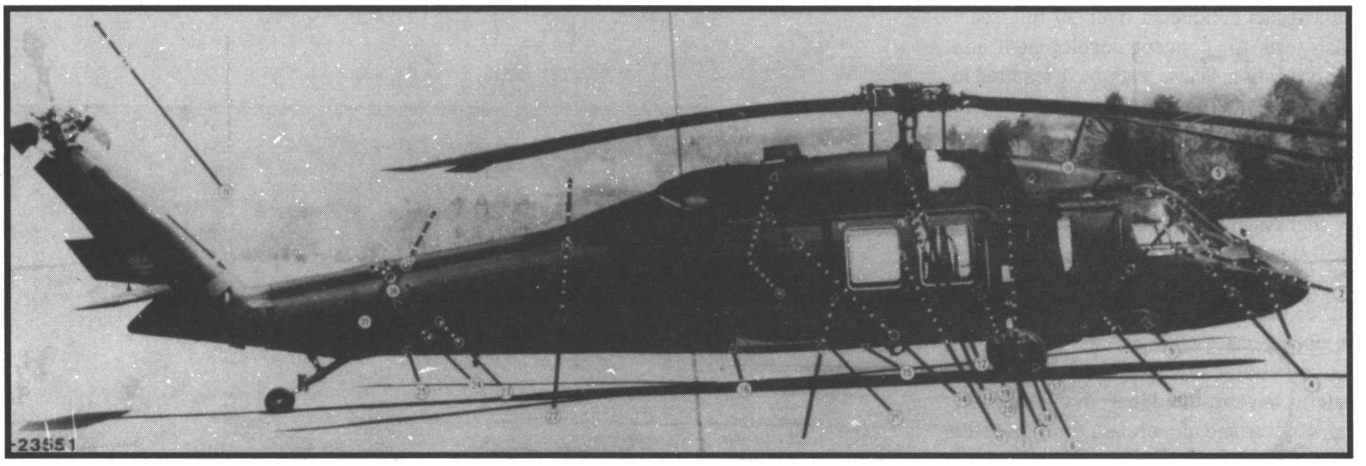


Figure 2

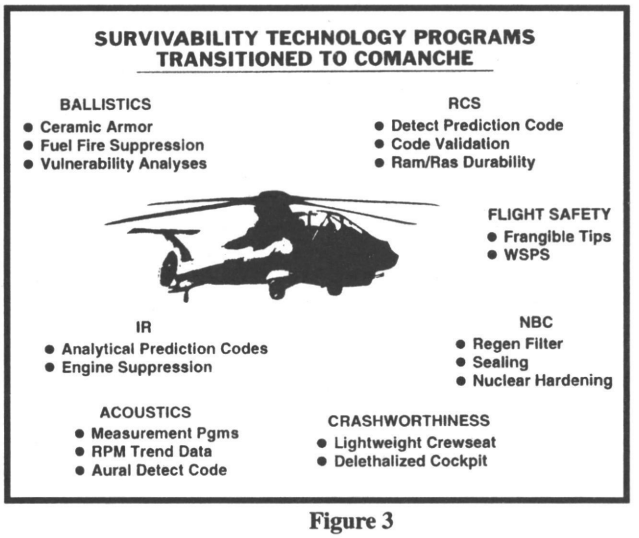


Figure 3

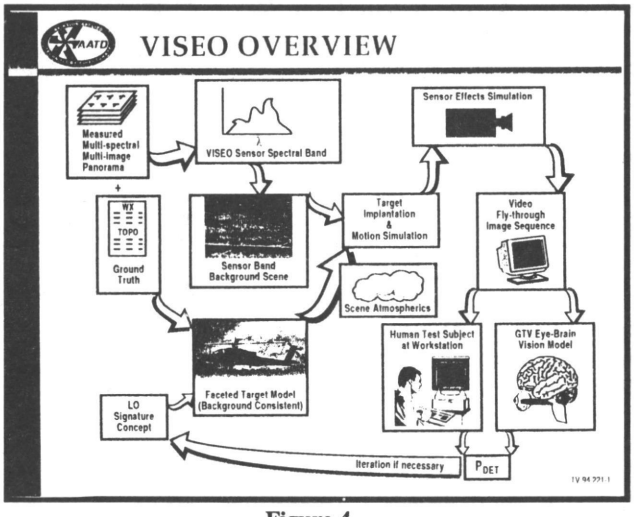


Figure 4

and requirements, executing the programs, and assuring technology transition to specific systems.

As far as **susceptibility reduction**, the division has conducted extensive research in rotorcraft signature control and reduction in the spectral bands of radar, infrared, acoustic, and visual.

Current and future thrusts in signature control focus on—

o The operational durability of radar–absorbing materials and structures (RAM/RAS) to assure they are durable and maintainable in service, and retain attenuation performance over long periods of time; low observable kits are being flown today for data gathering to address the durability issue.

o High–fidelity engineering modeling and simulation of threat systems and rotorcraft signatures to understand the performance of threat systems and how most effectively to defeat them. Figure 4 outlines a visual/electro–optic detection and analysis (VISEO) code for assessing signature control techniques to defeat these threat types. Figure 5 presents the computational fluid dynamic analysis of an advanced engine infrared suppressor.

o Flight testing of survivability enhancements to demonstrate concept feasibility and to produce a quality data base for validating prediction codes.

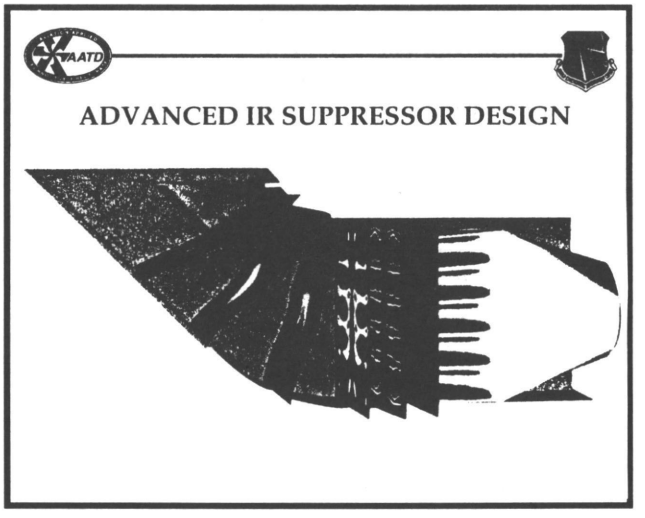


Figure 5

Vulnerability Reduction Technology

The division has long been a leader in development and implementation of **vulnerability reduction technology** in such critical areas as helicopter hardening against ballistic, NBC (nuclear, biological, and chemical), and directed energy weapon threats, and crashworthiness and flight safety. Several initiatives in lightweight, low–cost armor to protect the crew and flight critical components on the helicopter have ended in the fielding of several hundred armor kits such as those shown in figure 6.

Helicopter Crashworthiness

The division began its involvement in helicopter crashworthiness in 1955. Over the

years it has conducted over 30 full–scale crash tests for concept development and demonstration. These tests have resulted in a Crash Survival Design Guide used throughout the helicopter industry.

Research also during these years led to the development and fielding of crashworthy fuel systems which, since their fielding on all standard fleet helicopters, has resulted in not a single post crash thermal fatality. A further success story in flight safety is in the operational fielding of wire strike protection systems on the fielded fleet. These systems have resulted in a savings of more than 40 lives and numerous aircraft over the past 6 years alone.

Automotive Air Bag System Technology

The current thrust in crashworthiness is the application of automotive air bag system technology to the helicopter cockpit, as shown in figure 7. This technology minimizes secondary head and upper torso strikes during a crash.

Effective, Affordable Solutions

The demise of the Soviet Union cold war threat and the associated drawdown within the Department of Defense is creating a dynamically changing defense environment. The greatest challenge facing the survivability technologist is not only to develop survivability solutions that will effectively defeat advanced technology threats likely to proliferate around the world, but to assure these solutions are affordable. Such solutions must take advantage of all the survivability assets available and employ them in a system integrated, synergistic fashion. These assets include passive signature control; aircraft survivability equipment, including warning sensors, jammers, and expendables; mission planners; image–fused, cognitive decision aiding for the flight crew; and air vehicle hardening.

An important key to developing these effective, affordable survivability solutions lies in the use of credible constructive and virtual models and simulations, verified through judicious live simulation testing.

Conclusion

Despite uncertainties in today's environment, the Safety and Survivability Division is committed to providing quality, responsive technical support to its customers. Its other commitment is to maintain a technology base that significantly contributes to Army aviation's successful transition into the 21st century.

Figure 6

Figure 7

50 AATD

MISSION EQUIPMENT AND INTEGRATION DIVISION

Mr. John C. Macrino
Chief

MISSION

The mission of the Mission Equipment and Integration Division is to formulate and conduct exploratory and advanced development proof–of–concept programs for subsystems; i.e., mission equipment and integration into rotary air vehicle systems. To accomplish our mission, we coordinate and guide the planning and research of mission equipment development in meeting aviation performance and aircraft interface requirements to ensure efficient and cost- effective integration of those subsystems into the air vehicle. By doing this, we enhance the warfighting capabilities of current and future systems.

The mission requires extensive interface and coordination with the research and development (R&D) organization of U.S. Army Missile Command (MICOM), Redstone Arsenal Command, Ala.; U.S. Army Armament, Munitions, and Chemical Command (AMCCOM), Rock Island, Il.; and U.S. Army Communication–Electronics Command (CECOM), Fort Monmouth, N.J., as well as the user aviation community. This interaction ensures the relevancy and system performance of the technology application in meeting user needs.

TECHNOLOGY DEVELOPMENT EFFORTS

The following program descriptions are the most recent technology development efforts conducted by the division—

o Integrated Air–to–Air Weapons (INTAAW) Demonstration. The objective of the INTAAW program was to demonstrate a close–range (<1500m), defensive, air–to–air capability using the AH–64 Apache/ 30mm automatic cannon as the test vehicle. Accordingly, the program was structured to integrate and evaluate several relevant technologies developed under the aircraft weapons tech base program. We carry out this program in conjunction with the U.S. Army Armament Research, Development, and Engineering Center (USARDEC), Picatinny Arsenal, Dover, N.J.

These technologies included advanced adaptive turret control algorithms developed by Integrated Systems, Inc., and active recoil attenuation developed by HR Textron. McDonnell Douglas Helicopter Systems developed Air–to–Air Fire Control processing architecture and integrated all of the INTAAW components into the AH–64 test aircraft.

Tracking problems caused by autotracker limitations in Air–to–Air Dynamic scenarios were originally thought to be manageable through test control procedures. These problems prompted an additional phase in which autotracker improvements were incorporated and evaluated. Results indicate the INTAAW program achieved its objective. Consequently, Air–to–Air Fire Control is being transitioned into the fleet through the AH–64 Longbow upgrade. Furthermore, the INTAAW data are being considered in the RAH–66 Comanche Automatic Cannon Subsystem Design. This program was conducted in close coordination with USARDEC.

o Integrated Fire and Flight Control (IFFC). The marriage of weapons control with the flight control system was postulated to increase the combat effectiveness of the rotorcraft as a weapon system. This combination also was supposed to realize these benefits accurately. The pilot remains in complete control throughout the engagement, but his "flying" workload is reduced and the weapon is consistently and accurately placed on the target.

The IFFC program is a multiphased effort that began with defining conceptual integrated fire, flight, and propulsion control system architectures for rotary–wing attack aircraft. Development and assessments of these concepts were conducted in unmanned computer simulation environments. Coupled aiming techniques were investigated as well as automated aircraft maneuvers for launching weapons, active recoil compensation, weapon system envelope management schemes, and unconventional flight maneuvers to release weapons. Results showed the propulsion control system was a necessary ingredient for rotorcraft IFFC because of the highly coupled nature

of the helicopter. Major benefits of IFFC included significant reductions in pilot workload, and the time between target designation and weapon release; increases in the number and duration of firing opportunities; and improved accuracy and consistency reaching the weapon launch solution and constraints.

Phase 2 of the program is currently underway. In phase 2 IFFC designs are being explored through manned, full mission simulation. Real–time, pilot–in–the–loop simulation of IFFC control laws, fire control interferences, and cockpit displays is in progress. The simulation will provide proof of concept in terms of mission effectiveness for Army air-to-ground and air–to–air scenarios. Future plans include ground–based/software integration leading to flight tests.

o *Integrated Pump Actuator (IPA).* Although greatly improved over their predecessors, modern Army helicopters remain vulnerable to ballistic weapons. Analyses show hydraulic and mechanical tail rotor control subsystems are major contributors to the helicopter's vulnerability.

Even today's fly–by–wire designs use centralized hydraulic systems with long, high–pressure fluid lines through the tail boom to power tail rotor actuators. The threat of electromagnetic interference to fly–by–wire control systems also exists and may increase on future battlefields.

Older helicopters with mechanical control linkage or fully mechanical systems pay high weight penalties for required backup systems. A small, integrated hydraulic pump actuator module, driven by the tail rotor shaft, would eliminate vulnerable hydraulic lines and provide a line–replaceable, tail rotor control unit to reduce maintenance. Fluidics control systems are immune to electromagnetic interference and lightening, can save weight, and improve survivability.

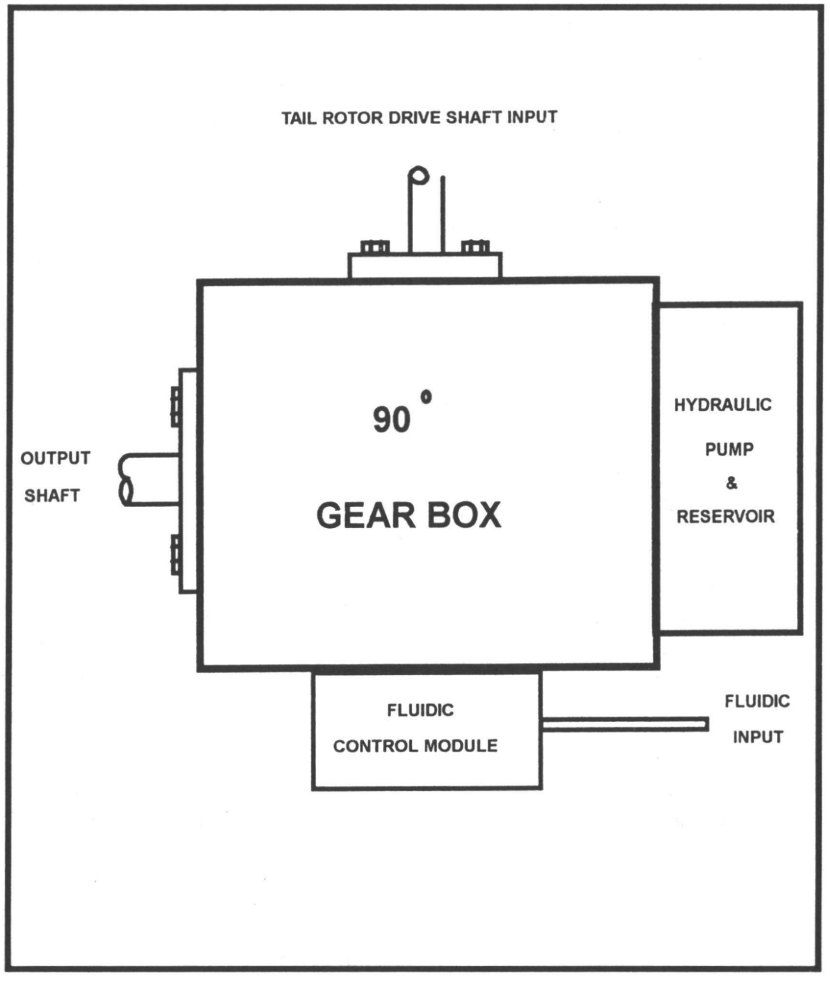
o *Integrated Pump Actuator Program (IPAP).* This program designed, built, and bench–tested a proof–of–concept, integrated pump actuator with a fluidics control subsystem for tail rotor control. The program was conducted jointly with the Nuclear and Directed Energy Division of the U.S. Army Research Laboratory, Adelphi, Md.

The program establishes a technology base for engineering development of lightweight, highly reliable, and highly survivable fluidics controlled pump actuator modules. As shown in the block diagram, figure below, the functions of a hydraulic pump and tail rotor servoactuator are combined into a single unit. The IPAP module actuates the tail rotor collective pitch through its servoactuator, using hydraulic power supplied by the integral pump.

The fluidics control subsystem was envisioned as a backup signal path for failed or disrupted fly–by–wire systems or mechanical signal paths (push–pull tubes) severed by ballistic hits.

In the IPAP configuration—fluidics linked the pilot to the IPAP module to control full authority of the tail rotor through pneumatic pedal transducers, control amplifier, and a pneumatic/hydraulic servovalve. The integrated pump actuator module and the fluidics control system were designed for actual flight demonstrations.

At the present time, all of the IPAP hardware has been thoroughly and successfully bench–tested.



Figure

50 AATD

WHAT MAKES IT WORK— THE THREE Ps OF ACQUISITION

Ms.Theresa M. Dery
Senior Contract Specialist

In 50 years the Aviation Applied Technology Directorate (AATD) and its predecessor organizations have earned a reputation of being in the forefront in aviation research and related technology. AATD not only is a leader in technology, but also in the process in which that technology is developed. Review and oversight teams from the U.S. Army Audit Agency, U.S. Army Materiel Command (AMC), U.S. Army Aviation and Troop Command (ATCOM), and the Department of the Army (DA) Inspector General have noted the accomplishments of the Directorate. The successes are too numerous to list; however, significant programs include the modified Bell UH–1B Huey, investigating high–speed flight characteristics of rotary–wing aircraft; the XC–142 Tilt–Wing Aircraft; the AH–56A Cheyenne (predecessor to the AH–64 Apache); the Aviation Ground Power Unit; the Longbow Apache, which AATD developed and demonstrated; and the RAH–66 Comanche, known as the light helicopter experimental (LHX) during its early development at AATD.

What makes it all work? In any organization, various ingredients that create success go into the bowl. The key ingredients that make the AATD system work are the "Three Ps of Acquisition—***Process***, ***Procedures***, and ***People***."

PROCESS: Just as the foundation of a house is built with blocks, the elements of the ***Process*** are the foundation blocks of the AATD acquisition system. If the ***Process*** is clearly defined, understood by all participants, and flows through fundamental process requirements, then the possibility for success is greatly enhanced. Although the acquisition process formally begins with completion of a local form titled "Acquisition Planning Schedule," the project engineer has already coordinated with his technical, quality assurance and data management, and contracting advisors. Thus begins the building of the cohesive acquisition team responsible for requirement development. The ***Process*** continues with three sequential and integrated reviews of all requirements over $25,000: the ***Technical Advisory Review Board (TARB)***, the ***Requirements Review Board (RRB)***, and the ***Solicitation Review Board (SRB)***. These boards consist of senior managers, senior engineers, and others as voting members with advisors from technical, contracting, quality assurance and data management, legal, program and budget, security, and other disciplines as required for the particular requirement.

The TARB, the least formal of the boards, reviews the statement of work (SOW) for relevancy, clarity, and a chance for successful completion; the source selection plan and evaluation criteria for applicability to acquisition requirements; and the contents of the ancillary documents for adequacy of supporting the requirement. Upon completion of the TARB, the project engineer formalizes all relevant information and documentation for presentation to the RRB.

The RRB reviews the entire requirement: the SOW, data requirements, instructions to offerors, Government–furnished data and property, and funding, to ensure a bona fide need exists and program objectives can be met. The project engineer uses the comments of the RRB to prepare the formal "acquisition request," which is forwarded through security (et al.) for its input. A completed acquisition request is then presented to the contract specialist who uses the request to prepare the solicitation and present it to the SRB.

The SRB convenes to conduct a final review of both the requirement and the solicitation to ensure—

- All issues have been resolved and changes made to the requirement.
- The acquisition strategy is proper.
- The SOW is not unduly restrictive.
- Adequate opportunity exists for subcontracting with small and small disadvantaged business concerns.
- The solicitation's terms and conditions, clauses, data requirements, delivery schedule, Government–furnished property, facilities, funding, and security requirements comply with the law and appropriate regulations.

The SRB reviews the source selection plan and evaluation criteria to ensure clarity, applicability, and the weights accorded technical evaluation elements and factors are acceptable, fair, and realistic for the proposed effort.

After receipt and evaluation of proposals, a Product Assurance Board (PAB) is convened for competitive acquisitions to review the results of technical and business evaluations. Although, at AATD, the technical proposals currently receive numerical scores and accompanying narratives, no scores are given to the business or past performance evaluation results; these elements receive only a narrative evaluation. The PAB identifies those offerors whom it believes have a reasonable chance of receiving award and those offerors that, through negotiations, can be made susceptible for receiving award. The PAB then recommends to the Contracting Officer that negotiations be conducted with these offerors. The Contracting Officer uses the PAB's recommendation to make the

final competitive range determination. Discussions and negotiations are then initiated with all offerors in the competitive range. After discussions and negotiations are completed and officially closed, the request for the "best and final offer" (BAFO) is issued to all offerors. The BAFOs receive a thorough evaluation by the Technical and Business Evaluation Committees. The PAB reconvenes to consider the BAFO evaluation results and to recommend to the Contracting Officer the offeror who has submitted the proposal that is considered the best value to the Government. Usually, the Contracting Officer is the source selection authority who makes the final determination of the successful offeror. In the more important or complicated acquisitions, a separate source selection authority may be designated.

The successful and timely award of the best value contracts has shown the effectiveness of the ***Process*** from inception of the requirement, pre–solicitation boards, evaluations, negotiations, and PABs, to selection and award, but what makes this ***Process*** work?

PROCEDURES: With the ***Process*** as an effective foundation, the AATD acquisition system's building blocks are its ***Procedures***. If ***Procedures*** implementing ***Process*** are comprehensive, detailed, understandable, executable, and accessible to all, then chances for success also are greatly enhanced. The ***Procedures*** at AATD are clearly defined and workable; a product of a long, successful history, being honed through experience, change, a striving toward excellence, and the careful and concerted efforts of the AATD collective. The ***Procedures*** have been established in such forms as the AATD Acquisition Desk Guide, Contracting Memoranda, and the Preaward Index.

Acquisition desk guide: Although in existence for quite some time, the Acquisition Desk Guide required a major revision to incorporate the changes effected by passage of the Competition in Contracting Act in 1984. Subsequently, the Desk Guide was rewritten and published as a working draft which was, for several years, massaged, expanded, refined, rewritten, and wordsmithed as it evolved into its current form. It became all inclusive of the ***Procedures*** used during the acquisition process and each chapter was fully coordinated with the cognizant organizational element. Finally, on 23 March 1993, the Working Draft became the full–fledged Acquisition Desk Guide, a 225–page, 24–chapter document covering not only the procedures to be followed to process a requirement through the organization, but also describing the duties and responsibilities of each person in the process. A copy of the Desk Guide is available to all members of AATD.

Ancillary memoranda: A series of memoranda covering topics such as Subcontracting Plans, Certificate of Contractor Eligibility, Contractor Information System, and Justification and Approval for Other Than Full and Open Competition have been issued by the Contracting Division. These memoranda pertain to actions contract specialists are required to complete during the acquisition process; they provide detailed instructions on the actions required and, in many cases, sample documentation is provided.

Preaward index: The Preaward Index is another efficient tool used to ensure all requirements of an acquisition are completed in a timely manner consistent with the acquisition schedule. The Preaward Index provides, in one place, a comprehensive list of all required actions, respective regulation cites, date action was completed, and the location of the related documentation in the preaward contract file. Using the Index helps ensure the contract specialist and supervisor no action required by law or regulation has been omitted.

The procedures outlined in the Desk Guide, the Contracting Memoranda, and the Preaward Index implement the ***Process*** and enhance the performance of all persons in the acquisition system.

What makes these ***Procedures*** work? They do not, themselves, ensure success. Rather, the successes of the effective ***Process*** and efficient ***Procedures*** are the result of the attitude, effort, and dedication of the ***People***.

PEOPLE: ***People*** are the adhesive that keeps AATD together and they create the environment in which success blossoms. Without ***People***, even the most effective ***Process*** and the most efficient ***Procedures*** cannot produce anything. ***People*** make things happen. ***People*** are the lifeblood of AATD's acquisition system. They are a talented, innovative, creative, dedicated, and persistent people. They have a "can do" attitude when it comes to getting the job done, no matter how small, since even small matters can become critical. AATD personnel continue to receive awards and recognition from within the organization and outside from ATCOM, AMC, DA, and various professional organizations.

The ***People*** of AATD also are known for fostering an attitude of cooperation. They do this by establishing "partnering" relationships, not only among themselves, but with members of ATCOM, AMC, valued military and civilian customers, and last, but not least, the valued partners from the defense industry. This "partnering" has tremendous results in the quality and quantity of work accomplished at AATD. This "partnering" or team concept prevails throughout AATD with ***People*** working together to assist, encourage, and to solve apparent problems and resolve issues quickly. This was demonstrated in the recent response to the need for "quick fixes" during Operation Desert Storm. Engineers, contract specialists, and defense contractors worked together with alacrity to solve erosion problems that desert sand was causing with rotary blades and turbine engine power plants. Numerous other ongoing projects were accelerated by AATD during Operation Desert Storm including battle damage repair kits for fuel lines, fluid lines, and electrical and fuel cells.

With all of its resources, facilities, ***Processes*** and ***Procedures***, and especially its ***People***, AATD can design, fabricate, demonstrate, and test just about anything in aviation research and related technology and emerging tech base requirements, and can do so even in critical situations with short lead times. AATD does it well and AATD does it fast. How can AATD help you?

50 AATD

POWER SYSTEMS DIVISION

Mr. Eric Clay Ames
Aerospace Engineer

AATD's Pursuit of Advanced Turboshaft Engines and Their Benefits to Army Rotorcraft

No other single technological development has provided the military helicopter with such markedly improved performance as the turboshaft engine. In research and development efforts, the Power Systems Division has conducted, and is continuing to conduct, the critical first steps that demonstrate the latest available turbine engine technology.

These demonstrations—in the form of component, gas generator, and full–engine testing—have served to define the level of technology available for full–scale development of a specific engine for a specific flight vehicle. Specifically, the 1,500 SHP [shaft horsepower] Demonstrator Engine was the precursor to the highly successful T700, which powers the UH–60 Black Hawk and AH–64 Apache aircraft. The Small Turbine Advanced Gas Generator (STAGG) and the Advanced Technology Demonstrator Engine (ATDE) formed the basis for the T800. The Modern Technology Demonstrator Engine (MTDE) defined the state–of–the–art for 5,000 SHP class engines for potential development in the mid to late 1980s.

The division currently is sponsoring efforts to demonstrate the technology required for a new generation of turboshaft engines with significant improvements in specific fuel consumption (SFC) and shaft horsepower–to–weight (SHP/Wt) ratio over those engines now powering the current Army helicopter fleet.

The Early Years

The search for a powerplant that is lightweight, efficient, reliable, and durable has continued since the days of the Wright brothers (see back cover). The helicopter—perhaps more than any other type of aircraft—has shown significant performance improvements in terms of range and payload with the introduction of each new generation of powerplants. During the period between 1945 and the late 1950s, military helicopters typically were powered by reciprocating engines of the radial configuration. One of the most capable piston–powered helicopters of this era was the Sikorsky H–34A Choctaw (see back cover), which was powered by a single Wright Cyclone R–1820–84 radial engine (figure 1).

The R–1820 developed a takeoff power of 1,430 SHP and it weighed 1,380 pounds, thus resulting in a SHP/Wt ratio of 1.03. It was a nine–cylinder, single–row, air–cooled design with a gear–driven supercharger. The H–34A was able to conduct missions with a radius of about 93 nautical miles (nm). Considering the high weight of the engine and the rotor aerodynamics of the period, this level of performance was quite respectable. The good brake specific fuel consumption (BSFC) of the R–1820 at cruise power levels was a major factor in producing this performance.

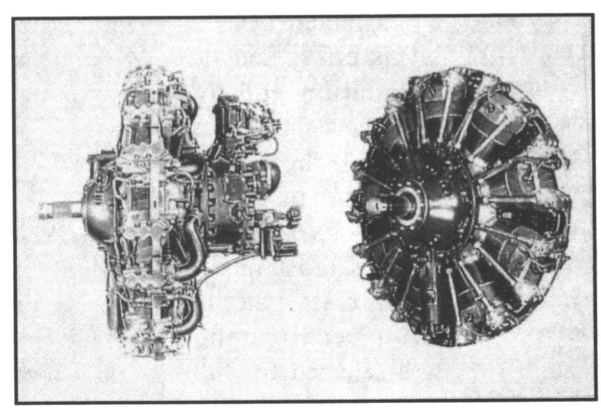


Figure 1. Wright Cyclone R–1820–84

By the mid 1950s, the aircraft reciprocating engine had reached a plateau in both performance and maintainability. This was due to the extensive development of these engines during World War II and their inherent limitations of high weight per horsepower, poor reliability, and high vulnerability.

The First Turboshaft Engines

The late 1950s saw the rapid development of the turboshaft engine as a viable powerplant for use in helicopters. The first, and possibly the most well–known, U.S. Army helicopter model to be powered by a turboshaft engine was the Bell Helicopter UH–1 Huey. The UH–1H version of this aircraft is powered by the Lycoming T53. The T53 is a simple–cycle,

front–drive, free–turbine engine, which is takeoff rated at 1,400 SHP. The weight of the engine is 540 pounds, which results in a SHP/Wt ratio of 2.59, more than double that of the R–1820 (figure 2).

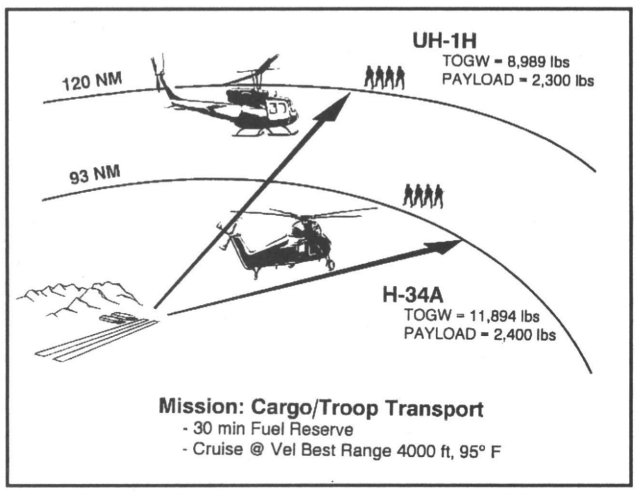


Figure 2. The Range of UH–1H Versus H–34A

During the initial fielding of the Army's first turbine–powered aircraft, AATD primarily focused on the integration, operability, and maintainability issues associated with the T53 as well as the T63 and T55 engines.The operating environment experienced by these engines in the Vietnam War highlighted the need for better performance, much greater tolerance to sand and dust ingestion, and a greatly simplified field maintenance.

Turbine Versus Reciprocating

A comparison of the H–34A and the UH–1H shows the UH–1H can carry nearly the same payload out to a 29–percent greater radius. The radius of action with a fuel capacity of 205 gallons is 130 nm. Much of this improvement was due to the ability of the T53–L13 to generate the same power with an engine weight 831 pounds less than the R–1820–84.

Development of the Modern Turboshaft Engine

As the Vietnam War had proven, the helicopter provided the U.S. Army with unprecedented mobility and the ability to project power quickly. AATD initiated an engine technology demonstration program known as the 1,500 SHP Demonstrator Engine. It did so through its experience with the early turboshaft engines and an awareness that technological advances in materials and aerodynamics were being developed.

In1967, contracts were awarded to two major turbine engine companies for the design, fabrication, and testing of engines, which had greatly reduced fuel consumption, higher SHP/WT, simplified maintenance, and tolerance to sand and dust ingestion. Pratt and Whitney's engine design had the ST–9 designation, while General Electric's engine design was known as the GE–12 (figures 3 and 4). Both of these engines underwent several cycles of design and testing. The purpose was to evaluate new approaches and optimize the performance and durability characteristics.

This effort laid the foundation and defined the technological state–of–the–art for the engines required to power two of the Army's most important aircraft. Later the GE–12 configuration was selected for full–scale development as the T700–GE–700, which now powers both the UH–60 and AH–64.The highest power versions of the engine weigh 445 pounds, resulting in a SHP/Wt ratio of 4.04, which is nearly 35–percent better than the T53–L13.

Major technological advances in materials, manufacturing, heat transfer, and aerodynamics allowed the T700 to be designed with higher overall cycle temperatures and pressures. This enabled a sizeable reduction in SFC and an increase in SHP/Wt versus the T53. These advances were made while increasing the operating times between overhauls from 1,000 to 2,500 hours.

The T700 was the first turboshaft engine to have an integral inlet particle separator (IPS) for sand and dust protection. The axial compressor is designed to be sand and dust tolerant. The IPS, along with the axial compressor, allows extended operation in severe desert environments. An internal emergency lubri-

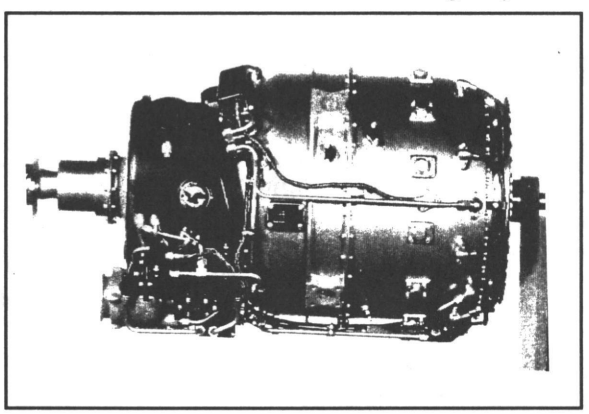


Figure 3. ST–9

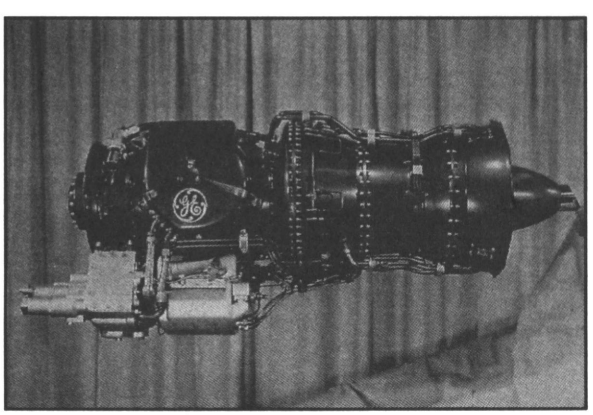


Figure 4. GE–12

cation system and top–mounted accessories improve the engine's ability to operate after a ballistic impact. The engine is a modular design for enhancing field maintenance and repairability. The benefits of this feature were evident during Operations Desert Shield and Desert Storm when frequent hot–section inspections were required because of the severe sand and dust environment (figure 5).

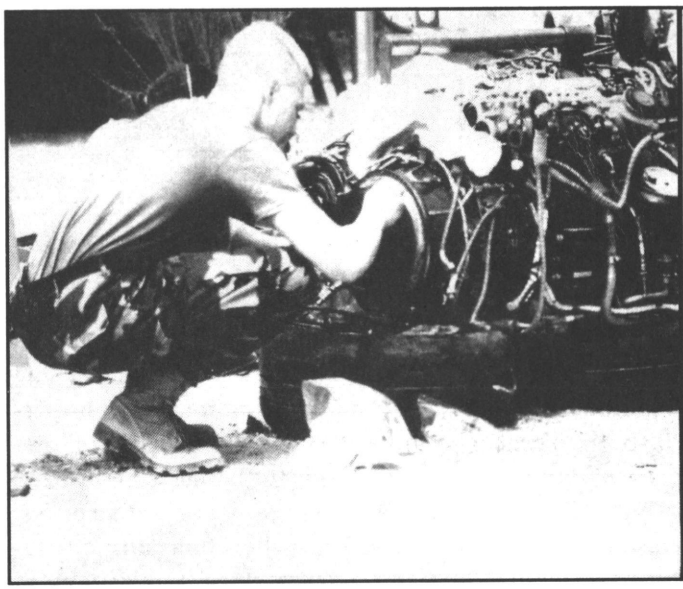


Figure 5. Field Inspection of T700 Hot–Section

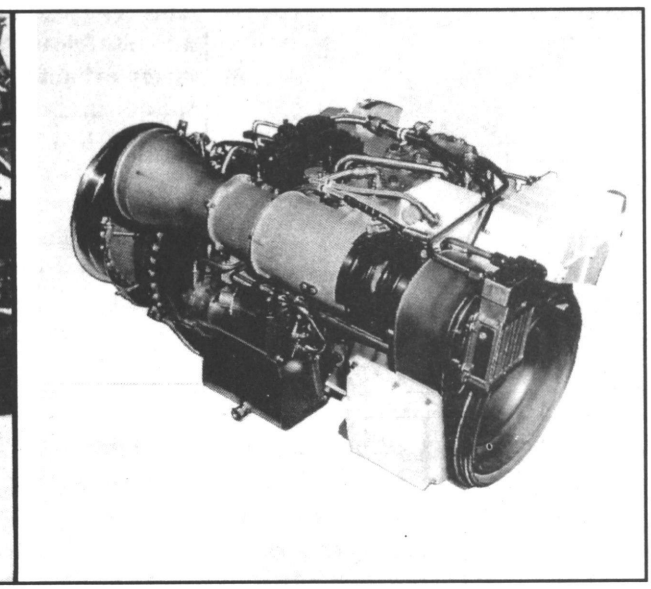


Figure 6. Lycoming ATDE

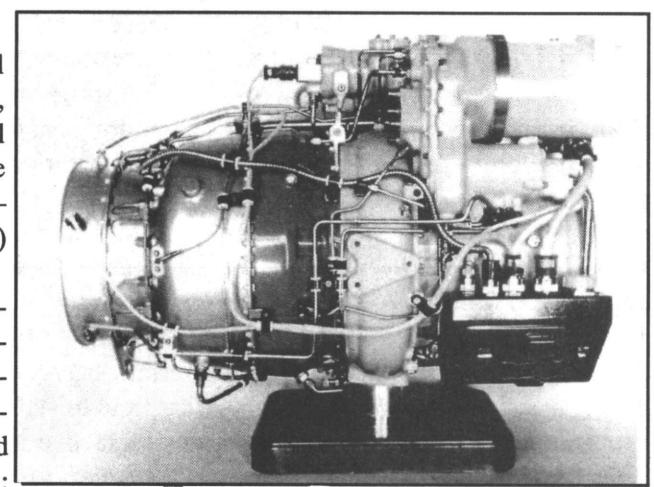


Figure 7. Allison ATDE

Advancing Small Engine Technology

After the development of the T-700, it became clear the Army intended to develop a light twin engine scout/reconnaissance helicopter. AATD had once again continued to follow the increase in gas turbine engine component performance; the Directorate had become very active in sponsoring research efforts aimed specifically at improving the temperature capability, efficiency, pressure ratio, and durability of individual engine components.

During the fall of 1972, four research contracts were awarded for the design, fabrication, and test of gas generators that were to be the cores of engines in the 400 to 800 SHP class. The gas generator is part of the engine that produces the hot gases that drive the power turbine and thus the output shaft. This program was known as the Small Turbine Advanced Gas Generator (STAGG). Avco Lycoming, Pratt and Whitney, Williams International, and Garrett Air Research all developed and tested designs under this program. Several key technical innovations demonstrated during the STAGG program included a centrifugal fuel slinger/injector, first use of small cooled turbine blades, and an all–electric (analog) engine control.

The STAGG designs did not include inlet protection systems, accessory drives, and power turbines; therefore, a full–engine demonstration effort was initiated in 1976. Two competing designs were selected under the effort known as the Advanced Technology Demonstrator Engine. Avco Lycoming and Allison Gas Turbines both had engines with advanced design features for improved performance, durability, ease of maintenance, and environmental tolerance (figures 6 and 7). (Several examples of these are the first use of single, crystal–cooled, turbine blades; full–authority, digital engine controls; and a high–pressure, twin–centrifugal compressor.) During the course of the program, detailed reviews were conducted in which AATD engineers evaluated the progress of the contractors to ensure that the goals of the program were being met. A key technique used during the program was the use of engine mock–ups for the evaluation of maintainability features.

(Continued on page 52)

THEY ALSO FLEW: PIONEER BLACK ARMY AVIATORS

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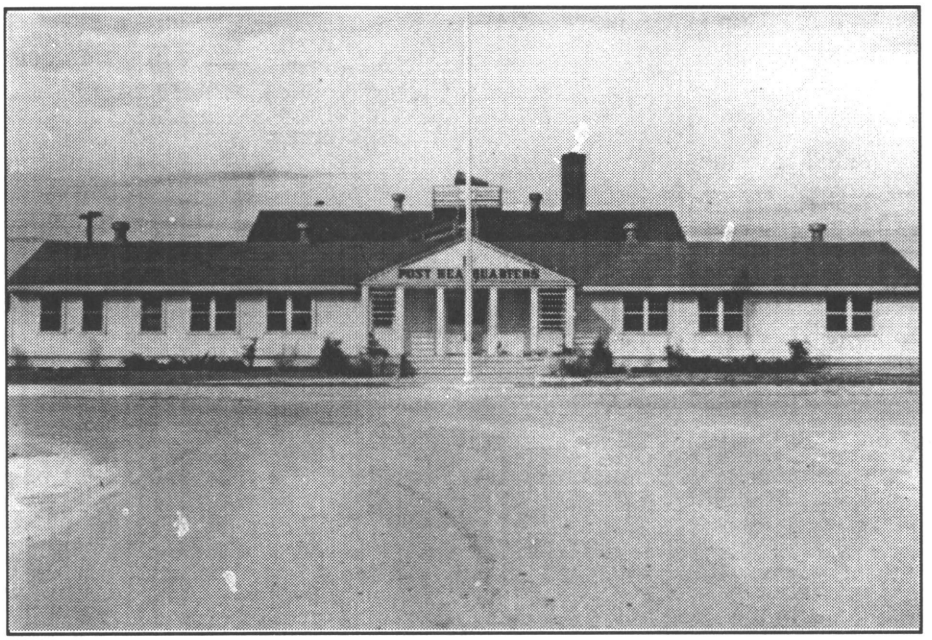
This is Part 2 of a series of articles about African American pioneer Army aviators. Part 3 will discuss the desegregation of the Army during the Korean conflict and describe some of the experiences and contributions of African American pioneer Army aviators of the post–integration period in a historical context.

As related in the first article of this series, only nine blacks were trained as Army Ground Forces aerial observation pilots before August 1943. Six of these had been eliminated from Army Air Forces flight training at Tuskegee Army Airfield in 1942 and had subsequently completed advanced flight training at Fort Sill, Okla., and became aerial artillery observers. The other three were field artillery officers who had completed primary training along with white students at Denton, Tex., and Pittsburg, Kans., and advanced training at Fort Sill. The majority of the black aerial observation pilots of World War II, however, began their military flight training at Tuskegee Army Airfield during the latter part of 1943.

The Army Air Forces headquarters instructed the commanding general of the Army Air Forces Training Command to prepare to provide liaison pilot training to 50 black artillery officers at Tuskegee Army Airfield. Three classes of 21 students each were to begin training on 2 August, 23 August, and 6 October 1943. This training was to be in addition to the weekly quota of 50 white artillery officers being trained at Denton and Pittsburg. The curriculum and the training time were to be the same for the black officers as for white officers at Denton and Pittsburg.[1]

Training these black field artillery officers on the Air Forces' segregated training facility at Tuskegee, Ala., rather than at Denton and Pittsburg constituted a change in policy. Although available documents do not provide a definitive explanation, it seems that the policy change resulted from the fact that significantly more black pilots were needed in late 1943 than previously. Aerial observers were required at that time to staff the recently organized black artillery units, and African American field artillery officers were available to receive the training. While training a few black officers along with white officers had apparently created no major problems either at Denton or Pittsburg, there seems to have been more concern in some quarters about training larger numbers of blacks—especially in areas of the country where there were very few blacks in the community.[2] Furthermore, the facilities at Denton and Pittsburg were being fully utilized to provide the quota of white pilots. Therefore, when field artillery requested that larger numbers of blacks be given primary training, the Army Air Forces decided to conduct this training at the segregated pilots' training base at Tuskegee rather than at the established primary liaison schools.

Both Tuskegee Army Airfield and the Southeast Air Forces Training Center at Maxwell Field, Ala., recommended that the liaison training be conducted at Tuskegee only as a last resort because the airfield there was already overcrowded. Upon being notified that the decision had been made to conduct the training at Tuskegee, however, the director of training there began to make preparations for the new program. Since Tuskegee Army Airfield instructors lacked experience in liaison training, Captain (CPT) Raymond Mackinnon and three or four other instructors were sent on



Post headquarters building at Tuskegee Army Airfield

temporary duty to Denton to familiarize themselves with the objectives, methods of instruction, and operation of a liaison training program.

In the meantime, CPT Errol Bechtold was detailed from Denton to Tuskegee to serve as director of liaison training until CPT Mackinnon returned from Denton. An effort was made to locate experienced liaison instructors, but none were available, so other type flight instructors were temporarily transferred to Tuskegee from other stations in the training command. Tuskegee Army Airfield also acquired 19 L–2 Taylorcraft planes to use for liaison training.[3] Apparently the preferred L–4 planes then used both at Pittsburg and Fort Sill were not available.[4]

Another major handicap of the Tuskegee liaison training program was that the airfield had become seriously overcrowded during 1943. Some 50 airplanes of three types and speeds were already being used for training on the base. To avoid interference with the ongoing training programs, the liaison flight training was conducted at Griel auxiliary field—6 miles away by air, but 12 miles by dirt road. Consequently, the students, instructors, mechanics, tools, spare parts, and fuel had to be transported by trucks one or two round–trips a day. The trips were time–consuming and exhausting in good weather and very difficult in wet weather.[5] The temporary nature of the liaison training program at Tuskegee was yet another factor that undoubtedly affected the quality of the program. The liaison program was known to be temporary from the beginning and was apparently given the attention that temporary and auxiliary programs are wont to be given. For the brief period of the liaison program, Tuskegee Army Airfield accepted and used inappropriate instructors, aircraft, and landing strips; graduated the required number of pilots; and then returned all attention to the permanent missions of training Army Air Forces pilots. Students in the program considered the training at Tuskegee to be significantly inferior to that being provided at Pittsburg.[6]

Tuskegee Army Airfield was charged with providing 50 rated pilots from a pool of 62 officers who began the training. While this permitted an elimination rate of 19 percent (the approximate average elimination rate at Denton and Pittsburg), several classes at those schools had elimination rates exceeding 30 percent. In two classes, 40 percent or more were eliminated. Consideration was given to entering four additional students in each Tuskegee class to anticipate a higher elimination rate, but the proposal was rejected, apparently by the commander of the Tuskegee Army Airfield.

The three classes at Tuskegee were conducted in accordance with a flow chart prepared at the beginning. The first class began with 21 students on 2 August 1943 and graduated 15 pilots on 4 October; the second class began with 21 students on 23 August and graduated 18 pilots on 25 October; the third class began with 20 students on 4 October and graduated 18 pilots on 6 December 1943. Tuskegee Army Airfield exceeded its requirement by graduating a total of 51 rated liaison pilots.[7] Some consideration was given to training another class of artillery officers at Tuskegee, but apparently there were not enough qualified black officers available at Fort Sill for another class. Accordingly, on 15 November 1943, the

Army Air Forces Training Command was notified that no more black field artillery pilots would be trained.[8]

The names of the graduates of the three classes trained at Tuskegee are listed below. Those with asterisks after their names are known to have successfully completed advanced training at Fort Sill and served as aerial observation pilots. Others also completed the training at Fort Sill but have not yet been identified positively by name as pilots in artillery units.

Class 43–CL–1

CPT William H. Shannon*
First Lieutenant (1LT) Chauncey Eskridge*
1LT James I. Minor
1LT William Y. Rose
2LT Darryl C. Bishop
2LT Harry W. Dungil*
2LT Charles G. Dunn
2LT Arnold D. Grant*
2LT Leander A. Hall, Jr.
2LT Alvin J. Johnson
2LT Benjamin R. Moore*
2LT Lloyd R.V. Taylor*
2LT Leonard E. Wilburn*
2LT Aldrick H. Wilson*
2LT James E. Woodson*[9]

Class 43–CL–2

1LT Terry H. Brooks*
1LT John B. Dudley
1LT Gaines C. Farley
1LT Fred E. Howard
1LT Leroy Stephens, Jr.
1LT Robert L. Wrenn*
2LT Henry Bennett
2LT George F. Bizzell
2LT Richard C. Chatman
2LT William J. Cleveland*
2LT John O. Cunningham
2LT John M. Franklin
2LT Louis K. Hanks*
2LT William M. Jordan*
2LT Thurston Mason
2LT John E. McCode
2LT Daniel C. Thomas
2LT Paul Weathersby[10]

Class 43–CL–3

1LT Lee Authur Baker
1LT Scott Kelly Cleage
2LT John D. Battle
2LT George Deforrest
2LT Charles B. Elam
2LT Ernest W. Goldsborough
2LT Maxwell Honemond*
2LT Sterling K. Jackson
2LT Horace W. Johnson
2LT Wendell W. Long
2LT Henry A. Norman*
2LT Horace W. Oates*
2LT Elwood A. Smith
2LT Sherman W. Smith
2LT Lemuel L. Tucker
2LT Edward Warner
2LT George Woods
2LT Johnny Young[11]

Lists of the names of the above named graduates, from the Army Air Forces liaison training program at Tuskegee Army Airfield, who successfully completed the advanced course at Fort Sill and became field artillery aerial observers, are not currently available. When the first Tuskegee class began advanced training at Fort Sill, the trainers there concluded that the student pilots from Tuskegee were poorly trained. An officer from Fort Sill made a trip to Tuskegee at that time to make an unofficial inspection of the program. It was indicated to him that the trainers at Tuskegee were reluctant to eliminate students from the liaison training program.[12]

In the advanced course at Fort Sill, the normal elimination rate was around 15 percent or lower. The elimination rate of the flyers trained at Tuskegee was estimated to be considerably higher, but no precise figure is available. According to two students in the third Tuskegee class, the elimination rate for members of their class was very high—according to one of them, only about 8 or 10 students from the class of 20 completed the course at Fort Sill.[13]

There may well have been some racial prejudice involved in the advanced training course at Fort Sill and in the appraisal of the abilities of the black flyers.[14] It should be remembered, however, that these same men had been permitted to complete officer candidate training at Fort Sill, and it was known that they would be sent into black units, as they would be regardless of whether they completed the advanced flight training. Furthermore, there seems to have been no particular problems with the black pilots who received their primary training at Denton and Pittsburg. One is therefore inclined toward other explanations for the higher elimination rate at Fort Sill of the Tuskegee–trained flyers. It is apparent to this writer that the liaison training program at Tuskegee failed to provide the caliber of training that was being provided at Denton and Pittsburg. All of the following factors probably contributed to the lower quality training at Tuskegee and to the higher elimination rate of the Tuskegee–trained flyers in the advanced course: the temporary nature of the program at Tuskegee; the lack of experience of the instructors in liaison training; the overcrowded facilities; the use of L–2 rather than the preferred L–4 aircraft for training; the understanding that it was incumbent on the Tuskegee program to graduate and rate at least 50 pilots; and the fact that Tuskegee was a Jim Crow segregated facility.[15]

There was probably a total of between 40 and 60 African American aerial artillery observation pilots during World War II. Thirty–two have been identified by name as having completed the advanced course at Fort Sill and served with artillery units. The following accounts of personal experiences and careers of a few of these pilots would probably be somewhat typical of the group as a whole.

2LT Maxwell Honemond was in the third class of officers to com-

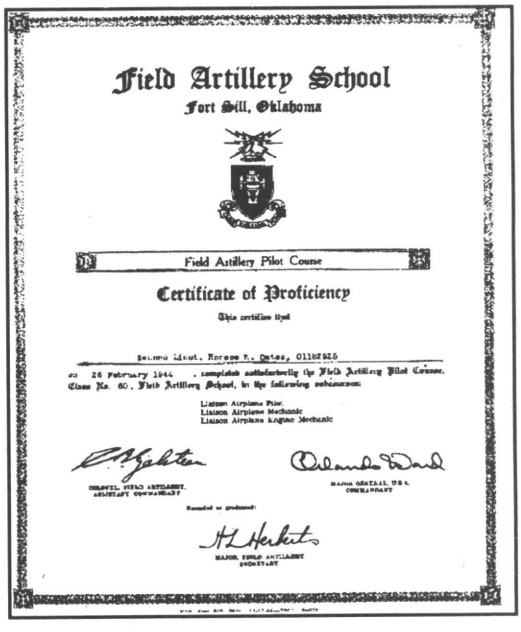
2LT Horace Oates was assigned to the 597th Artillery Brigade, 92d Infantry Division, in Italy.

plete primary training at Tuskegee. Before being inducted into the Army in September 1941, 2LT Honemond had completed the civilian pilot training program at Dover, Del. He had applied for admission into the Army Air Forces pilot training program, but his applications were allegedly "lost." 2LT Honemond was recommended to the Field Artillery Officer Candidate School from his station at Fort Huachuca, Ariz. He was one of three blacks in an officer candidate class of over 700 soldiers. After receiving his commission, he was assigned to a replacement depot at Fort Sill and then ordered to Tuskegee for flight training. Upon completing his training at Tuskegee and Fort Sill, 2LT Honemond was sent to Italy where he was assigned to the 351st Field Artillery Battalion.[16]

2LT Horace Oates was placed in an officer pool at Fort Sill after completing officer candidate school. He saw a notice on the bulletin board about the aerial observer training and applied. He had no flight experience before being sent to Tuskegee for primary training. According to 2LT Oates, the training at Tuskegee was not comparable to what white artillery officers were receiving at Denton and Pittsburg. 2LT Oates remembered the long truck ride to the auxiliary field where liaison training was conducted and also the high elimination rate of Tuskegee–trained flyers at Fort Sill. 2LT Oates was assigned to the 597th Artillery Brigade in the 92d Infantry Division in Italy.[17]

Octave Rainey, one of the enlisted observation pilots who was later commissioned, was awarded the Air Medal in September 1944. He was recalled to active duty during the Korean conflict and flew L–5s on artillery observation and other type missions in Korea.[18]

After World War II, the first black commissioned officer to become an Army aviator, Charles N. Brown, served in the Army Reserves until 1948, when he was recalled to active duty. The unit to which he was assigned, the 74th Combat Engineer Battalion, was assigned to Korea in September 1950. Brown flew L–16s and H–13s for the 74th during the Korean conflict; he was recommended for the Distinguished Flying Cross, but the commanding officer would not sign the recommendation, reportedly because he "had too many medals already for a black



Field Artillery School
Fort Sill, Oklahoma

Field Artillery Pilot Course

Certificate of Proficiency

This certifies that

Second Lieut. Horace R. Oates, 01182825

on 26 February 1944 , completed satisfactorily the Field Artillery Pilot Course, Class No. 60, Field Artillery School, in the following subjects:

Liaison Airplane Pilot
Liaison Airplane Mechanic
Liaison Airplane Engine Mechanic

COLONEL, FIELD ARTILLERY
ASSISTANT COMMANDANT

MAJOR GENERAL, U.S.A.
COMMANDANT

Recorded as graduated:

MAJOR, FIELD ARTILLERY
SECRETARY

2LT Horace Oates' Field Artillery School Pilot Course Certificate of Proficiency.

Major (Ret) Charles R. Brown holding a model of an L-4 Grasshopper

man." Brown was replaced in October 1951 by another black aviator, LT William M. Jordan, who had been in the second class of artillery officers who completed primary flight training at Tuskegee Army Airfield. Brown retired from the Army Reserves in 1965 as a master aviator with the rank of major. In 1980, he was inducted into the Field Artillery Officer Candidate School Hall of Fame at Fort Sill.[19]

Ernest Davenport also applied for Army Air Forces pilot training before being inducted into the Army in 1941. One of the first three African Americans to complete Field Artillery Officer Candidate School, Davenport graduated, along with the other two, in the fourth class at Fort Sill, in February 1942. He was then assigned to the 184th Field Artillery Battalion at Fort Custer, Mich., from where he applied for field artillery observer training. After completing primary training at Denton, and advanced training at Fort Sill, Davenport was stationed briefly at Camp Livingston, La., and Fort Huachuca. He then joined the 92d Division in Italy. He left active duty after the end of World War II and retired from the Army Reserves in 1970 with the rank of lieutenant colonel.[20]

Several other African American pilots that served in the 92d Division in Italy have been identified by name. These include the aforementioned James Christian, Tully Hickman, and Lawrence Johnson, who had begun their field artillery careers as enlisted aviators; Arnold D. Grant, Chauncey Eskridge, Robert L. Wrenn, Benjamin F. Moore, Henry A. Norman, Leonard E. Wilburn, James E. Woodson, Louis K. Hanks, Lloyd Taylor, and Aldrick H. Wilson, all commissioned artillery officers who had received their primary training at Tuskegee Army Airfield; Welton Taylor, who received his primary training at Pittsburg; and Regional Woolridge, Clifford Stewart, and Lester McCants, who apparently also were given primary training at Pittsburg in early 1944.[21]

CPT Ernest H. Davenport, artillery liaison pilot, awaits orders to take off during the fifth campaign in Italy.

ENDNOTES

[1]Memo AFACT–2B, Brig. Gen. Robert W. Harper, Headquarters, Army Air Forces, Washington, for commanding general Army Air Forces Training Command, 21 July 1943, sub: liaison pilots for field artillery, Air Force Historical Research Agency (AFHRA), 220.01, vol. 13, p. 223.

[2]This concern was expressed in the histories of the Army Air Forces Central Training Command for both 1943 and 1944 (AFHRA, 223.01).

[3]Memo for record, Lt. Col. Paul E. Todd, 19 July 1943, sub: colored liaison pilots, AFHRA, 220.765–2, vol. 4, 1943; "History: Eastern Flying Training Command, January — December 1943," vol. 2, pp. 1053—1056, AFHRA, 222.01; "History of Tuskegee Army Airfield, 1 January 1943—29 February 1944," AFHRA, 289.28–3. Some of the new white enlisted instructors were apparently unhappy with their assignment of teaching flying to black officers and openly demonstrated their scorn for them (notes on telephone conversation by author with Mr. Horace Oates, 19 Aug. 1994).

[4]When L–2 Taylorcraft planes were reintroduced into the training fleet at Pittsburg in 1944, the accident rate increased as also did the elimination rate in the advanced course at Fort Sill of students provided primary training in L–2s (History of the Army Air Forces Training Command, 7 July—31 December, 1944, vol. 6, 1366–70, AFHRA, 220.01).

[5]"History: Eastern Flying Training Command, January—December 1943," vol. 2, pp. 1053–1056, AFHRA, 222.01; "History of Tuskegee Army Airfield, 1 January 1943—29 February 1944," AFHRA, 289.28–3.

[6]In addition to the use of L–2 rather than L–4 aircraft, one student observed that at Tuskegee they used ordinary road maps rather than proper aviation maps (notes on telephone interview by author with Horace Oates, 24 August 1994).

[7]"History of Tuskegee Army Airfield, 1 January 1943 to 29 February 1944," AFHRA, 289.28–3, pp. 68–69; "History of Army Air Forces Training Command, 7 July 1943—31 December 1944," AFHRA 220.01, vol. 4, pp. 1356, vol. 13, doc. 220.

[8]Memo AFACT–2T, Brig. Gen. Robert W. Harper, Hdqts, Army Air Forces, Washingon, for commanding general Army Air Forces Training Command, AFHRA, 220.765–2, vol. 4, 1943.

[9]Baltimore ***Afro–American***, 16 October 1943, ***Tuskegee News Clippings File***, see the sections on aviation in John W. Kitchens, ed., ***Microfilm Edition of the Tuskegee Institute News Clippings File*** (252 microfilm reels and printed guide, Tuskegee, Ala.: Tuskegee Institute, 1978), reel 84.

[10]Chicago ***Defender***, 2 November 1943, ***Tuskegee News Clippings File***, reel 84.

[11]Personnel orders no. 55, Hdqts., Army Air Force Eastern Flying Training Command, 27 November 1943, Aviation Branch History Office, Charles Brown file.

[12]Notes on telephone interview by author with Lieutenant General (Ret) Robert R. Williams, 12 August 1994.

[13]Notes on telephone interviews by author with Colonel (Ret) William R. Matthews, 12 and 30 August 1994. Notes on telehone interviews by author with Mr. Maxwell Honemond and Mr. Horace Oates, 16 and 24 August 1994.

[14]For example, two civilian instructors initially refused to teach the black students, but were told that they either do it or resign (notes on telephone interview by author with Colonel (Ret) William R. Matthews, 20 August 1994).

[15]A somewhat different point of view was expressed to me a few hours before this manuscript was submitted for publication. Lieutenant Colonel (Ret) Ernest Davenport, who served with many other black artillery observer pilots during World War II considered some of the Tuskegee graduates to be technically superior in their flying skills to other pilots. He attributes the high elimination rate of these flyers at Fort Sill to the shortage of spaces available in black artillery units. Since there were a limited number of positions available for black pilots, he believes a larger portion was eliminated than would otherwise have been. (Notes on telephone interview by author with Colonel Davenport, 1 September 1994.)

[16]Notes on telephone interview by author with Mr. Maxwell Honemond, 16 August 1994.

[17]Notes on telephone interview by author with Mr. Horace Oates, 24 and 31 August 1994.

[18]Houston ***Informer***, 16 September 1994, ***Tuskegee News Clippings File***, reel 87: Notes on telephone interview with Mr. Octave Rainey, 1, 23, and 31 August 1994.

[19]Notes on telephone interview by author with Charles Brown, 12, 17 August 1994; "A Log of Achievement," ***U.S. Army Aviation Digest*** (June 1980), pp. 6–8; ***Army Times***, 14 February 1980.

[20]Notes on telephone interview by author with Mr. Ernest Davenport, 29 August and 1 September 1994.

[21]Notes on telephone interview by author with Mr. Ernest Davenport, and Mr. Horace Oates, 29 and 31 August 1994.

Warrant Officer Aviator Conversion to Modernized Aircraft

CW5 Clifford L. Brown
Chief, Aviation Warrant Officer Proponency
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The Aviation Restructure Initiative (ARI) is rapidly converting units to the new A–series modification tables of organization and equipment (MTOE). As this organizational conversion occurs, requirements for aviators qualified in modernized aircraft increase, while requirements for aviators qualified in nonmodernized aircraft decrease. Modernized aircraft are the AH–64 Apache, OH–58D Kiowa Scout and Warrior, CH–47D Chinook, and the UH–60 Black Hawk.

Many aviators have speculated about the viability of a career as a nonmodernized aircraft qualified aviator. They have the perception that their career is "dead" if they do not receive a modernized aircraft qualification within the next 12 months. *This is absolutely untrue!* Because warrant officer (WO) aviator positions in aviation companies are coded for WO, W3, and W4, most warrant officer aviators (83 percent) will eventually receive a modernized Aviator Qualification Course (AQC).

The active component warrant officer aviator strength totals 6,300 warrant officers. Of this total, 4,195 are qualified in a modernized aircraft, leaving 2,105 who are qualified in nonmodernized aircraft. Of the 2,105 who are not qualified in a modernized aircraft, about 1,300 are WO1s and CW2s, 705 are CW3s and CW4s, and 100 are CW5s. By the end of ARI conversion in fiscal year (FY) 98, requirements will exist for about 513 aviation warrant officers (AWOs) qualified as UH–1 Iroquois "Huey" AWOs, 182 AWOs qualified as AH–1 Cobra AWOs, and 300 AWOs qualified as OH–58A/C Kiowa AWOs. This represents 17 percent of AWO positions.

TheWarrant Officer Division receives about 375 modernized AQC quotas per year, including 45 fixed–wing quotas. By dividing the number of modernized AQC quotas per year into the inventory of nonmodernized–aircraft–qualified warrant officer aviators, it would take a little less than six years to qualify every warrant officer aviator now on active duty. However, there is no intent to qualify every warrant officer now on active duty in a modernized aircraft. As of 1 October, 50 percent of each initial entry rotary wing (IERW) class received a modernized AQC. Although this will reduce the number of modernized AQCs available for aviators currently on active duty, it is a crucial step in building the future aviator force. Despite downsizing and ARI modernization, viable warrant officer aviator career patterns will continue to exist until the year 2010 for WO1s through CW4s flying AH–1, OH–58A/C, and UH–1 aircraft. Of the approximately 375 AWOs who graduate from IERW each year, about 40 will remain in nonmodernized aircraft systems throughout their entire career. Warrant officer aviators in the grades of WO1, CW2, and CW3 will get a modernized aircraft qualification as they are assigned to a modernized aircraft line company. A WO1 on active duty with one year of time in grade has about 12 years in which to obtain a modernized AQC. CW4s may get a modernized aircraft qualification, depending on their retirement plans, location, future assignment, and career track. CW5s who do not already have a modernized aircraft qualification will probably not get one. Aviators who already have one modernized aircraft qualification will not get a second modernized aircraft qualification. Remember, modernized AQCs and advanced skills selection are a competitive board process conducted at the U.S. Total Army Personnel Command (PERSCOM). Only the best–qualified aviators who apply will be selected to attend.

Aviation Proponency

Readers may address matters concerning aviation personnel to—
Chief, Aviation Proponency
ATTN: ATZQ–AP
Fort Rucker, AL 36362–5000,
or call DSN 558–2359 or commercial 205–255–2359/3423.

Air Traffic Control: Safe, Orderly, and Expeditious

MSG Eddie L. Spivey
Fixed Base Support Division
U.S. Army Air Traffic Control Activity (USAATCA)
Fort Rucker, Alabama

Air traffic control (ATC) is a system based upon pilot and controller communication and understanding as well as upon regulations. These basic components make the airspace system work and ensure that the process goes smoothly and safely. When one of these components breaks down, the consequences can be devastating.

We, as air traffic controllers, are charged with the responsibility of maintaining situational awareness at all times, while the pilot operates his aircraft according to controller instructions and regulatory guidelines. This bonding forms a relationship of mutual trust that makes our air traffic system safe and prevents accidents.

Historically, accidents have revealed that communications and procedures are vitally important. The postanalysis of most accidents occurring in terminal areas cites that deviation from procedures, outdated policies, and lax management and training were significant contributing factors.

Recent accidents emphasize how imperative it is that we operate according to regulatory guidance. ***Federal Aviation Administration Handbook 7110.65*** prescribes those procedures, phraseology, and correct pilot/controller terminology for all air traffic controllers.

Shift supervisors, facility chiefs, and ATC chiefs, as part of their duties, check the phraseology used at their facilities to ensure that all controllers are using the correct pilot/controller terms and procedures. The facility's success depends on each member's being aware of potential hazards.

Monthly training further instills values and basic ATC principles. This training impresses upon controllers the importance of memorizing call signs, knowing various aircraft maneuvers and sequencing and spacing techniques, and having the ability to conceptualize and visualize the execution of their plan to control aircraft. Complacency perpetuates accidents; most mishaps can be avoided.

The success of an airfield is built upon a mutual understanding among ATC, airfield operations, and aviators. According to Army Regulation 95–3, ***Aviation: General Provisions, Training, Standardization, and Resource Management***, an ATC representative will be a member of the aviation standardization committee. The ATC chiefs work through this committee to enlighten the aviation community on ATC safety concerns and practices.

Another vitally important process is the *Operational Hazard Report*, Department of the Army (DA) Form 2696–R. This report is not used to wage a technical gripe between ATC and pilots but instead records information about hazardous acts or conditions so that corrective action can be taken. As a supplement to this process, the ATC chief and others in the aviation community foster a relationship that is based upon education and accident prevention.

The time and effort we invest now will be beneficial to the future of Army aviation. We must stand by our creed to be *safe*, *orderly*, and *expeditious* in protecting lives and preserving our highly valued aviation resources.

U.S. Army Air Traffic Control Activity

Readers may address matters concerning air traffic control to—
Commander
USAAVNC
ATTN: ATZQ–ATC
Fort Rucker, AL 36362–5265.

The XM56 Motorized Smoke Screen System

MAJ Edwain Courtney
and
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TEXCOM Engineer and Combat Support Test Directorate
Fort Hood, Texas

The use of smoke screens in military operations began simply to hide the movements of the friendly force from the enemy eye. However, with the leaps and bounds of technology as we approach the twenty–first century, smoke screens have taken on additional requirements.

The new threats on the battlefield include visual–frequency sensors from the unaided eye to image intensifiers and sophisticated surveillance, target acquisition, and night observation devices.

The Engineer and Combat Support Test Directorate (ECSTD) of the U.S. Army Test and Experimentation Command (TEXCOM) conducted an operational test of the XM56 Motorized Smoke System to determine the capability of the new system to counter the threats.

A significant difference with the XM56 is the capability to produce obscuration that can defeat infrared target acquisition systems (thermal sights).

The XM56 is a modular mobile smoke system mounted on the heavy version (M1097) of the High Mobility Multipurpose Wheeled Vehicle. The XM56 is based on a gas turbine engine to which various modules can be added.

Using the 172d Chemical Company as the threat force and the blue (friendly) force provided by the Division Long Range Surveillance Company—both from 4th Infantry Division (Mechanized), Fort Carson, Colo.—the test was conducted at Fort McClellan, Ala. The tactical concept was simulated combat operations in a field training exercise (FTX) environment under Army Training and Evaluation Program (ARTEP) conditions.

Large–area screening smoke was provided in support of various types of operations, including both attack and defense scenarios. During these operations, TEXCOM testers pre–positioned some data collection instrumentation; other equipment was mobile. All measured the capability of the XM56 to perform as advertised.

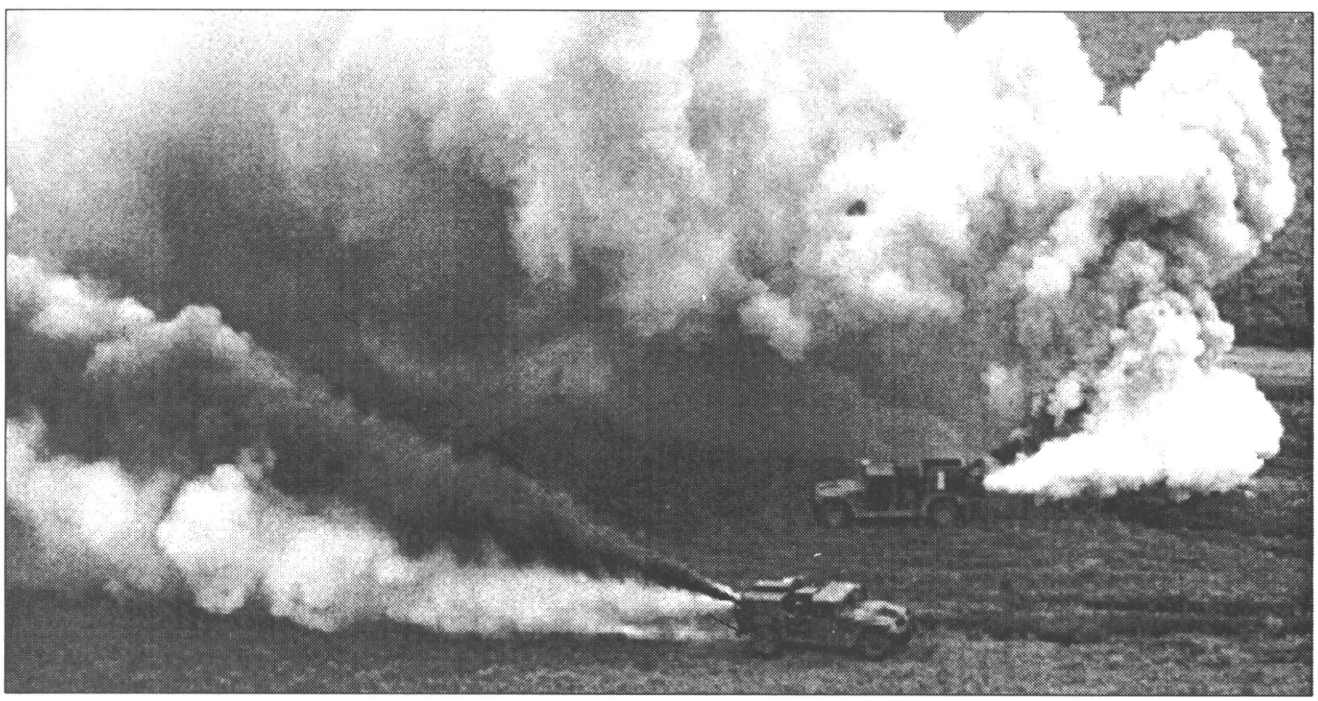
Visual–on–visual and infrared obscuration were among the multiple iterations of force–on–force missions conducted.

The testers collected both instrumented and manual data in the categories of manpower and force structure, human factors, operational performance of the system, user (soldier) perception of the usefulness of the system, logistics supportability, safety, and reliability.

As the test units redeployed to Fort Carson, the test team redeployed to Fort Hood, Tex., to write its test report, which will support a decision for the classification and production approval.

U.S. Army Test and Experimentation Command

Readers may address matters concerning test and experimentation to—
Headquarters
TEXCOM
ATTN: CSTE–TCS–PAO
Fort Hood, TX 76544–5065.



The XM56 Motorized Smoke System was tested at Fort McClellan, Ala., in a realistic battlefield environment.

U.S. Army Class A Aviation Flight Mishaps

Fiscal Year	Number	Flying Hours	Rate	Military Fatalities	Total Cost (in millions)
FY 93 (through 30 September)	23	1,299,337	1.77	22	102.2
FY 94 (through 30 September)	21	1,268,050	1.66	11	94.2

The U.S. Army Maintenance Test Pilot Course

MW4 Jessie Dize (retired)
and
Mr. Tom Blake
Training Specialist/Course Manager
U.S. Army Aviation Logistics School
Fort Eustis, Virginia

The Maintenance Test Pilot Course (MTPC) produces qualified maintenance test pilots for the U.S. Army. This military–occupational–specialty–producing course has been taught continuously for more than 27 years. The MTPC is unique, with an intense mixture of classroom instruction that includes aircraft inspection and systems troubleshooting, fault identification, analysis, and corrective action; aircraft ground operations and maintenance operational checks (MOC); and flight training. The goal of the MTPC is to increase the mission readiness of Army aircraft through the use of maintenance test pilots. Because of their training, the test pilots can safely, accurately, and rapidly identify, analyze, and determine the appropriate corrective action for an aircraft fault condition.

The Army's MTPC began in 1966 as part of the U.S. Army Transportation School at the world's first military heliport, Felker Army Airfield, Fort Eustis, Va. Before the MTPC, the only test flight instruction was a one–hour demonstration flight in a UH–1 Iroquois "Huey" helicopter during Phase II of the Aircraft Maintenance Officer Course (AMOC).

Originally, AMOC was taught in two phases and concentrated on maintenance management policies and procedures.

Phase III was added using the UH–1 as the basis of instruction. As other helicopters were added to the curriculum, each aircraft's model designation was added to AMOC I Phase III to differentiate between the separate courses of instruction. These separate courses became known as tracks. The Fixed Wing Course began as AMOC Phase IV in 1968.

Initially, only a small percentage of the Phase I and Phase II graduates were afforded the opportunity to attend Phase III. When arriving at Felker Army Airfield, MTPC students were expected to have prior maintenance experience and a minimum of 500 flight hours and be current in the aircraft. The typical student was a graduate of AMOC Phases I and II with three years of unit–level aircraft maintenance experience and 1,000 maintenance test flight hours.

In 1975, the MTPC became an integral part of AMOC. The sections of AMOC were redesignated as Phase I for aircraft maintenance management and procedures and Phase II for the MTPC. The individual aircraft sections of Phase II were referred to as tracks. Most Phase I graduates would attend one of the Phase II tracks.

With the creation of the Aviation Branch in 1983, AMOC was transferred from the Transportation School to the Aviation Logistics School. The course was changed from the Aircraft Maintenance Officer Course to the Maintenance Management (MM)/MTPC). The maintenance management portion of the course was referred to as the core, and the maintenance test flight portion of the course was referred to as the track. The aircraft designation was placed in front of "track."

Typically, all students attend one of the test–flight tracks immediately after they graduate from the core portion. Those who have previously graduated from AMOC or MM/MTPC may attend just the track portion for additional aircraft maintenance test pilot qualification.

The first MTPC began with the UH–1B– and D–model Hueys and was known as AMOC Phase II. The first class graduated in November 1966. As new models were added or older models were removed from the active Army's fleet, the program of instruction (POI) for the UH–1 was updated to reflect the current status. This procedure became the standard operational mode for all subsequent aircraft tracks. The POIs for the UH–1 track have included the B, C, D, H, and M models. Today, the UH–1 POI concentrates on the UH–1H.

The CH–47 Chinook track started in 1967, and the first class

graduated in August 1967. Initially, the CH–47 track instruction covered only the B model. It was expanded in 1969 to include the C model and again in the early 1970s to include the "Super C." The D model was incorporated into the POI immediately after the Army modernization program began upgrading A– and B–model Chinooks into D models. The CH–47D was significantly different. It evolved into a separate track in 1987. The CH–47C was retired from the active Army inventory, and the C model was dropped from the MTPC POI in 1989. Today, the Chinook track concentrates on the D model.

The AH–1G Cobra was added to the course in 1968. With the exception of the gun turret and stability control augmentation system (SCAS), the G–model Cobra shared systems and components with C– and M–model Hueys. The classroom instruction for the G–model Cobra was part of the Huey track, and only the test flight training was separate.

The G–model Cobra evolved into six models: AH–1Q (TOW [tube–launched, optically tracked, wire–guided] Cobra), AH–1R, AH–1S (Modified), AH–1P (Production), AH–1E (ECAS [Enhanced Cobra/TOW Armament System]), and AH–1F (Modernized). The AH–1Q and AH–1R were short–lived and were never added to the MTPC curriculum. All of the Q and R aircraft were modified into S models. The difference between the S model and the original G model (the Huey) was extensive. Thus, the Cobra instruction was severed from the Huey course, and the S–model Cobra became an independent track in 1974. The scope, but not the duration, of the course was increased to accommodate the P, E, and F models, as well as the AH–1S modified Cobra as they were introduced into the Army inventory. Teaching all models during the one–month training cycle proved to be too burdensome. The course now concentrates on the AH–1F fully modernized Cobra.

The Scout track was added to the course of instruction in 1972. Instruction was conducted in both the OH–58A Kiowa and OH–6A Cayuse. The OH–6 was phased out of the active Army inventory in the early 1970s. The MTPC discontinued OH–6 instruction in 1977. The OH–58 track was expanded in 1978 to include the C model.

A fixed–wing track was added in 1968 as AMOC Phase IV. The course of instruction was totally separate from the rotary–wing tracks. Initial instruction was for the OV–1 Mohawk A, B, and C models. The D model was added in 1971 and later became the only OV–1 model taught. Because of lack of demand, the fixed–wing track was dropped in 1974.

The UH–60A Black Hawk track began in 1978. This track was unique as it started before the aircraft was fielded. When the first Black Hawk was delivered to Fort Campbell, Ky., trained maintenance officers met the aircraft. Like the others, the Black Hawk track has expanded to include new models or adaptation of existing models as they have entered the Army's ESSS (E–triple–S) model and L model. The UH–60 track has overtaken the UH–1 as the largest class–size track. About 120 UH–60 maintenance test pilots are trained each year.

The AH–64A Apache track started in 1986. As with the Black Hawk course, Apache maintenance test pilots were being trained before the aircraft was fielded. The Apache track is unique because pilots attending the track have six weeks of maintenance test flight instruction as compared to only four weeks of instruction in the other tracks.

The OH–58D came on board in 1987. As with the Black Hawk and Apache, maintenance test pilots were trained before the first aircraft was fielded. The D–model POI was upgraded to include the OH–58D Kiowa Warrior information. This increased the track length to five weeks and two days. The Kiowa Warrior program is unique as it includes armament system maintenance procedures. Maintenance test pilots started training under the new POI in April 1993.

Previous maintenance and test flight experience is no longer a prerequisite for students to attend the MTPC. Aviator students may attend the course straight out of flight school. Experienced students are not usually current in the aircraft when they report for MTPC. Most students do not have any previous maintenance experience.

Despite an increase in aircraft complexity, a decrease in pilot experience, and an increase in the number of aircraft models, 12 MTPC classes have been conducted each year (except for the Apache and Kiowa Warrior). To ensure that the field continues to have qualified and well–trained maintenance test pilots, the MTPC training system has undergone a series of significant changes. Originally, the only qualification an MTPC instructor needed was maintenance experience. The instructor had to teach only the finer points and techniques of aircraft maintenance and test flying. As the experience levels of the students decreased, a need arose for

increased instructor expertise. The solution to this problem resulted in an instructor position that is unique in the Army.

Today, MTPC instructor pilots must be both aircraft maintenance technician/test pilot and instructor pilot. The MTPC instructor pilots have a military occupational specialty special qualification identifier (SQI) of G for a maintenance technician and C for an instructor pilot. Army positions that require a dual SQI are rare.

All instructors perform duties as classroom instructors, instructor pilots, maintenance test pilots, and maintenance test flight maintenance evaluators. Most of the instructors have had unit– and intermediate–level maintenance experience before becoming instructor pilots. All of the noncommissioned officers have extensive maintenance experience and are both technical inspectors and classroom instructors. Contracting, research and development, and safety officer experience are also represented.

Each instructor is the primary instructor for at least one subject and is a backup for a least one other subject of classroom instruction. Each MTPC track has an aircraft technical inspector (a sergeant first class). The duties include supervising the installation and removal of aircraft training gigs (fault conditions) and conducting classroom instruction for aircraft maintenance procedures and inspection.

The course curriculum and procedures have changed to increase efficiency. The commander's open time has been all but eliminated. Each block of classroom instruction has been reviewed and nonessential material removed. Redundant instruction (subject matter taught during the core portion of the aviation maintenance course) has been removed. Superior students are accelerated through the flight portion of training.

Strict and sequential training schedules have been eliminated. If weather conditions are unfavorable, aircraft are unavailable, or 50 percent of the students cannot be flown, the flight period is canceled and classroom instruction begins immediately. This is possible because the classrooms and flight line are collocated. Written tests are administered after all classes are conducted for a particular block of instruction. Tests may be administered two or three days ahead of the original schedule. Students are advised of this likelihood on the first day of class. Therefore, students must not fall behind in their studies. The objective is for students to complete the classroom work as soon as possible to counter the possibility of lost flight periods. The goal is for students to receive as much training and instruction as possible during the training days.

The UH–1, AH–1, and UH–60 tracks each have a class B aircraft training aid. The OH–58D has a cockpit procedures trainer. These trainers have proven to be invaluable as reinforcements to classroom and flight instruction. Students also use the aircraft trainers after–hours to practice cockpit drills and flight procedures or as study guides. In the case of the Cobra, while one student is flying, his "stick buddy" may be undergoing additional instruction—for example, running through cockpit drills or using the device to reinforce learning.

The average student spends 4 hours in the classroom and 4–plus hours undergoing intensive instruction on the aircraft. The average total aircraft operating time per student is 32 hours, 11 of which are flight time. Examples of the classroom curriculum are 12 hours of engine and fuel systems, 12 hours of electrical, and 8 hours of rotor systems. Flight–line gigs include electrical, hydraulic, rigging, and instrument malfunctions for which students must identify, analyze, and prescribe corrective action. Students must correctly perform all cockpit, run–up, and in–flight checks and procedures without reference to any material other than the test flight sheet. To accomplish all that is required, the typical student must study an additional 3 to 4 hours per day.

The Maintenance Management/ Maintenance Test Pilot Course began a new chapter in its history on 13 May 1994 when MTPC began its first class at Fort Rucker, Ala. The course was moved to consolidate all aviator training and to maximize economies of scale during Army right–sizing initiatives.

The MTPC remains one of the most demanding aviation courses of instruction in the Army. Course graduates experience a sense of accomplishment for overcoming a difficult challenge. Field commanders know that course graduates can excel and see them as critical elements in aircraft mission readiness.

U.S. Army Aviation Logistics School

Readers may address matters about aviation logistics to—
Assistant Commandant
U.S. Army Aviation Logistics School
ATTN: ATSQ–LAC
Fort Eustis, VA 23604–5415.

USAASA Sez

Global Positioning System (GPS) Update

Mr. Walter W. Perron
Acting Chief, Aeronautical Information Division
U.S. Army Aeronautical Services Agency
Fort Belvoir, Virginia

The Federal Aviation Administration (FAA) is developing the Wide Area Augmentation System (WAAS) for Category I precision approaches and a Local Area Differential Global Positioning System (LADGPS) for Category II/III precision approaches. The current WAAS concept is for the installation of about 20 to 30 ground stations that transmit information to two Ground Monitoring and Control Stations. These process the information and transmit the corrected information to one or more geostationary satellites. The current FAA plan is for geostationary satellites to transmit the corrections to transiting aircraft on an L1 transponder.

If the Department of Defense (DOD) uses the FAA system as the cornerstone of its worldwide augmentation system, DOD will have to identify its requirements to the FAA soon so that the specifications can be included. DOD combat aircraft are required to use P–Code, and differential corrections for DOD aircraft will be encrypted. The military receivers will not be able to use Standard Positioning Service (SPS) corrections provided by the FAA because military GPS receivers do not contain the necessary SPS lonospheric algorithms to accomplish the differential corrections.

The L1 frequency broadcast from geostationary satellites allows for the minimum number of ground stations and avionics types. It has the minimum impact on receiver designs and frequency spectrum requirements; can be implemented with different geostationary satellites; and maintains complete separation between surveillance and navigation. The WAAS navigation message, although on the L1 channel, will not be usable by existing receivers because of a higher data rate (500 symbols per second, 250 information bits per second) than current receiver designs can handle.

WAAS Minimum Operational Performance Standards (MOPS) are being developed by RTCA, Inc. (formally the Radio Technical Commission for Aeronautics), and will include many of the requirements from RTCA document 208 and Technical Standard Order C–129. The MOPS should be published by the end of this year, with WAAS initial service proposed for 1998.

The FAA is also looking at LADGPS, which will augment WAAS in high mountain valleys and will replace the Microwave Landing System for Category II/III approaches. The final configuration of LADGPS has not been determined.

Differential GPS works by canceling out most of the natural and man–made errors that creep into normal GPS measurements. The inaccuracies in GPS signals come from a variety of sources, such as satellite clocks (timing is critical to GPS accuracy—GPS satellites are equipped with very accurate atomic clocks); imperfect orbits; and especially from the signal's trip through space. Satellites transmit their timing information by radio, and that is another source of error because the signals do not act as we would like them to.

When the GPS signals arrive at the surface of the earth, they may reflect off local obstructions or other surfaces before reaching the antenna. This effect is called *multipath error* because the signal is getting to the antenna via multiple paths. GPS receivers also induce errors, which are usually caused by their internal clocks or by internal noise. Because these errors are variable and hard to predict, an additional receiver is needed on the ground to detect errors and to provide a correction factor for each satellite. The precise location of this stationary receiver is determined by survey, and that data is entered in the stationary receiver. The receiver calculates the difference between the data received from the satellites and the data determined by actual ground survey The two receivers must work simultaneously to do the job. The "reference" receiver stays put and continuously monitors the errors and transmits those errors so that the aircraft receiver can apply those corrections.

U.S. Army Aeronautical Services Agency

USAASA may be contacted at DSN 656–4871 or commercial 703–806–4871; or write to—
Commander
U.S. Army Aeronautical Services Agency
ATTN: MOAS–AI (Bldg 1466)
9325 Gunston Road, Suite N319
Fort Belvoir, VA 22060–5582.

Enlisted Training Program at the Eastern Army National Guard Aviation Training Site

CSM Jeff Culp
Command Sergeant Major
Eastern Army National Guard Site
Fort Indiantown Gap, Pennsylvania

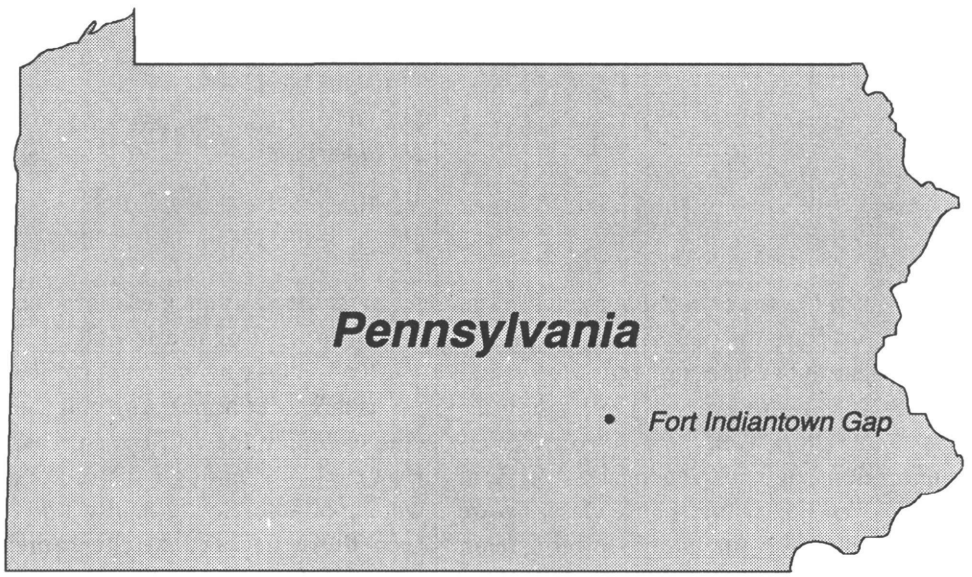
On 1 October 1993, the Eastern Army National Guard (ARNG) Aviation Training Site (AATS), Fort Indiantown Gap, Pa., initiated an expanded enlisted training program for Reserve Component soldiers in career management fields (CMFs) 67 (Aircraft Maintenance) and 93 (Aviation Operations). More than 550 enlisted soldiers received training in 14 courses. The courses, based on Reserve Component Configured Courseware (RC^3), included military occupational specialty (MOS) qualification, MOS transition, and Phase II of the Basic Noncommissioned Officer (NCO) Course (BNCOC) and the Advanced NCO Course (ANCOC). Flight engineer courses were also conducted in the CH–47D Chinook helicopter and C–23 Sherpa cargo airplane.

The Eastern AATS was no stranger to enlisted training having taught the 67V (Observation/Scout Helicopter Repairer), OH–6 Cayuse/OH–58 Kiowa MOS transition course, for three years. More than 300 soldiers completed this course, which significantly helped raise the 67V MOS qualification in the Army National Guard.

When the Eastern AATS flight training program made the transition to modernized aircraft systems training, the need was identified for concurrent enlisted training in the same systems. MOS transition courses were developed for the 67N (UH–1 Helicopter Repairer), 67T (UH–60 Repairer), and 67U (CH–47 Helicopter Repairer) MOSs to support the requirement in the field for UH–1H Iroquois "Huey," UH–60 Black Hawk, and CH–47D aircraft repairer training. The prerequisites for the transition courses limited students to those soldiers who were currently qualified in a CMF 67–series MOS and a sergeant or above or a specialist who held the MOS for at least 24 months. The transition courses, each four weeks in length, were based on the RC^3 MOS qualification courses minus the enabling skills that each soldier meeting the prerequisites would have. All programs of instruction were forwarded to the U.S. Army Aviation Logistics School for approval before the courses began. MOS transition courses preclude sending a soldier back to advanced individual training (AIT) to gain a new MOS, build on existing aviation maintenance and experience available in the units, and significantly reduce the training costs associated with awarding an MOS. All tasks are trained to Army standards in these courses.

In Training Year (TY) 1994, the only MOS qualification course conducted at the Eastern AATS is the 67N, UH–1H repairer. This course takes six weeks to complete and includes all of the tasks necessary for a Reserve Component soldier to become a UH–1 mechanic at skill level 1.

Phase II of the RC^3 BNCOC was conducted in 67N, 67T, 67U, 93B (Aeroscout Observer), and 93P (Aviation Operations Specialist) MOSs. Students were required to complete Phase I, Common Leader Training—at a Regional NCO Academy or State Military Academy—before reporting for Phase II. The Basic NCO Courses conducted



at the Eastern AATS continue the leadership training begun in Phase I and are conducted in an "academy atmosphere," using RC[3] materials approved by the United States Army Training and Doctrine Command (TRADOC). Phase IIA, BNCOC–CAM (Common Aviation Management) is consolidated for the 67N, 67T, and 67U soldiers who then track out by MOS to the Phase IIB portion of the course. MOS 93B and 93P soldiers also complete Phase I before attending Phase II to complete their Basic NCO Course.

The MOS 67–40 Advanced NCO Course, Phase II, was also conducted at the Eastern AATS. Soldiers in most CMF 67–series MOSs could attend this course to complete their Noncommissioned Officer Education System (NCOES) requirements for promotion to sergeant first class or platoon sergeant. As with the basic course, leadership skills continued to be sharpened in the Advanced NCO Course. Phase II of the 93P Advanced NCO Course completed the ANCOC offerings in TY94.

The Basic and Advanced NCO Courses, stepping–stones in the NCOES ladder, were taught seven days a week to shorten the time soldiers were away from their unit of assignment and to reduce the training dollars associated with each course.

In April 1993, the Eastern AATS was fully accredited as a Reserve Component Training Institution (RCTI) by TRADOC. All Eastern AATS enlisted instructors have completed the Instructor Trainer Course (ITC) while instructors who interact with NCOES students also have completed the Small Group Leader Course. A chief of Enlisted Training and 14 ARNG AGR soldiers make up the core of enlisted trainers. These individuals are supplemented with additional part–time instructors as required to fulfill the training requirements placed on the Eastern AATS by the units. All Eastern AATS courses are scheduled by the Army training requirements and resource system (ATRRS).

The Eastern AATS enlisted training mission will expand further in TY95 with the addition of many 68–series Basic and Advanced NCO Courses as well as increased quotas in the 67N, 67T, 67U, 93P and 93B MOSs.

The 67T MOS Transition Course has been identified to increase from 40 planned quotas to more than 200 in TY95 because of the modernization of the ARNG utility fleet from UH–1s to UH–60s. ATRRS projections for the Eastern AATS place the enlisted training work load at more than 1,200 training–seat requirements in TY 95. The Eastern ARNG Aviation Training Site stands ready, as an accredited Reserve Component Training Institution, to meet the challenge and provide quality training to Army standards to the enlisted aviation soldiers of the Reserve Component.

Reserve Component Configured Courseware (RC³):
Aviation Life Support Equipment Technician (ALSET) Course Continues

U.S. Army Reserve Command shoulder patch.

Mr. Danny L. Rode Sr.
Program Analyst
Aviation Office
U.S. Army Reserve Command
Atlanta, Georgia

Some of you may remember an article in the December 1988 issue of the ***Aviation Digest***—1–88–12, pages 20 through 22—about the Joint Continental U.S. Army Aviation Life Support Equipment (ALSE) Course being conducted at Fort McCoy, Wisc. Since the writing of that article, several stumbling blocks have fallen in our path, but we stepped over them, conquered new challenges, and met new milestones. It has not been a clean battle. Some disappointing events occurred, and the course sat stagnant for a number of years. I am proud to now say that, with the assistance of many dedicated people, the course is once again open to the Reserve Component (RC) under the guidance of the United States Army Reserve Command (USARC), Atlanta, Ga.

A brief history will bring you up to the present course situation. The course was conceived as a Joint Continental U.S. Army ALSE course back in 1985. In December 1986, we conducted our first RC course. Since then, we have conducted seven courses at that location, graduating more than 200 RC soldiers, both U.S. Army Reserve and Army National Guard. Graduation results in award of the additional skill identifier (ASI) H2 for commissioned and warrant officers and Q2 for enlisted personnel. The last time the course was taught under the auspices of the Continental U.S. Army was in 1989, using instructors from the U.S. Army Aviation Logistics School (USAALS) at Fort Eustis, Va. Those classes were taught via the mobile training team (MTT) concept. Last, in 1990, the United States Army Training and Doctrine Command (TRADOC) conducted one three–week RC course at Fort Eustis for us.

In 1991, upon inactivation of the Fourth United States Army, I was reassigned to the newly formed USARC, at Fort McPherson, Ga., as a Program Analyst. At my new assignment, I continued to pursue reopening the course. In late 1991, during a desk–side briefing on the USARC Aviation Office with MG Roger Sandler, who was dual–hatted as both the Commanding General of USARC and the Chief, Army Reserve, the subject of the ALSE course came up. MG Sandler had attended our Cold Weather Survival Course in Ely, Minn., and as a Fourth U.S. Army alumni, was aware of the ALSE course at Fort McCoy. He asked the current status of the course. I told him that it was stagnant. His direction was straightforward and music to my ears: "Reopen it." Thus, in 1991, the Joint Continental U.S. Army ALSE course was back in business, under control of the USARC.

The first tasking was to convince USAALS to continue to teach the course under the MTT auspices. However, not enough instructors were available. Seems as if we had been there before. At the same time, USAALS was putting together a Reserve Component Configured Courseware (RC³) Aviation Life Support Equipment Technician (ALSET) Course, consisting of 86 hours of inactive–duty training and 92 hours of active–duty training. The formal TRADOC RC³ course packet was presented to the field in 1992. While this concept, for the RC soldier, was easier than the six–week resident course at Fort Eustis, it still did not meet the basic need: a two–week, ASI–producing ALSET Course. The two–week gate is to allow the RC soldier to attend in an annual–training status, which, in turn, allows the commander to get personnel trained without spending six weeks away from the unit. Completion of the TRADOC RC³ course takes about nine hours of dedicated ALSE time during each drill period for nine months. After that, an additional two–week period of additional duty training is needed to finish. Can you think of a soldier, or his or her commander, who can afford nine months of drills for

nothing but ALSE training? I didn't think so. A visit to Fort Eustis was in order.

In February 1993, I visited USAALS at Fort Eustis. My mission was to obtain approval to conduct a two–week, in–the–door/out–the–door, ASI–producing RC^3 course. After many meetings, tons of correspondence, and a whopping telephone bill, permission was granted to USARC to run the course.

Even with that approval, our goal of a two–week course remained enormous because the USARC was still building up and time and personnel were at a premium. As a Program Analyst, I could not spend the time needed to do the course justice. My first mission was to get an assistant—MSG C.J. Chaplin, from our USARC Aviation Resource Management Survey Team. He took a very active and dedicated interest in the ALSE course. Without his unflagging efforts to obtain the RC^3 course packet from USAALS and to mold it into a two–week program of instruction (POI), this course would have not happened as soon as it did.

Our next tasking was to get instructors. We contacted Mr. Frank Heyl, a world–renowned survival expert and then an instructor at the now–defunct Sixth U.S. Army Western Region Aviation Life Support Equipment and Survival School (AWRASS). (The AWRASS, again if you recall the December 1988 article on this course, was the nucleus of this concept.) Mr. Heyl, president of Universal Training Systems Incorporated, Lake Oswego, Ore., was interested in the continuation of this course. When we asked if he would be interested in teaching the course under contract, his answer was a very enthusiastic "yes!" Mr. Heyl selected several top–notch instructors to help us conduct the course: Mr. Wayne Engle, an Adjunct Professor at the University of Alaska (Anchorage); Mr. Jim Angelos, newly retired from the U.S. Army as a sergeant major, who was the ALSE Project Manager at Aviation and Troop Command, St. Louis, Mo.; Ms. Judy King, a troop program unit (TPU) soldier from the Aviation Support Facility, Orlando, Fla.; and Ms. Betsy Rutkofske, also a TPU soldier, from the Aviation Support Facility, Selfridge, Mich.

U.S. Army Reserve Command crest.

All instructors are either TPU soldiers or retired Army individuals and are top–notch ALSE experts. Their ALSE expertise, dedication, and experience have resulted in our USARC–sponsored RC^3 course at Fort McCoy still being "the place" for the RC soldier to get ALSE training. We continue to have aviation experts present briefings at our course and provide updated information on equipment. Mr. Jimmy Dittmer, from the ALSE Project Manager's Office at the Aviation and Troop Command, and Mr. Jerry Johnson, from the Gentex Corporation of Carbondale, Pa., are just a few of the experts we have available to us and have used to assist us in conducting this course.

After ordering the RC^3 course package from Fort Eustis, we met with Mr. Heyl and reviewed the package to see how it could be taught in a two–week time frame. We still faced a daunting task. After obtaining waivers from USAALS to reduce the RC^3 by reducing the time spent on classroom instruction on equipment that is not used in the RC, we finally had a complete 14–day course on our hands. The trade–off for reducing this course to two weeks does have a side effect on the soldier; he or she must put in some very long hours and days to absorb the complete course in a very short time. We continue to have 10–hour days and weekend instruction on occasion, but the underlying result is still a 14–day course, awarding certification for the ALSE ASI.

In May 1994, historical headway was made; we conducted our first truly formal, two–week USARC–sponsored RC^3 ALSET Course at Fort McCoy and graduated 24 soldiers. We taught our second course in August 1994 and graduated 21 soldiers.

The course map and course POI continue to be a challenge for us, but we are still keeping our heads above water. We have four more courses planned for 1995. With the dedication of the people named above, we continue to make the USARC–sponsored RC^3 ALSET Course at Fort McCoy a truly professional course. This course relieves some of the burden from the instructors at the USAALS six–week course and provides an alternative to the unit commander in getting his troops ALSE qualified.

As a joint venture among instructors from the private sector, dedicated experts in the ALSE arena, the USAALS schoolhouse, and the USARC, we again have proven that we, the RC, can and will meet the challenge and be prepared to train, fight, and survive on the modern battlefield.

For more information on this course, call the author at commercial 404–629–8675, or toll–free at 1–800–359–8483, extension 8675; or write to—

U.S. Army Reserve Command
ATTN: AFRC–AVO (Rode)
3800 Camp Creek Parkway SW
Atlanta, GA 30331–5099.

POWER SYSTEMS DIVISION
(continued from page 33)

The demonstration efforts that were conducted under both STAGG and ATDE provided the technological base from which the two competing engine designs for the T800 emerged. The team of Allison and Garrett (now Allied Signal Engines) ultimately won the competition for the T800 engine, which will power the RAH–66 Comanche scout/attack helicopter.

Large Turboshaft Engine Technology

The 1,500 SHP Demonstrator Engine and the STAGG and ATDE were successfully completed and transitioned. AATD then recognized the need to improve the capability of engines in the 4,000 to 6,000 SHP class. This size class of engines is used primarily for cargo helicopters and fixed–wing turboprop applications. Engines such as the T56, T55, and T64 were the workhorses of this class. These engines were based on designs using early 1960's technology. Thus their fuel economy and power–to–weight ratio were poor compared to what AATD engineers knew could be accomplished with state–of–the–art materials and aerodynamics.

A joint program was carried out with the Naval Air Propulsion Center located in Trenton, N.J. In this effort AATD initiated a full–engine demonstration program known as the Modern Technology Demonstrator Engine (MTDE). Contracts were awarded to General Electric Company and Pratt and Whitney in 1983. During this time period, it was evident several aircraft could benefit directly from the MTDE program. These included the U.S. Army's CH–47 cargo helicopter, the Air Force's C–130 turboprop transport, and the Navy's P–3 and E2–C turboprop antisubmarine and radar aircraft. The Army and Navy also were developing plans for a new hybrid type of aircraft known as the Joint Vertical Lift Experimental or JVX. The Army eventually withdrew from the effort and the Navy continued development into what is now known as the V–22 Osprey. The MTDE requirements were structured to demonstrate all of the necessary features to allow easy transition of the technology into any of the candidate aircraft. This required that the engines be capable of shipboard operation, tilt from horizontal through 110 degees nose up, have a power turbine that could operate at 15,000 RPM for turboprop applications and 12,500 RPM for helicopter and V–22 applications. The maintenance procedures and vulnerability aspects of each application also were considered. Again, full–scale engine mock–ups were extensively used to ensure these requirements were met. The results of the test and demonstration program yielded an engine design with fuel consumption, power–to–weight, maintainability, and durability characteristics far exceeding any other turbine engine developed during the 1980s (figures 8 and 9).

Future Advanced Turboshaft Engines

The three military services, the National Aeronautics and Space Administration, the Advanced Research Project Agency, and the U.S. gas turbine engine industry currently are conducting a three-phase program to double the performance of the gas turbine engine soon after the turn of the century. This program is known as the Integrated High Performance Turbine Engine Technology (IHPTET) initiative. As a specific effort under IHPTET, the Army, Navy, and Air Force are sponsoring the Joint Turbine Advanced Gas Generator (JTAGG) program.

The ultimate goals of JTAGG are to demonstrate a 40–percent reduction in SFC and a 120–percent increase in SHP/Wt relative to current modern production turboshaft engines. This will be accomplished in three steps.The first step, known as JTAGG I, is currently underway and has as its goals a 20–percent reduction in SFC and a 40–percent increase in SHP/Wt. These goals are to be demonstrated with durability equal to that being designed into current development engines such as the T800–LHTEC–801. JTAGG I is concentrating on engines in the 1,500 to 4,500 SHP class.

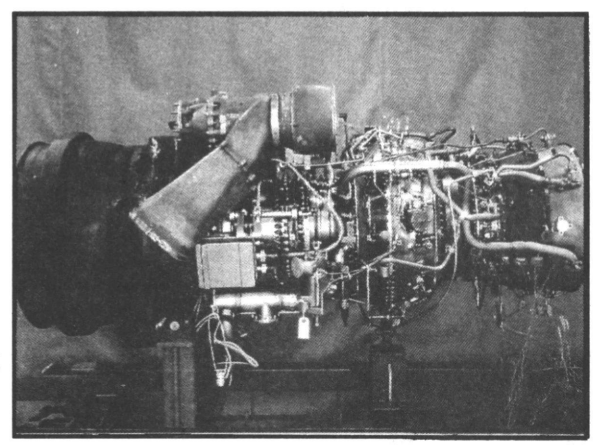


Figure 8. GE MTDE

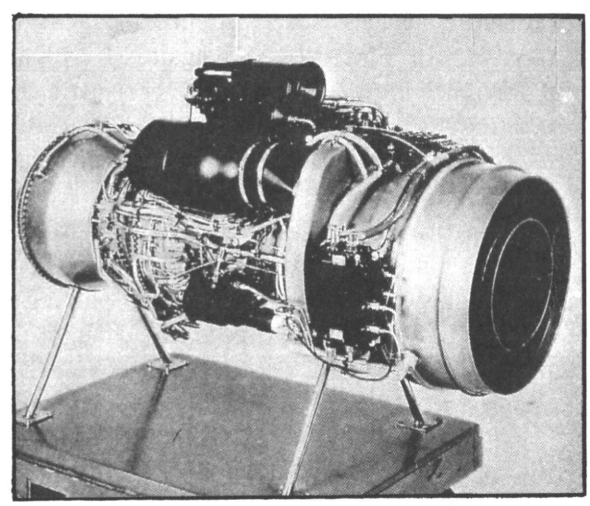


Figure 9. Pratt & Whitney MTDE

Two concurrent tri–service contractual efforts are presently underway to demonstrate the JTAGG I goals. One program is being conducted by Textron Lycoming and another by the team of General Electric and Allied Signal Propulsion engines (figures 10 and 11). Results to date indicate that the JTAGG I goals are readily achievable.

Several key technological features make this possible. The use of three–dimensional computational aerodynamic and mechanical design techniques have allowed the optimization of designs for minimum weight and high efficiency. High–temperature materials; advanced, single–crystal fabrication methods, and high–cooling effectiveness configurations have provided higher cycle temperatures while reducing the amount of cooling air needed. Together, these and other techniques allow the JTAGG engines to be smaller, lighter, and more fuel efficient than the current generation of turboshaft engines.

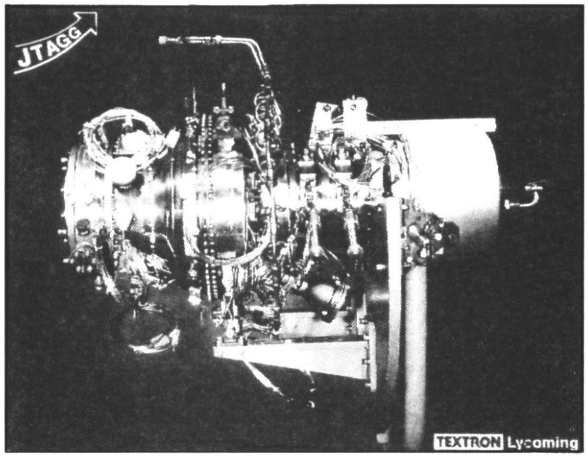


Figure 10. Lycoming JTAGG

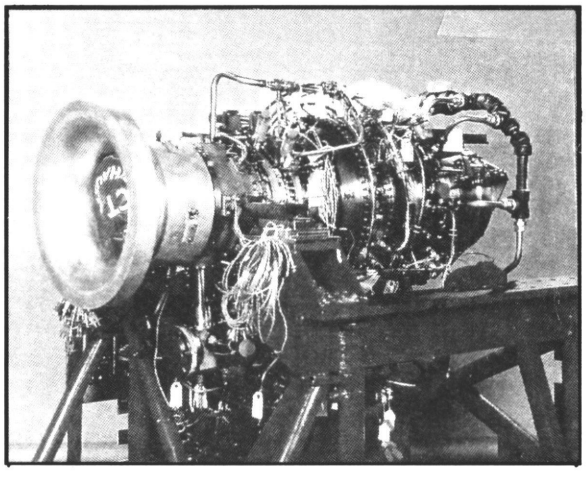


Figure 11. GE JTAGG

Benefits To Current Fleet Aircraft

The T53 provided the UH–1H with a major payload/range improvement versus the R–1820 powered H–34A; the T700 provided the UH–60 with the same benefits relative to the UH–1. Just so can JTAGG I technology engines greatly improve either the payload or range capability of the UH–60L, AH–64A, and CH–47D (figure 12).

An increase in range can be provided as a result of two effects. First, the increase in SHP/Wt results in reduced engine weight, which potentially allows more fuel to be carried at a constant take off gross weight (TOGW). Second, the reduced fuel burn rate due to lower SFC converts directly into an increased specific range (nm/pound (lb) of fuel).

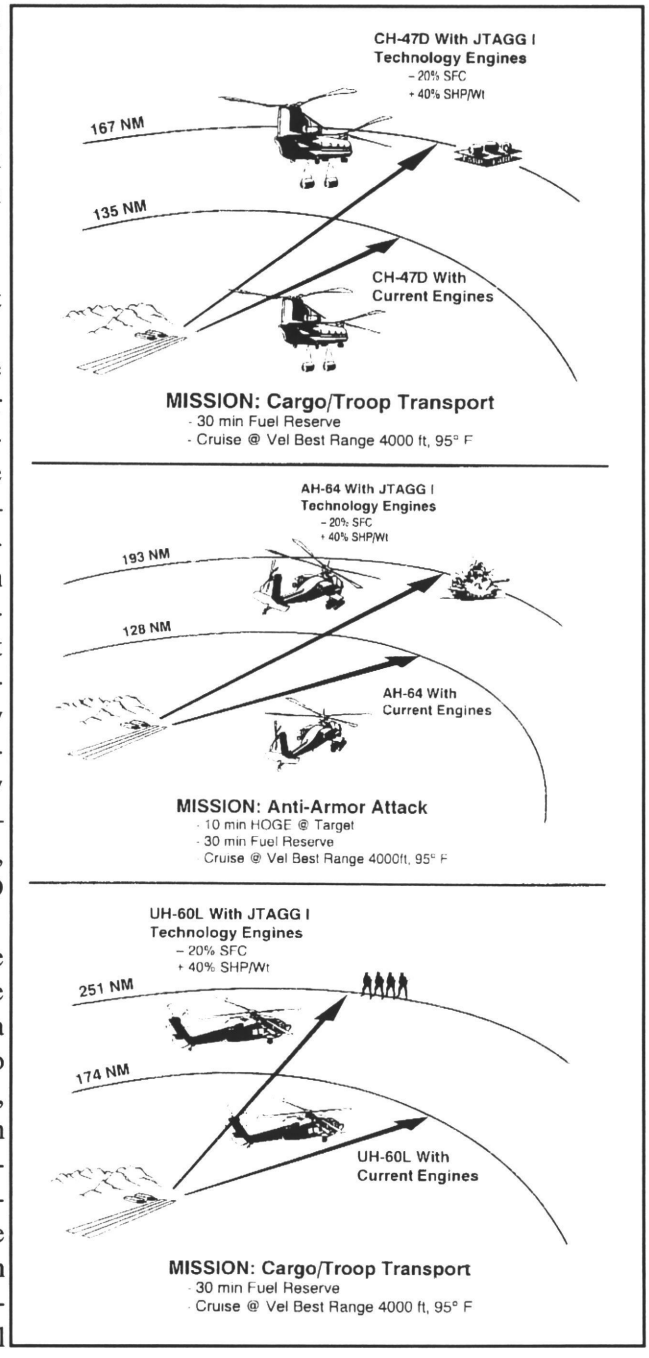


Figure 12. Range Improvements with JTAGG I Technology Engines

Conclusion

The technology demonstration efforts conducted by AATD have provided Army aviation with the most advanced powerplants in the world. And as history has shown, the helicopter has enjoyed a significant improvement in operational capability with the development of each new generation of powerplants. With the development of JTAGG I technology engines, another major increase in range or payload capability for the current fleet aircraft will result.

The search for a lightweight, powerful and reliable engine has continued since Igor Sikorsky's first flights of the VS-300A.

ENGINE: FRANKLIN – 4 cylinders, horizontally opposed, air cooled
WEIGHT: 250 lbs POWER: 100 H.P. (@ max)

H-34A CHOCTAW

ENGINE: SINGLE WRIGHT CYCLONE R-1820-84
9 Cylinder, Radial, Turbocharged