AVRADCOM ISSUE

Army Aviation

JAN.-FEB., 1980

Boeing Vertol CH-47D begins U.S. Army developmental testing.

ARMY AVIATION

ARMY AVIATION
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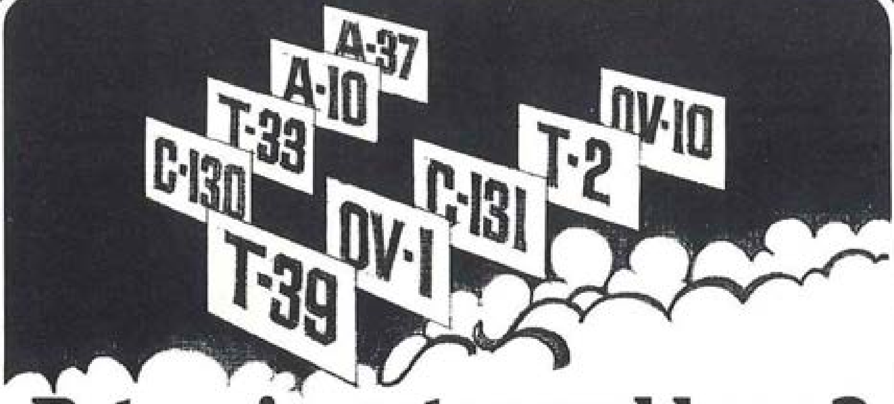
AVRADCOM SPECIAL ISSUE

(AVRADCOM SPECIAL ISSUE — Continued on Page 92)



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Bell's XV-15 goes full tilt.

On July 24, 1979, the NASA/Army XV-15 TiltRotor aircraft passed a major milestone — its first in-flight conversion to airplane mode.

Bell's TiltRotor offers *twice* the speed and range of present-day helicopter systems on the *same* amount of fuel. Projected cruise speeds of over 300 knots open up new operational capabilities never before possible in tactical profiles . . . and it's self-deployable worldwide.

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Bell's TiltRotor: The best qualities of helicopter and airplane . . . combined in one aircraft, and it's ready for prototype development now.

Imagine what one could do for you.

Join AAAA in Atlanta!

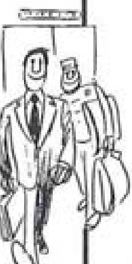
Be a part of its 22nd Nat'l Convention!

Thursday evening, 10 April, through Sunday noon, 13 April, at the convenient Sheraton Atlanta-Hotel

AN OUTSTANDING TWO-DAY PROFESSIONAL PROGRAM

The programming theme is "Army Aviation — A Report for the 80's" and the Presentations Chairman is General Robert M. Shoemaker, the FORSCOM CG.

★ ★ ★ ★ ★



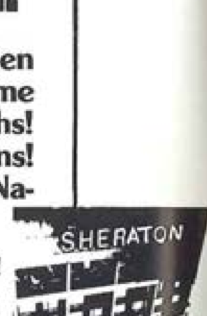
Hear about the Status of Forces—1980. The Army's Operational parameters (numbers/types of units, mix), relationship of Army Aviation effort to the total Army effort. Current and projected manning. Logistical implications for the Army of the 80's. TRADOC's Game Plan for the 80's/The ARCSA IV parameters/Division 86. Industry presentations and panel with representatives of five prime manufacturing firms. Status of the major aircraft systems in the 80's; systems' innovations and growth (UH-60A/SOTAS/Hellfire, AAH and Hi/Lo Mix, ASH, CH-47D). "The Army in the Field"— Reports from commanders on significant small unit aviation activities, tests, and contingency operations. Aviation Unit Presentations by invited representatives from USAREUR, USARAL, and EUSA. These and many other interesting subjects will be discussed by the AAAA professionals in attendance at Atlanta-1980.

AN '80 CONVENTION REGISTRATION FORM MAY BE FOUND ON PAGE 102.

An exciting social program!

Up to Nine Chapter Hospitality Suites! — Two Open Nights Downtown! — Army Aviation Hall of Fame Induction Luncheon — 53 Industry Display Booths! Early Birds', President's, and Diehards' Receptions! A Great Getaway Brunch! — The 22nd AAAA National Awards Banquet and Dinner-Dance!

JOIN YOUR FELLOW MEMBERS AT THIS ANNUAL GATHERING!



This is AAAA's second Nat'l Convention outside of Washington, D.C. in the last 20 years, and the second successive convention in the heart of the Rucker-Bragg-Benning-Campbell-Knox complex (We'll return to Washington in '81). Sit in on the professional sessions (They'll be outstanding!), visit the large Exhibit Hall, enjoy one-hour coffee breaks, and mingle, socialize, and be hosted by AAAA members as many as nine Chapter Hospitality Suites. There's an exceptionally low double room rate for military members! The Professional Programming ends in mid-afternoon on BOTH days so that you can meet and mix with many of your widespread friends at this Annual Army Aviation Reunion. Join us in Atlanta this April 10-13 at what promises to be another great AAAA national convention . . .

ARMY AVIATION ASSOCIATION
1 Crestwood Road, Westport, CT 06880 — (203) 226-8184

February 1, 1980

1980 NATIONAL CONVENTION

Planning for the Army Aviation Association's 1980 National Convention continues with preliminary details of the April 10-13 gathering in Atlanta appearing on pages 100-102 of this issue. The Sheraton-Atlanta Hotel is the AAAA's 1980 convention site, the second year in a row the AAAA has held its convention in the center of the Rucker-Bragg-Benning-Campbell-Knox complex. Details of the two day professional programming developed by **GEN Robert M. Shoemaker,** the FORSCOM Commander and 1980 Presentations Chairman, also appear on a following page.

INTERNATIONAL AFFAIRS

As your President, I recently directed a letter to the Secretary of the Army requesting D/A "support for participation by Army personnel and equipment in the **World Helicopter Championships** to take place in Poland in 1981." Together with other organizations (NAA, HCA, AHS, HAA, and the Whirly Girls), the AAAA will support the national efforts to field competitive U.S. entries in the 1981 rotary wing flyoffs. **COL Robert R. Corey, Ret.,** serves as AAAA Program Coordinator.

FIFTH REGION—AAAA AWARDS

A highly successful Fifth Region—AAAA Awards Dinner was held December 5 at the Corpus Christi NAS Officers' Club. Regional President **MG Richard G. Thompson** presented the awards honoring the Region's CY 78 outstanding active Army unit and top individuals. Photos of the awards made at the function hosted by AAAA's Corpus Christi Texas Chapter will appear in next month's issue.

1980 AAAA NATIONAL SWEEPSTAKES

Join the **Sweepstakes** (Pages 94-96)! You have **eight chances** to win.

George S. Beatty Jr

GEORGE S. BEATTY, JR.
Major General, USA (Retired)
President, AAAA

RU-21H Guardrail

EH-1X Quick Fix II

EH-60 Blackhawk

101st's Black Hawk Comp

FOR the first time, a U.S. Army company, equipped with UH-60A **BLACK HAWK** helicopters, has been deployed to an Army operating location, taken part in a mock battle, and then been transported back to its home base.

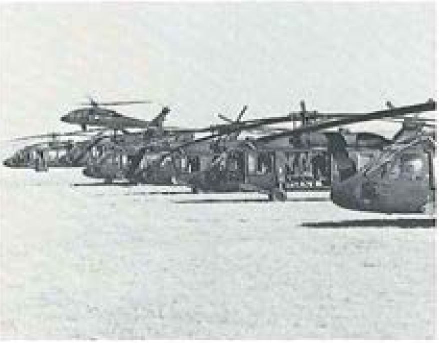
It happened recently as part of the Army's **Operation DRAGON TEAM XI.** D Company, 158th Avn Bn, 101st Abn Div (AASLT), loaded their 15 Sikorsky Aircraft **BLACK HAWK** helicopters aboard three giant USAF C-5 transports for airlifting to Ft. Hood, TX, where the unit participated in a simulated battle.

The loading, flight, and unloading took about 18 hours, just as planned, and a few hours later D Company was ready to transport troops and equipment to the battle zone.

A normal sortie, carrying troops or equipment into the battle area, lasted less than a half hour. Each UH-60A returned for load after load, operating non-stop for three hours or more. Refueling in the field extended the amount of time each **BLACK HAWK** could remain in the battle zone. One **BLACK HAWK** flew more than 26 hours during a 34-hour period.

In the pick-up zone, a squad of 11 soldiers with full field packs, would scramble aboard the UH-60A while other **BLACK HAWKS** would carry equipment to the field troops, slung under the aircraft from cargo hooks

TOP LEFT: 14 BLACK HAWKS OF D CO, 158TH AVN BN, AWAIT LOADING ON C-5 TRANSPORTS AT FT. CAMPBELL, KY. TOP RIGHT: BLACK HAWK NO. 962 IS UNLOADED AT FT. HOOD. BOTTOM LEFT: 101ST ABN DIV CREWS PREPARE THE UH-60A'S AS THE C-5'S DEPART. BOTTOM RIGHT: MG JOHN N. BRANDENBURG, CG OF THE 101ST, CONFERS WITH HIS STAFF.



any engages in "combat"

capable of carrying up to four tons of cargo.

Troop movements were continuous. At dusk, after a brief respite for the aircrews near a field command post, a night assault was ordered and the pilots began their preparations. The next day the order was given to withdraw the troops, the simulated objectives having been reached.

The **BLACK HAWK** helicopters and their crews then repeated the previous day's activities . . . in reverse.

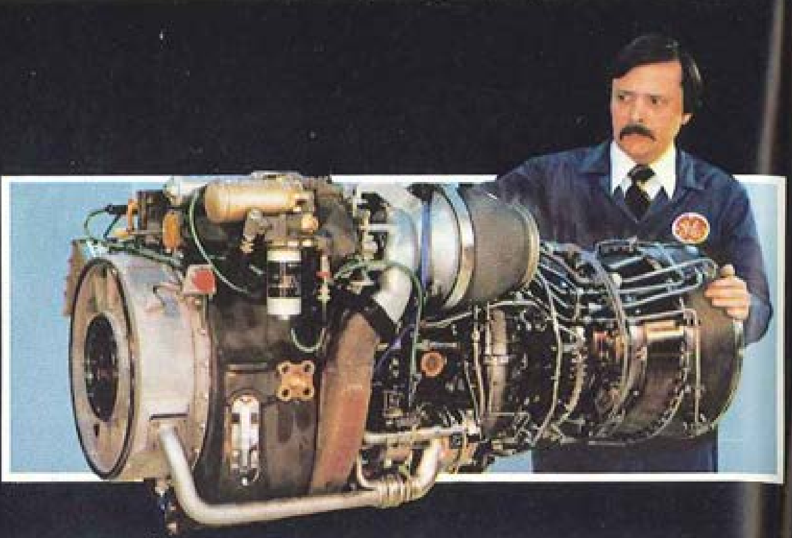
Commenting on the speed of the field airlift, **LTC William Golding**, 158th Avn Bn Commander, stated, "Obviously we're moving faster with the greater capacity of the aircraft." During the 27 hours of the actual field exercise, **BLACK HAWK** helicopters flew a total of 164.3 hours.

The success of the deployment of the 15 **BLACK HAWKS** and the first **Emergency Deployment Exercise** of the **BLACK HAWKS** assigned to the 101st, clearly demonstrated the purpose of the mock battle.

It gave the people who'll move the equipment and those who'll fly the **BLACK HAWK** the chance to learn how to do it right so they'll be ready if the real thing comes. There is little doubt after **DRAGON TEAM XI** that the "Screaming Eagles" of the 101st and their **BLACK HAWK** helicopters will be ready.

TOP LEFT: PREPARATIONS COMPLETED, THE UH-60'S TAKE TO THE SKY AT FT. HOOD. TOP RIGHT: D COMPANY PILOTS PREPARE TO TAKE-OFF. BOTTOM LEFT: A TRIO OF BLACK HAWKS ARRIVE IN THE "BATTLE ZONE." BOTTOM RIGHT: A FLIGHT OF BLACK HAWKS, WITH TROOPS ABOARD, PREPARES FOR TAKE-OFF FROM THE FT. HOOD "BATTLEFIELD."

AAH Power



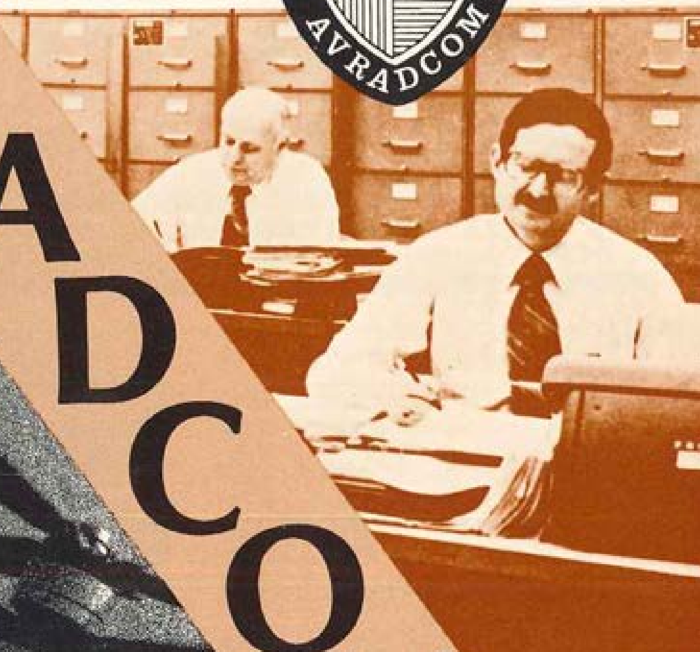
The T700: Thoroughly proven power for the rugged AAH mission

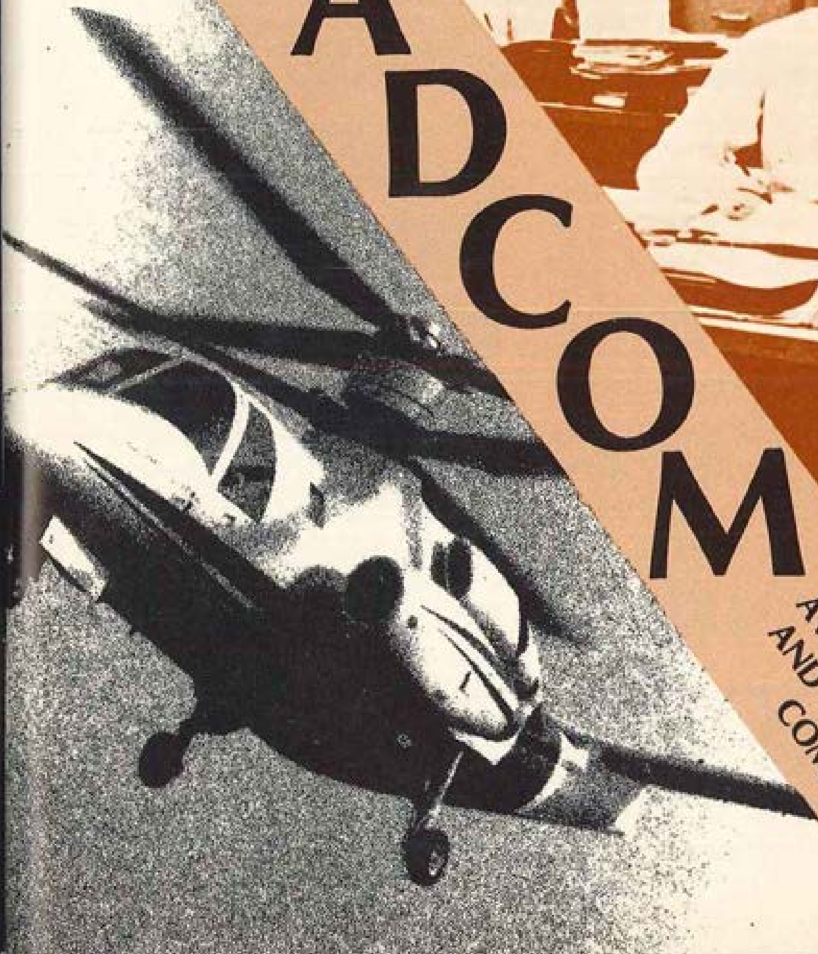
When the Army/Hughes AH-64 Advanced Attack Helicopter arrives on the modern, tank-heavy battlefield, its T700 engines will be equal to the challenge. Backed by exceptionally rigorous testing, plus years of experience powering the Army's Black Hawk, the T700 will provide the extra reliability, survivability and simplified maintenance needed for the AAH's demanding operating environment.

GENERAL ELECTRIC

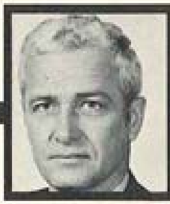
AVRADCOM

U.S. ARMY
AVRADCOM





U.S. ARMY
AVIATION RESEARCH
AND DEVELOPMENT
COMMAND



THE ARMY STAFF'S ROLE IN AVIATION MATERIEL DEVELOPMENT

BY BRIGADIER GENERAL RICHARD D. KENYON
DEPUTY DIRECTOR OF REQUIREMENTS, ODCSOPS, DA

ARMY Aviation has never been more integrated into the total Army mission than it is today.

Attack and scout helicopters are a major part of the cutting edge of anti-armor defense elements; the UH-1 Huey and the incoming UH-60A Black Hawk utility helicopters perform air assault, resupply, and command and control missions; and, the CH-47 helicopter provides necessary logistic support and displacement of troops, artillery, and other items in air lanes above the barricades on the roads and highways in wartime.

Observation helicopters and fixed wing aircraft, together with Special Electronic Mission Aircraft (SEMA) (OV-RV-1 and RC-12D), and helicopters (EH-1, EH-60A, and EH-60B) perform missions of electronic warfare, reconnaissance, and surveillance for the ground commander which are so vital to the decisions made in fighting the land battle. Helicopters comprise over 90% of the Army's fleet of aircraft.

ARCSA establishes usage

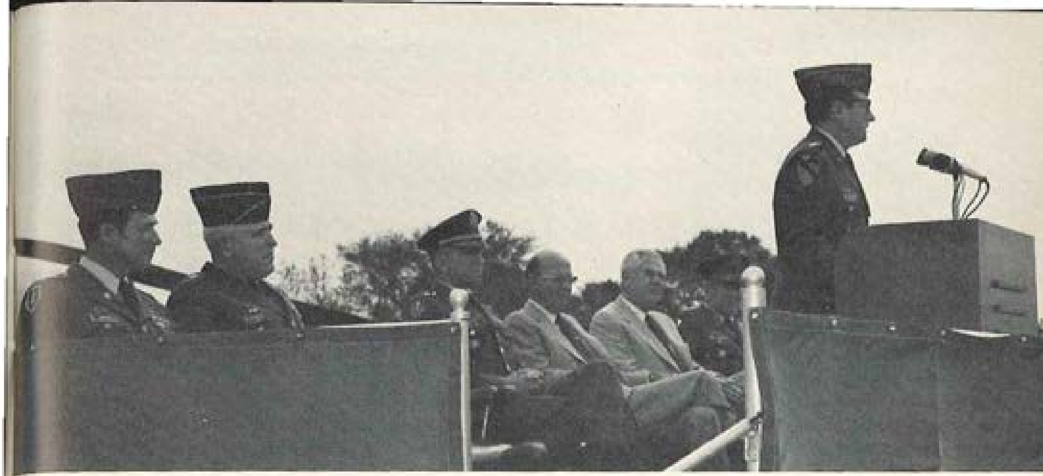
The Aviation Requirements for the Combat Structure of the Army (ARCSA) studies have provided the medium to decentralize and strengthen the organization of Army Aviation assets by placing control of aircraft at levels of command commensurate with the need for these assets. ARCSA is used in conjunction with ongoing force structure modifications to determine the composition of both active Army and Reserve Component units.

The development and procurement of aircraft systems are tied closely to the force structure because force structure, along with determinations of combat needs, creates the "requirement" for a new system or the modification of an existing system.

Continuous DA monitorship

The Army Staff must continuously co-ordinate materiel requirements to ensure that the equipment needed by the Army to accomplish its mission is up to date, cost effective, and accomplishes the required tasks. Equipment must be designed and developed for a task, or series of tasks, and integrated with other existing systems to avoid duplication. In Aviation materiel, different types and models of aircraft are procured to cover the broad spectrum of Army mission requirements. Some of these systems, such as the attack helicopter, are specialized, while others such as the UH-1 Huey, perform multiple roles. The key is to define the mission and to develop a system to perform it.

On the battlefield, Army Aviation performs the critical roles of finding and attacking the enemy, moving troops and supplies, evacu-



ACCEPTANCE—Shown at the mid-December CH-47D acceptance ceremonies at Ft. Rucker, AL, are, l-r seated, COL Terry L. Gordy, CH-47D PM; MG John J. Koehler, Jr., CG, USA TECOM; BG Carl H. McNair, Jr., DCG, USAAVNC; Otis H. Smith, President, Boeing Vertol Company; William P. Jones, Director, Mil Hcptr Prog, Boeing Vertol; and COL William E. Crouch, Jr., Cdr, USA Avn Devel Test Activ. LTG Robert J. Baer, Dep Cdr for Materiel Devel, USA DARCOM, is at shown standing at the lectern.

ating casualties, conducting command control, and supplementing communications.

The development, procurement, and fielding of aircraft systems to perform these functions is accomplished by TRADOC as the combat developer, DARCOM as the materiel developer, and HQDA as decision authority.

At HQDA, the combat developer is represented by the **Office of the Deputy Chief of Staff for Operations and Plans (OSCSOPS)**, and the materiel developer by the **Office of the Deputy Chief of Staff for Research and Development (ODCSRDA)**.

Gathering the "inputs"

Each year HQDA (ODCSRDA) tasks DARCOM to submit an aviation program covering all three principal appropriations, RDT&E, APA, and O&MA. This information is combined during a series of HQDA reviews to form a DA aviation program. To insure user visibility and inputs at all levels of this process, **ODCSOPS** gathers inputs from all the MACOMs and articulates this information to DARCOM. DARCOM constructs the aviation portion of their program in conjunction with all of the other commodities being developed by the Army.

The major components of the RDT&E program are: 6.4, engineering development; 6.3, advanced development; 6.2, exploratory development; and 6.1, basic and applied research. Recognizing the Army's concern for near term readiness, the highest priority in recent years has been placed on those project managed items which are considered essential to improve the effectiveness, survivability, and affordability of Army Aviation.

Programs such as the attack helicopter (AH-64), UH-60A, CH-47D Modernization, and Aircraft Survivability Equipment fall into this category. In addition, there is a strong user support for a family of focused aviation demonstration systems proposed by the Developer that will provide the Army with a solid advanced technology base for the 1980's.

The programs ahead

Such programs are a near millimeter wave all-weather target acquisition system; a pilot-enhancing digital aircraft flight control program; a fuel efficient advanced turbo shaft engine; a survivable, efficient all-composite structural aircraft; and a research simulator to aid in the improvement of NOE flying qualities.

More than any other commodity, Army Aviation has cohrent requirements in terms of a coordinated user and developer dialogue which is insured through joint formulation of programs and frequent DARCOM/TRADOC reviews.

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 EISENHOWER AVE., ALEXANDRIA, VA. 22333
OFFICE OF THE COMMANDING GENERAL

I am extremely proud to introduce this special issue dedicated to the US Army Aviation Research and Development Command (AVRADCOM). AVRADCOM, one of DARCOM's major subordinate commands, is the Army's leader in the research and development of aviation systems. Its team is comprised of many of the aviation community's leading scientists and engineers, widely recognized throughout the free world.

As you will note, AVRADCOM has a widely diversified mission accomplished by activities which are geographically dispersed from coast to coast. The mission not only spans the entire R&D cycle for systems, subsystems, and individual components, but also includes providing support to the colocated DARCOM Project Managers responsible for development of two of the Army's major aviation programs--BLACK HAWK and AAH. The Command also provides engineering support for fielded aircraft to the Troop Support and Aviation Materiel Readiness Command and maintains plant cognizance at three of the helicopter manufacturing plants which assist numerous DOD agencies.

Increased competition for dwindling dollar resources dictates that we use our ingenuity in conducting R&D programs not only to improve the operational effectiveness of our aviation systems but also to reduce the overall life cycle costs of those systems. AVRADCOM has accepted this challenge.

This issue will acquaint you with the research, development, and acquisition side of Army Aviation and the advances that are being spearheaded by AVRADCOM in order to enhance the effectiveness of Army Aviation as part of the total combined Arms Team.

JOHN R. GUTHRIE
General, USA
Commanding

AVRADCOM MEETS THE CHALLENGE!

BY LIEUTENANT GENERAL ROBERT J. BAER
DEPUTY CG FOR MATERIEL DEVELOPMENT (DARCOM)

THE military and economic environment in which the free world lives today challenges the DARCOM community to the fullest.

To elaborate (See **Figure 1** on the next page) we must prepare the total Army for rapid transition to combat and furnish it with a full capability to perform its wartime mission. A highly effective and responsive civilian and military support force is necessary. Materiel must be developed, procured, stored, issued, and fielded to maintain a balanced and sustaining combat capability.

Deployment capability sought

Improvement must be achieved in Army deployment capability to move forces readily and to increase early availability of combat power. Improvement is also needed in Army equipment and in concepts to exploit new technology. Lastly, we must manage and utilize existing and programmed resources more effectively within this framework of goals and strengthen the Army's resource justification process.

AVRADCOM's mission, in meeting this challenge, encompasses aviation research and development together with materiel readiness and materiel acquisition support. The R&D mission entails the development of affordable technology for aviation systems, increasing their reliability, availability, and maintainability while enhancing system's safety, survivability/operability, and improving aircraft weaponization and avionics integration.

Material readiness support is reflected in the accomplishment of initial procurement and the demonstration of equipment suitability while support for materiel acquisition is provided through the development of technical improvements for fielded systems and the accompanying reduction in cost of ownership.

Some perspective regarding the fiscal resources necessary to accomplish this mission is provided in a FY 80 RDT&E/Procurement dollar comparison between the total DARCOM and AVRADCOM budgets as depicted in **Figure 2** on the next page. The AVRADCOM staff responsible for management and implementation of these funds includes approximately 188 military and 1,920 civilian personnel.

Organized to meet the challenge

AVRADCOM and its predecessor Commands, AVCOM/AVSCOM, have a long and distinguished record in responsiveness to the needs of the Army Aviation community. Beginning in 1952 all logistical functions for Army Aviation were transferred from the Ordnance Corps to the Transportation Corps and a field service organization was located in St. Louis, MO.

In 1964, through a process of evolution, the

The Challenge

(Continued from Page 17)

U.S. Army **Aviation Command (AVCOM)** came into being, devoted fully to aviation, with a limited research and development capability. **1966** saw **AVCOM** become a major subordinate command of AMC with full responsibility for development, engineering, and procurement of Army aircraft.

In April 1974, the **Army Materiel Acquisition Review Committee (AMARC)** recommended that DARCOM evolve toward separating management of new weapons and major product improvement acquisition from the minor product improvement and logistics aspects of fielded systems. This recommendation culminated in the establishment of AVRADCOM in July 1977.

Since that time AVRADCOM has realigned some of its organizational elements, and with a new Technical Director and Advanced Systems Directorate, is making major strides in providing progressive planning for future technology trends, closing existing voids within current technology, and making visible inroads on the immensely difficult problem of integrating the overall aviation R&D program into a cohesive and viable entity.

Technology Accomplishment

Before delving into more recent technology accomplishments one must acknowledge the earlier **AVCOM/AVSCOM** track record which is also shared with previous Command elements now a part of **TSARCOM. Figure 3** outlines those aircraft engineered, tested, and fielded which continue to be a mainstay of the Army Aviation inventory. The quality of these aircraft and untold service provided to meet total Army requiremets act as a sounding board reverberating the AVRADCOM standard for excellence.

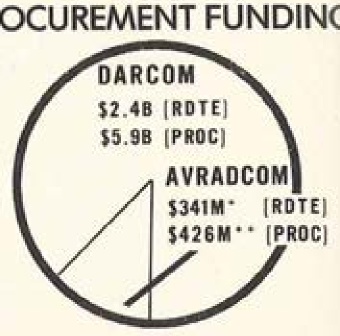
FIGURE 1

THE DARCOM CHALLENGE

- READINESS
- HUMAN
- MATERIAL
- STRATEGIC DEPLOYMENT
- FUTURE DEVELOPMENT
- MANAGEMENT

FIGURE 2

FY 80 RDTE/ PROCUREMENT FUNDING



*INCLUDES $176 MILLION FOR DARCOM AVIATION PROJECT MANAGED PROGRAMS

**INCLUDES $355 MILLION FOR DARCOM AVIATION PROJECT MANAGED PROGRAMS

The previous DARCOM/AVRADCOM budget comparison was a bit misleading in that there was no break out of the approximately $531 million DARCOM aviation project-managed programs. These programs cannot be forgotten because AVRADCOM is inextricably involved in their support. Although programs such as the **Black Hawk** and the Advanced Attack Helicopter are separately managed, AVRADCOM support is extensive in providing complete procurement for first production items and other contract support requirements.

Technical support is also furnished directly to the PM's for ongoing project evaluation/monitorship, studies, program design reviews and definition/incorporation of necessary avionics. Product assurance capability is used extensively by the PM's in monitoring key RAM requirements and Source Selection Evaluation Boards are staffed primarily from AVRADCOM HQ elements and field labortories. Flight qualification and evaluation testing are also accomplished through the AVRADCOM test activity at Edwards AFB.

Technology is transfused into these programs directly from ongoing AVRADCOM Laboratory efforts while aircraft survivability equipment, avionics, and navigation equipment developments are supported from AVRADCOM PM's and Research Activities. Because of this support, it can readily be seen that the development of new aircraft systems and subsystems has blossomed resulting in considerable technology progress.

This progress is typified by advances such as elastomeric rotors; increased aerodynamic efficiency and reduced noise signatures; control stick force augmentation and fluidic stability augmentation; as well as fire control and target acquisition subsystem gains. Other meaningful progress must include run dry gear boxes, crash survivable seats and fuel systems, advanced technology engine features, and utilization of composite materials in rotor blades and airframes. The list is endless in attempting to identify AVRADCOM's contributions to these programs.

Infusing new life

AVRADCOM's Project and Product Managers have also been responsive to total Army requirements. The CH-47 Modernization PM is infusing new life and advanced hardware into the Army's medium lift capability with the updated CH-47D aircraft, a program being brought in below cost and ahead of schedule.

The ASH PM, now in the throes of a rigorous concept evaluation process, is attempting to fulfill the Army requirement for a new Scout Helicopter while at the same time assuring maximum RSI compatibility.

The RPV Product Manager is embarking on an ED program to integrate significantly complex avionics technology into a lightweight airframe that will give the user pilotless surveillance and target acquisition/designation capability. The NAVCON PM is currently wrestling with the problems of providing self contained area navigation for fleet wide application as well as development of a new navigation system for special electronic mission aircraft.

Lastly, we have to consider the fundamental technology upon which new aircraft systems/subsystems are founded. These advanced development and technology base programs are primarily accomplished within AVRADCOM's laboratories and field research activities. Some of the more recent program accomplishments, in setting the stage for the development of new technology, include the initiation of an advanced digital/optic flight control system development and flight demonstration program and the start of an advanced composite aircraft program.

FIGURE 3

THE MAINSTAYS OF THE ARMY AVIATION INVENTORY

BOEING VERTOL CH-47 CHINOOK
BELL UH-1 IROQUOIS
BELL OH-58 KIOWA
SIKORSKY CH-54 TARHE
GRUMMAN OV-1 MOHAWK
HUGHES OH-6 CAYUSE
BELL AH-1S COBRA

Technology milestones

A cross section of ongoing program technology milestones achieved over the past year is outlined below:

- A first for current U.S. helicopter technology — XV-15 full conversion from helicopter mode to horizontal cruise (160 kts).
- Advancing Blade Concept (ABC) first flight with auxiliary power.
- Rotor Systems Research Aircraft (RSRA) first "all-up" flight.
- First run of 800 hp Advanced Technology Demonstrator Engine (ATDE) gas generator.
- Laser holograph potential demonstrated for aerodynamic flow field visualization.
- Bearingless main rotor flight tested.

The ABC, RSRA, and XV-15 (See photos on the next page) are technology demonstrator aircraft. Both the ABC and XV-15 embody new aircraft concepts which offer potential for improved mission performance capability in future aircraft system developments. The RSRA is a research tool that will permit inflight evaluation of new rotor system components, a capability heretofore nonexistent.

The ATDE development will close an existing gap in the aircraft engine horsepower spectrum and the laser holography flow field visualization concept will offer greater accuracy and measurements currently not possible with con-

The Challenge
(Continued from Page 19)

ventional instruments. The bearingless main rotor offers potential for an infinite life rotor system with obvious life cycle cost reduction impact. The accomplishment of all of these milestones translates into a better performing and more reliable product for the user at a price that is affordable.

Accrued Benefits

The length of this article precludes identification of all of the AVRADCOM technology achievements, but it must be noted that the RDTE program is specifically structured to address operational deficiencies. The technical program evolves around five disciplines: propulsion, aeromechanics, aviation electronics, armament systems, and structures.

Each discipline is broken into technology areas oriented toward satisfying operational deficiencies in the order based upon user priorities. One of the chief goals of this entire effort is to make the user's job easier. All of the equipment supporting the Army's airmobile concept had its origin somewhere in the R&D life cycle and a significant amount can be traced to early developments nurtured by AVRADCOM.

Moving to optimum support

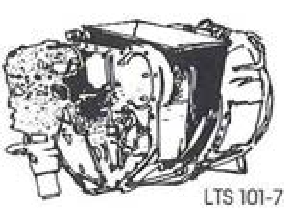
The previous technology program description made no mention of the planning necessary to close technology gaps, explore new technical trends, or structure programs such that future battlefield threats are nullified. The advent of a new Army Aviation RDTE plan (first published in October 1978) makes it plain for the world to see that AVRADCOM is coming to grips with these problems and is orienting its entire R&D effort toward optimum support of the total Army requirement in both the near and far term.

The ongoing close coordination/updating of this plan annually with other Commands, services, industry, and the operational community can only result in success for all concerned. It is this type of continuous and far thinking effort which will help DARCOM meet its challenges.

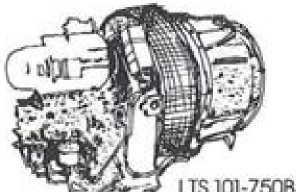
The Advancing Blade Concept (ABC) Research Aircraft

The XV-15 Tilt Wing Technology Demonstrator Aircraft

The Rotor Systems Research Aircraft (RSRA) in flight



LTS 101-750C



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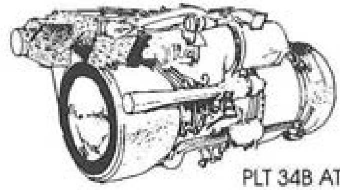

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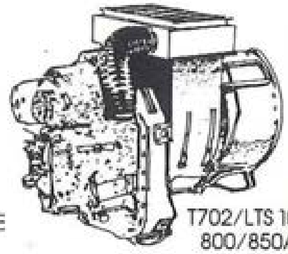

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R&D: THE SOLUTION TO TOMORROW'S THREAT

BY MAJOR GENERAL STORY C. STEVENS, COMMANDER, USA AVIATION RESEARCH & DEVELOPMENT COMMAND

GENERAL Baer's article noted some of the past achievements of the U.S. Army Aviation Research and Development Command (AVRADCOM).

The progress that AVRADCOM has been able to make over the past several years is the direct result of collective efforts on the part of many people within the developer and user communities.

The user provides the impetus

The impetus for AVRADCOM's efforts has always been provided by the TRADOC user who, in turn, is motivated by the ever-changing threat. Over the next twenty years the environment of the battlefield will present a foe who is increasingly efficient in detecting and destroying personnel and equipment.

The adversary of the future will be employing new technology weapon systems to gain and maintain the tactical advantage on the battlefield. These new systems will employ acoustical and infrared devices to detect and identify targets under the complete spectrum of climatological conditions. Once detected, these targets will be designated, tracked, and destroyed by a variety of newer and more efficient methods. These methods will incorporate traditional hardware such as rockets, artillery, and ballistic weapons.

However, the discriminator for these more traditional annihilators is that they will be radar and laser controlled, thus providing greater accuracy and efficiency at higher rates of expenditure. More exotic techniques for disabling electronics may include the use of **Electro-Magnetic Pulse (EMP)**. All of these types of hardware will most likely be available and utilized by the threat forces over the next 15 to 20 years.

The requirement to field selected items of aviation-related materiel is directly tied to the threat. The research and development activity of AVRADCOM must, therefore, be pursued with an awareness and understanding of the threat and its capabilities, both now and in the foreseeable future.

Threat assessments

Currently, threat assessment is projected 15 to 20 years into the future. While the threat scenario is projected to consider a multitude of regional possibilties, the most threatening is considered to be that of the Central European region opposing the Warsaw Pact countries. The threat in Europe will have the NATO countries facing a numerically superior force both in equipment and personnel.

Since Army Aviation will play an active and important role in this scenario, the development of aviation systems must be pursued with emphasis on increased efficiency at lower cost.

R&D: The Solution

(Continued from Page 23)

We must lead in the development and fielding of new technology systems to provide our forces the multiplex needed to stand a chance against a numerically superior foe.

The price of pursuing advanced technology and maintaining a creditable technological base is not inexpensive. The judicious management of scarce research and development dollars dictates that only the most necessary and effective projects be undertaken.

Cross-fertilizing the areas

Consequently, in conjunction with the threat evaluation, the user requirements are constantly reviewed to see where technology can effectively be exploited to improve mission capability and effectiveness. By cross-fertilizing these areas of user requirements, the threat, available dollar resources, and technology appraisal, AVRADCOM is able to establish the set of general program objectives under which it operates.

Our responsibility is to evaluate wisely and develop the appropriate research and development plans and programs which will give the user alternatives which will be useful and cost effective. Currently, the development community has to live with a six to 15 year development lead time on selected major hardware systems.

Given this reality, it is apparent that the future of U.S. Army Aviation on the battlefield is dependent on what we are doing now! It also becomes obvious that we must decide on a course of action and stay with it or we will never see new equipment in the field. We should not change well founded plans on the spur of the annual moment, although we must reevaluate and update plans and programs regularly.

The Laboratories of AVRADCOM consist of the **Research and Technology Laboratories (RTL)** and the **Army Avionics Research and Development Activity (AVRADA)**. It is through the capability of these organizations that AVRADCOM is pursuing the initiative in several areas important to Army Aviation. The facilities are instrumental in producing the technoligical bow-wave needed to maximize mission capabilities and operational effectiveness of Army airmobile systems while simultaneously minimizing life cycle costs.

The **Aeromechanics Laboratory** is located at the Ames Research Center at Moffett Field, CA. The investigatory work pursued there is designed to provide an understanding of the mechanisms of aeromechanics as it pertains to rotorcraft technology. An outstanding example of the payoff for their analytic techniques in advanced rotorcraft is the **Bearingless Main Rotor (BMR)**. This concept will provide a payoff in reliability, availability, and maintainability on future rotor systems.

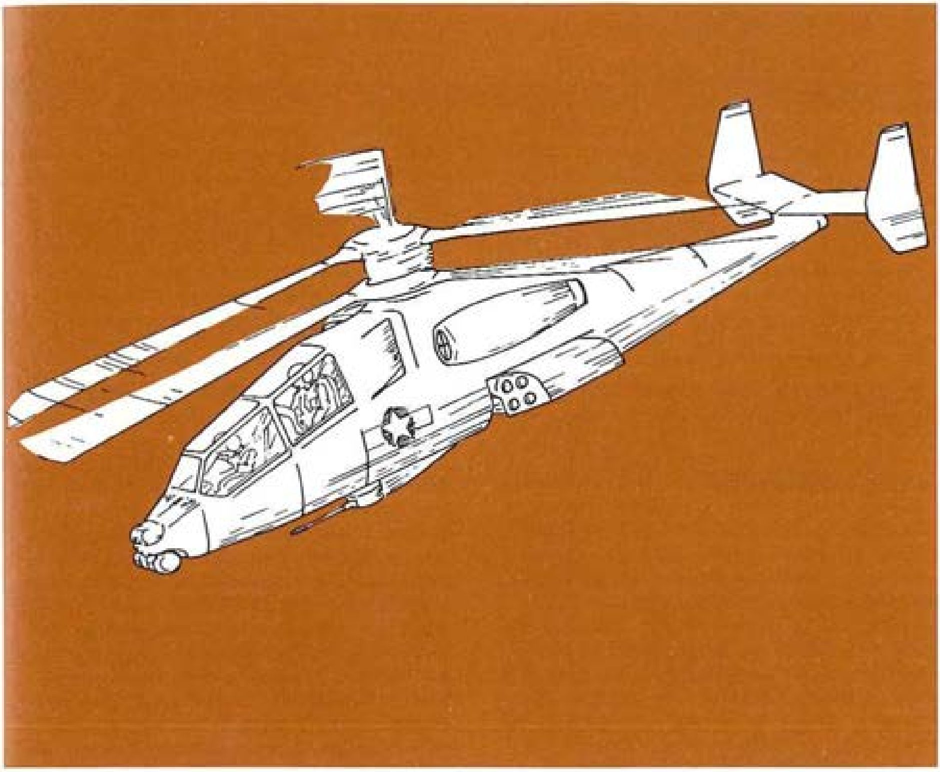
Flying testbeds optimize design

The **Rotor System Research Aircraft (RSRA)** and the **Advancing Blade Concept (ABC)** aircraft provide flying testbeds for optimization of rotor design. Testing of design techniques for selection of airfoil sections, blade platform distribution, and tip shape are providing spin-offs for the **CH-47D** modernization program, the **Black Hawk** and the AAH.

The **Structures Laboratory** is located at Langley Research Center at Hampton, VA. Under their purview, new composite components to enhance survivbility, maintenance, and costs are being investigated. Work is currently underway to develop a new rotor hub to validate the use of composite materials in high strength dynamic components. Advantages of this concept will be lighter weight, lower cost, reduced radar signature, and reduced maintenance.

The full potential of composite materials will be exploited in the **Advanced Composite Airframe Program (ACAP)**. This program will provide the typical composite material benefits plus an increased tolerance to ballistic damage.

The **Propulsion Laboratory** is located at the Lewis Research Center in Cleveland, OH. The forte of this organization is in advancing the state-of-the-art in turbine engine technology. The technological investigations undertaken by the **Propulsion Lab** provide the basis for future engine breakthroughs and **Product Improvement Programs (PIP)**.



LIGHT HELICOPTER-ATTACK (LHX-A)

The development strides made by the **Propulsion Lab** enable helicopters to operate at improved levels of efficiency thereby reducing fuel requirements. Coupled with advancements in airframe and rotor technology, new engine improvements will allow for a smaller and lighter helicopter to perform the required mission in a more cost effective manner.

An orderly continuity of efforts

The organization that provides the expertise for assuring an orderly continuity of efforts from research through exploratory development to demonstration of technology is the **Applied Technology Laboratory (ATL)** at Fort Eustis, VA. The primary mission of **ATL** is to orchestrate the transfer of knowledge to developers and contractors for application to military operations by the Army user. Their involvement at AVRADCOM's 6.2 and 6.3 funding level is key to insuring that the exploratory and advanced development provides the greatest return on investment.

One area that **ATL** has been in the forefront with in the application of high payoff technology is the **Advanced Technology Demonstrator Engine (ATDE)**. The **ATDE** is a feasibility demonstration of an 800 shaft horsepower class engine being utilized in light helicopters. It will provide a 20% reduction in fuel consumption, a significant improvement in specific power, and improvements in vulnerability, cost, reliability, and maintainability.

The **AVRADA** is located at Fort Monmouth, NJ. The mission of **AVRADA** is to conduct that portion of the AVRADCOM mission that per-

R&D: The Solution
(Continued from Page 25)

tains to aviation electronics. This responsibility includes research and development, value engineering, production engineering, maintenance engineering, product assurance, and human factors engineering for all aviation electronic subsystems and interfaces. The **AVRADA** is spearheading several new projects which should prove to be a major contributor to more efficient aviation communications and control.

Coming: IACS and PMDS

One such system is the **Integrated Avionics Control System (IACS)**. The **IACS** will be able to provide centralized control and display for communications, navigation, and identification of equipment. The program is aimed at saving cockpit space, simplifying and standardizing crew operational procedures, and providing a flexible growth capability permitting equipment addition, deletion, or substitution without extensive aircraft rewiring.

Another innovation which will have far reaching effects on future aviation employment capabilities is the **Projected Map Display System (PMDS)**. This system, when coupled with a Doppler system and **IACS**, will greatly improve **Nap-of-the-Earth (NOE)** navigation capability.

The bottom line

The bottom line for all the work performed by AVRADCOM and its subordinate organizations is the eventual type classification and fielding of equipment resulting from exploitation of our technology base. Two excellent examples are the **Black Hawk (Figure 1)** and the CH-47D **(Figure 2)** modernization programs.

The **Black Hawk** utility helicopter evolved from the development of newer and better subsystems and their integration into a single major system. The **Black Hawk** recently entered into production as a replacement for the aging UH-1 fleet. Further, the combination of emerging user requirements, evolving technology opportunities, and threat revalidation provide the opportunity to follow-on with **Black Hawk** model changes well into the 1990's.

The **CH-47D** modernization program represents the utilization of composite blade aerodynamic technology. Composite technology led to the production and installation of fiberglass blades which will significantly enhance the **Reliability, Availability, and Maintainability (RAM)** characteristics of **CH-47** rotor blades. The incorporation of other system modifications on the **Chinook** will allow the existing aircraft to gain a new lease on utility.

The prime emphasis of this program is to apply the best of new technology to an existing system. This has thus far proven to be a more cost effective and acceptable alternative to a new design and development.

Responding to the armor threat

In the area of developing a direct response to the armor threat, AVRADCOM is playing a major role in the fielding of systems like the AH-1S **(Figure 3)**, the AAH **(Figure 4)**, and the future generation of lightweight helicopters. The mission capability of these aircraft is tied directly to the advanced technology integrated into subsystems such as the **Target Acquisition and Designation System/Pilot Night Vision System (TADS/PNVS)**, advanced avionics, and weapons control systems.

Evolution may well lead to a **Light Helicopter Family of Aircraft (LHX)** for the 1990's. The **LHX-Attack (LHX-A) (Figure 5)** could be a small unsophisticated attack helicopter for armed reconnaissance, area suppression, and point target destruction. It could provide a low cost aerial fire support system in an optimum mix where mission requirements would otherwise require the AAH. In addition, the **LHX-A** would be capable of conducting missions in tactical requirements for the more lightly armed/equipped scout helicopter.

The challenge to AVRADCOM

General Baer has challenged AVRADCOM to provide the optimum in capability to meet the total Army Aviation requirement. AVRADCOM recognizes the benefit that is provided to the user through the availability and maintenance of a technology base. It is the stepping stone to the advanced engineering development and the eventual fielding of needed hardware.

It will always be the intention of AVRADCOM to focus its priorities and efforts on what is needed by the user.

THE GROWING RECOGNITION OF IMPROVED RDT&E PLANNING

BY DEAN C. BORGMAN, CHIEF, ADAVANCED SYSTEMS TECHNOLOGY AND INTEGRATION OFFICE (AVRADCOM)

"PEOPLE don't plan to fail, they just fail to plan." It is amazing how the truth of this old and well worn quotation continues to plague the R&D world.

When an organization has an abundance of resources, and is not overly concerned about any stewardship responsibilities, the need to plan for tomorrow has a tendency to be shelved because there is no over-riding concern about tomorrow. Conversely, for an organization which has a scarcity of resources to accomplish the job at hand, the tendency is to use all available resources on today's problems. However, in this case, planning for tomorrow is an absolute necessity or there won't be a tomorrow!

Planning vs resources

Although no formal proof will be offered, I am sure that a theorem could be developed which relates the need for planning to the availability of resources in an inversely proportional manner.

The results of good planning should not only help take us through the times of scarce resources but should also help to garner future additional resources. Since good planning is indicative of optimum utilization of available resources, the wise planner is likely to be the recipient of additional resources in the future, assuming his management is also concerned about maximizing return on investment. And investing is, in fact, what we are concerned with since research and development is an investment on the part of the Army.

One of the primary functions of the R&D community is to convince the appropriate decision makers that a particular R&D investment strategy holds a high probability of providing a positive return on investment over some specified period of time.

How does this relate?

So how do we relate all this good philosophy to Army Aviation R&D? For those who may have any lingering doubts as to whether the R&D resources available to the Army's aviation program dictate the need for solid planning, your attention is invited to **Figure 1.**

This figure illustrates the funding available for demonstrations of advanced development projects over the past few years. Although this is only a portion of the aviation R&D program, and there were some extenuating circumstances for some of the years shown, it is nonetheless an important portion of the R&D program and the bottom line is the same — the trend needs to be reversed.

The need for a technical planning and management function was recognized by the architects of the reorganization which created AVRADCOM in 1977. One result of this recognition was the establishment of the **Ad-**

The Growing Recognition
(Continued from Page 27)

vanced Systems Technology and Integration Office (ASTIO) with its subsequent assignment to produce the Army's Aviation RDT&E Plan.

Although an Aviation RDT&E Plan had been published previously, it concentrated on technology forecasting whereas the new thrust was to project the available and developing technology into systems. The first results of ASTIO's R&D planning efforts were published as the Army Aviation RDT&E Plan in October 1978.

A team effort

In approaching the preparation of the plan, ASTIO gave emphasis to integrating several pieces of the R&D puzzle to arrive at a comprehensive plan. **Figure 2** illustrates some of the pieces of that puzzle which need to be pulled together.

Accomplishing this job was a team effort. Participants included members of almost every element of the AVRADCOM organization, other DARCOM R&D commands, and TRADOC as well as members of industry.

At the outset, the threat to Army Aviation was analyzed and evaluated. TRADOC provided inputs into the use of advanced technology on a future battlefield. The industry/government laboratory community provided the technology forecast of what can be developed with a reasonable budget and reasonable time based on what is currently known of R&D opportunities. The result is an investment road map for Army Aviation.

ARMY AVIATION
ADVANCED DEVELOPMENT FUNDING

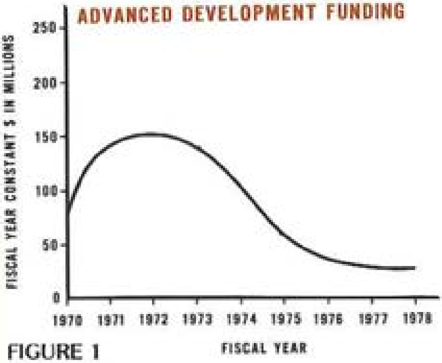


FIGURE 1

RDT&E PLANNING AND INTEGRATION
A PUZZLE WITH MANY PIECES

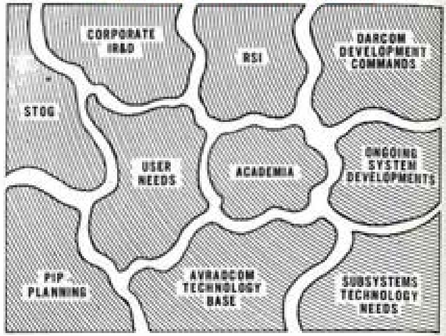


FIGURE 2

The plan provides insight into the interrelationships between technology and user capabilities in the context of evolving and developing new aviation systems. It facilitates the early initiation of system integration, budgetary planning, and establishing program priorities.

Since its initial publication, the plan has been used extensively as a guide in the Army budgetary process. **Figure 3** broadly indicates the time phased relationship between development of the plan and the budgetary process.

The first draft of the plan is developed in time to assist in the Spring Review of the aviation program, a major program review conducted annually and chaired by DARCOM. The final draft is timed to coincide with the preparation of the initial submission of the target fiscal year budget in the Fall (FY82 at this time).

The plan should not be confused with the program. The program is happening now while the plan, based on the current situation, is for the future.

But the program and the plan do interact. When funds are applied against the plan, the plan becomes the program.

Decisions on the program are guided by the impact on the future as reflected in the plan and the plan is constantly revised as reality is revealed to us. The relationship of the plan to the development of the program is further illustrated by **Figure 4**.

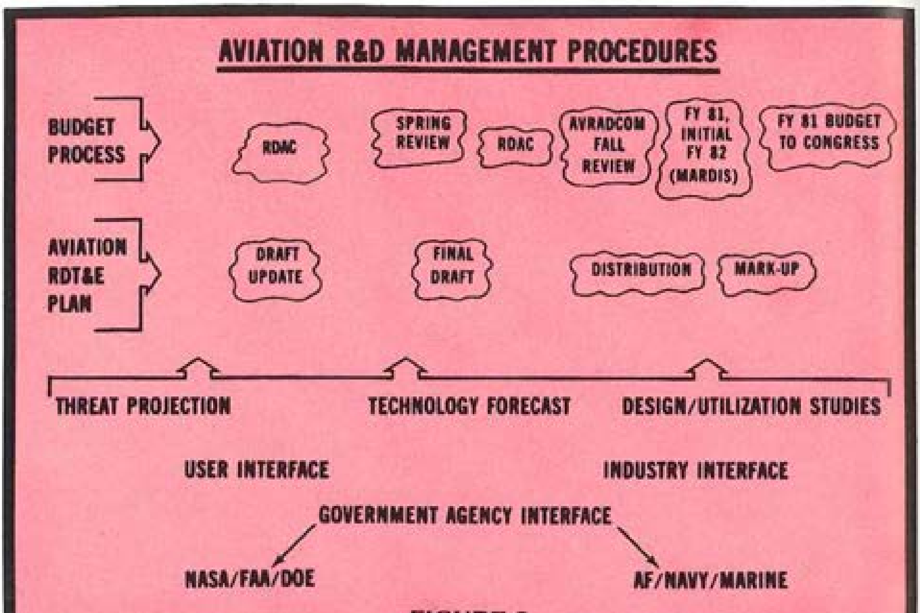


FIGURE 3

More important, however, is the relationship indicated between the user and the development community — that interactive re ationship is vital to a viable Aviation RDT&E Plan.

The Aviation RDT&E Plan published in 1978 is a benchmark document, but it was only a beginning. The 1979 edition has now been published and is another significant step. The plan has been expanded to a series of volumes. This series of documents will be a tremendous aid in the management of the aviation R&D program, but will require time to mature to full value.

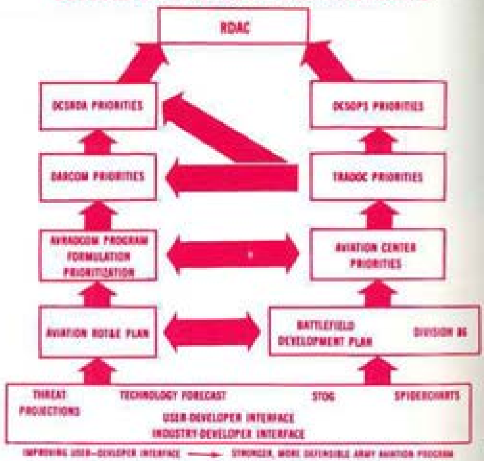
The development of a viable RDT&E Plan becomes involved and difficult as we attempt to make it more comprehensive. The process to produce the plan, with all of the necessary feedback loops, is shown in **Figure 5.**

The growing recognition for the importance of this planning process and its intricacies was a contributing factor to the recent AVRADCOM reorganization. As part of this reorganization, **ASTIO** becomes the **Directorate for Advanced Systems.**

The **Directorate for Advanced Systems** will continue where **ASTIO** left off, building the organizational interface between Command elements/technical disciplines to enhance sys

FIGURE 4

DEVELOPER AND USER RELATIONSHIPS



tem integration, relating the community capabilities and user requirements to a viable Command R&D program, and publishing the Army Aviation RDT&E Plan.

In addition, the Directorate will also be the Command's focal point for user requirements, industry IR&D reviews, and unsolicited proposals, since these activities must all be integrated as part of the long range planning responsibility.

The Directorate for Advanced Systems has also intensified its commitment to guiding the development of advanced airmobile concepts. The Directorate will be responsible for developing new concepts and guiding them until a Project Manager is established.

During the coming year, the Directorate will be conducting trade-off analyses and studies while working with the user to develop the basis for new and improved aviation weapons systems. The payoff for Army Aviation will be a stronger plan and a healthier program — and the trend depicted in **Figure 1** will indeed be reversed as illustrated in **Figure 6.**

Will it really happen? No one can say at this point in time, but we must plan for success. We must never be accused of failing to plan!

FIGURE 6

ARMY AVIATION ADVANCED DEVELOPMENT FUNDING

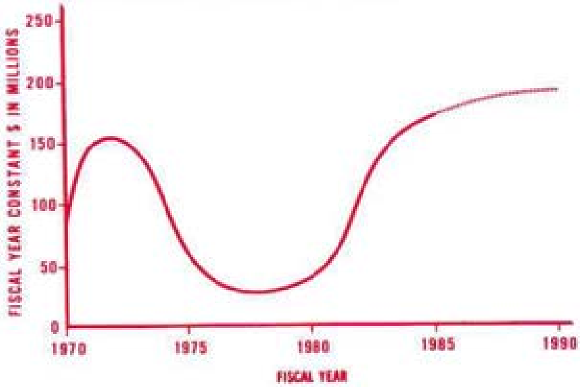
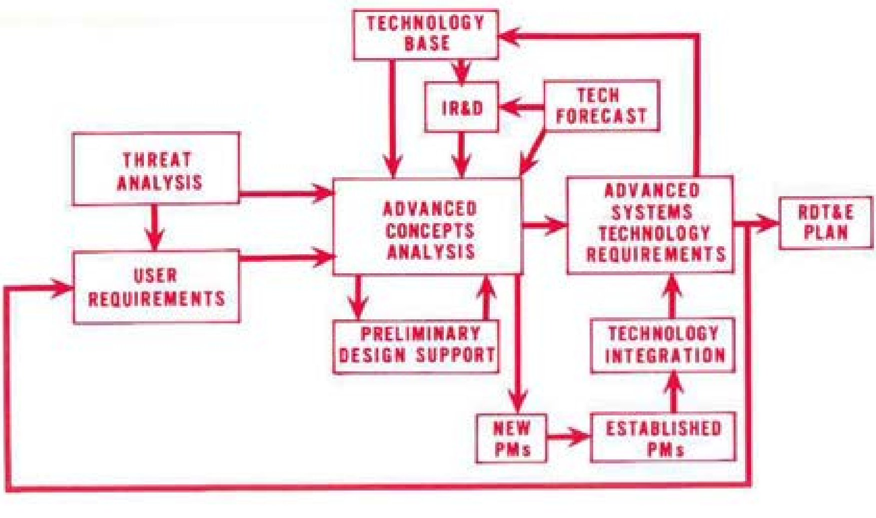
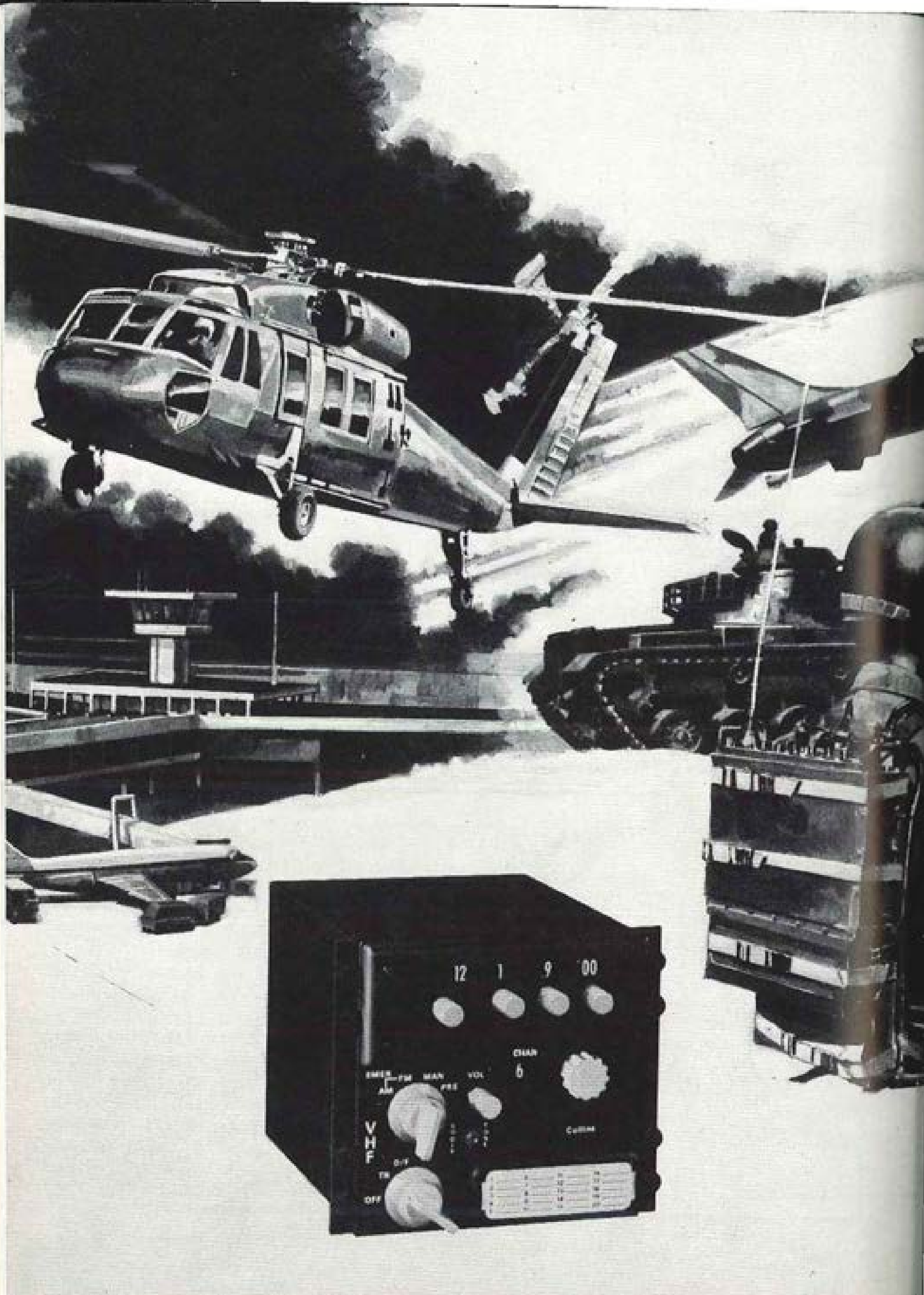


FIGURE 5

RDT&E PLANNING PROCESS

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OF THE TACTICAL KIND

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TRADOC/AVRADCOM INTERFACE

THE KEY TO SUCCESSFUL AVIATION R & D PLANNING

BY MAJOR GENERAL JAMES H. MERRYMAN
COMMANDER, US ARMY AVIATION CENTER

IF Army Aviation is to have the necessary capability on the battlefield of tomorrow it must appropriately modernize.

In determining what should be done, the TRADOC **Battlefield Development Plan (BDP)** provides the first adequate scenario with which we can assess the Army's capability as an effective force on the modern battlefield. The **BDP** gives guidance in the form of "needs" that our development efforts should be addressing.

Defining our hardware requirements

By comparing these needs with the objectives outlined in the **Science and Technology Objectives Guide (STOG)** and other materiel developments, we can employ the Combat Developments Process to better define our hardware requirements and establish priorities for combat aviation materiel developments.

For the Combat Development Process to work, that is, if we are to have proper development and fielding of combat equipment, we must have close cooperation between the user and the developer. In order for the developer to do his job right, the user must provide him (in this case, AVRADCOM) with definitive and timely guidance to insure that our technology effort is exerted in the appropriate direction.

In order to perform this task the user must become familiar, first hand, with base technology laboratory programs, and assess their relationship to and impact on aviation requirements. The task then becomes one of articulating these relationships in such a way as to focus the development efforts on a useful user product.

The Aviation Center's mission has been enlarged to execute these responsibilities for TRADOC. We have been tasked to function as the integrator for all aviation mission proponents in support of improved aviation effectiveness in the Combined Arms Team.

The missions defined

To accomplish this, we see our mission to be as follows:

- Be involved in all things pertaining to Army Aviation.
- Integrate Army Aviation efforts.
- Make sure the Army gets what it should from Army Aviation.
- Keep appropriate people involved.
- Don't try to do it all at Fort Rucker.
- Insure efforts are on the right things.
- Work closely with DARCOM and DA.
- The **bottom line:** Make things happen **on time** and in the **right way.**

The Aviation Center and and AVRADCOM have established a meaningful interface program. For almost a year now, they have had a continuous dialogue going on between the

TRADOC/AVRADCOM

(Continued from Page 35)

Center's Combat Developments project officers and the Laboratories and R&D agencies of AVRADCOM.

The Center has participated with AVRADCOM in the annual DARCOM Laboratory Project/Budget Review process, and supported the funding of programs responsive to the user needs. The Directorate for Advanced Systems (DAS) at AVRADCOM works closely with the Center's Combat Developments Directorate. These directorates participate jointly in the preparation of AVRADCOM's Aviation RDT&E Plan. This plan sets forth AVRADCOM programs and objectives for the next 20 years, with emphasis on the first five years.

The Center's participation in this planning enables us to learn what can be done in the various technology areas, and influence how those technologies are applied to specific user interest. Joint participation between AVRADCOM and the Aviation Center is also going on in preparation of the TRADOC Materiel Acquisition Priority Program.

The thrust in this area is to identify and align the most critical development and procurement programs to meet the Army's needs. AVRADCOM, as well as other developers, use this as input to structure their lab programs, as it represents the user's statement concerning his most urgent shortcomings.

Underlying all of this, however, is affordability. We are addressing affordability by getting the user and developer together early in the cycles to reduce lost motion, misunderstanding, and wasted resources.

Sighting on the same target

The interface effort developed between the Aviation Center and AVRADCOM is essential to insure that the future materiel needs of Army Aviation are addressed. Through cooperation and understanding we are better able to evaluate the impact of technologies on user capabilities, establish realistic priorities, and accelerate or telescope programs to meet user requirements.

In this way, AVRADCOM and the Aviation Center are sighting on the same target — developing the greatest fighting Army in the world.

Manufacturing Technology Conference to be held

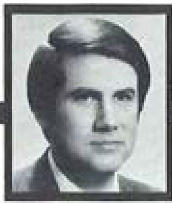
Hosted by AAAA's Corpus Christi Chapter, the 1980 Army Aviation Manufacturing Conference II will be held in Corpus Christi, Tex., 18-22 February. The conference, which features presentations by military and industry representatives, is structured around five aviation system functional group panels.

Information regarding pre-registration, accommodations, format, etc., may be obtained by contacting Sandra Strub at (512) 939-3600 or AV 861-3600/2611.

The 1980 conference is sponsored by AVRADCOM and the Corpus Christi Army Depot.

ACES' CLUB

Major William E. Coleman, VP—Membership of AAAA's Aviation Center Chapter, presents Major Jerry Kruger (seated) with his "Ace's Certificate". The hand-lettered clobber card reflects that the major enrolled five new members in the AAAA.



THE ARMY'S NEXT HELICOPTER

BY RICHARD B. LEWIS, II
TECHNICAL DIRECTOR (AVRADCOM)

ONE of the major challenges of Army Aviation R&D is to find opportunities to apply the products of our laboratories.

As a total systems developer, AVRADCOM has focused on all of the engineering disciplines inherent in modern aircraft in order to insure that technology is available whenever needed. We have applied these technologies in solutions to problems in the current fielded fleet in a variety of product improvement programs, in major modification efforts, and, of course, evolving new aviation systems.

The Black Hawk and AAH both clearly illustrate the focused nature of aviation R&D. These aircraft were designed primarily for rapid development and fielding without significant technological risk. Nonetheless, major improvements in survivability, crashworthiness, reliability, maintainability, and efficiency have resulted from selected application of our research products.

A number of major questions

As we prepare each year's aviation RDT&E program, a number of major questions are asked. These include: "What does the user really need?" "How can we best meet these needs with affordable, effective systems?" "What does a change in one area do to the total system performance?"

Next, we look at the facts of life as portrayed in the funds that will be available for aviation RDT&E. Historically, there is a fairly level total obligational authority available to aviation, and this is not likely to change. We have pointed out that the Army operates more than one-third of the nation's military aircraft, but is forced to develop and buy these with less than one-fifth the RDT&E and one-tenth the procurement funding.

Answers are needed

As the Army mission becomes increasingly complex, so do all our aviation systems, and our arguments that aviation funding be proportionately increased must be answered.

As we marry our perception of user needs with realities of available funding, we have constructed an Army Aviation RDT&E Plan which identifies options for application of technology. Recognizing the over 9,000 helicopters in the active Army inventory, there are many opportunities for product improvement and modular evolutionary development.

During the next two decades the Army will benefit from these modernization efforts. Tremendous improvements are available:

- To detect and destroy at survivable standoff ranges is a central theme of our aircraft weaponization efforts. The Mast Mounted Sight, as demonstrated on the UH-1, OH-6, and OH-58, has shown dramatic improvements in conceal-

The Next Helicopter
(Continued from Page 37)

ment, permitting exploitation of Army NOE doctrine.

AVRADCOM is prepared to apply this technology in an engineering development program on the AH-1S if funding priorities are established. Another challenge to target acquisition is the dirty battlefield environment, and to meet this a pod-mounted near millimeter wave radar will be demonstrated next year. As a supplement to emerging imaging target acquisition systems like the AAH **Target Acquisition Designation Systems (TADS)**, **Forward Looking Infrared (FLIR)**, and **Forward Augmented Cobra TOW Sight (FACTS)**, the near millimeter wave radar will permit target engagement in rain, haze, dust, and smoke environments.

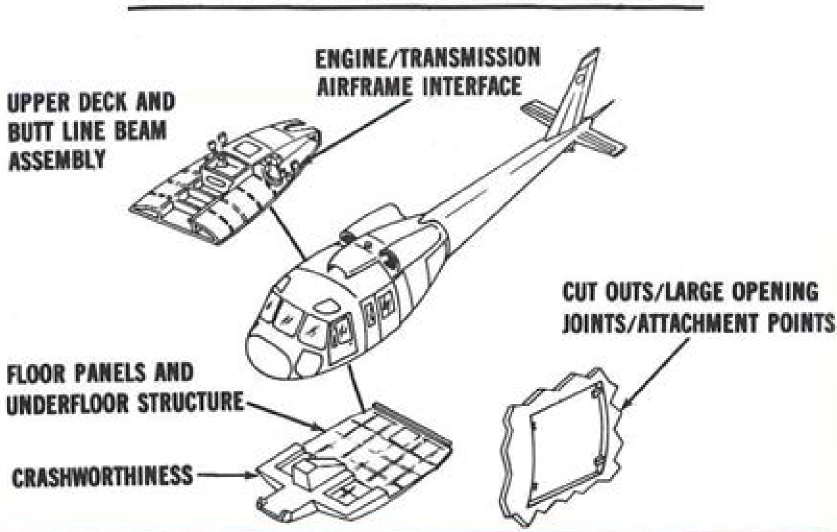
- Crashworthiness of our systems has been materially improved as evidenced in the **Black Hawk** and AAH. MIL-STD-1290, developed by AVRADCOM's Applied Technology Laboratory, is the key document in achieving crashworthiness. Increased use of composite structures will be demonstrated in our **Advanced Composite Aircraft Program (ACAP)**; higher strength metals such as those employed in the CH-47D transmission, and new crashworthy design concepts also will help.

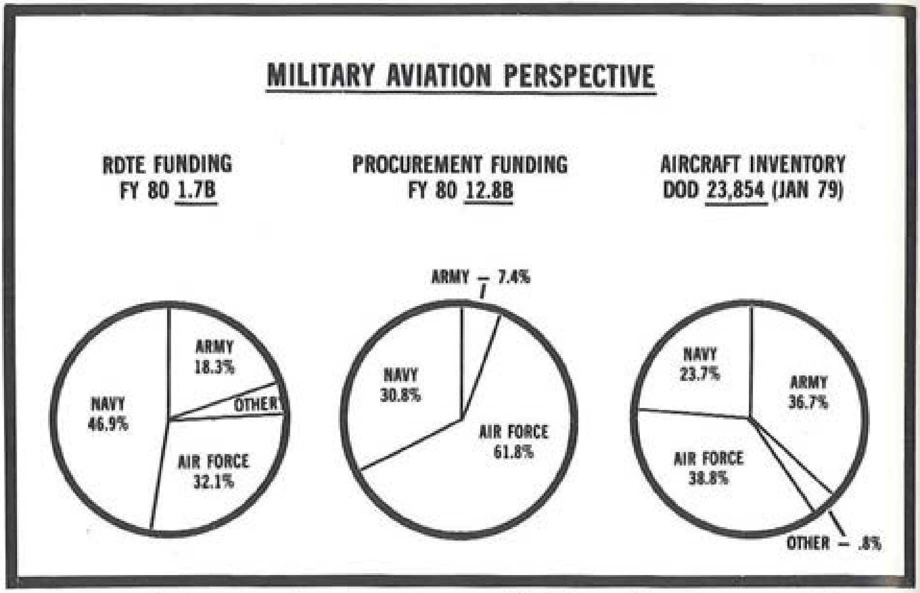
- A major opportunity exists for increasing aircrew performance through improvement of the man/machine interface. Central features of this technology are seen in the **Integrated Avionics Control System (IACS)** currently completing competitive engineering development and the **Electronic Modular Master Advisory and Display System (EMMADS)** which is in the initial stages of advanced development. These systems, tied to all the navigation, com-

NEXT MONTH!

The 1980-82 Inductees to the Army Aviation Hall of Fame will be announced in the March 1980 issue of ARMY AVIATION. The Inductees were selected from some 43 nominations submitted to the Army Aviation Hall of Fame Board of Trustees during December-January. The selectees will be inducted at a Hall of Fame Luncheon to be held at the AAAA National Convention in Atlanta, Ga., on 11 April.

ADVANCED COMPOSITE AIRFRAME PROGRAM





munication, and information electronics via a multiplex data bus, permit mission-tailored cockpit design.

In the longer term, an all-digital aircraft employing electromagnetic-pulse resistant fiber optics data transfer will enhance the survivability and operability of Army aircraft.

- We have achieved substantial fuel efficiency improvements with the T700 engine on the **Black Hawk** and AAH, and both the T700 engine and the 800 horsepower **Advanced** Turbine Demonstrator Engine (ATDE) have potential for application to other Army aircraft.

Each of the technologies described above will find its way into one or more of the current Army helicopters, and in fact, a majority of the Army's future helicopters will be evolutionary improvements of our current fleet. In the longer term, however, it is clear that new systems will be required to replace aging technology in our light utility and light attack systems. AVRADCOM, working with the Aviation Center, has defined a generic new aircraft, designated **Light Helicopter Family of Aircraft (LHX)**, which could use a common set of dynamic components to replace the **Huey** and **Cobra** early in the next century.

While we are still several years away from the beginning of engineering development on the **LHX**, it is not too soon to consider how aviation technologies can play together to maximize the effectiveness and affordability of the **LHX**.

An artist's concept of the **LHX** shows a combination of many of these technologies: advanced rotor systems, improved flight controls, digital modular avionics advanced composite structures, fuel efficient engines, all-weather target acquisition systems. All of the foregoing provide maximum effectiveness, operability, and survivability for the next generation of Army aviators.

HELPING HANDS!

Mrs. Linda Braun and Mr. David Knepper were jointly responsible for the coordination of all editorial copy in this special "AVRADCOM Issue." They are both Management Analysts in the Force Development and Management Office of the Aviation Research and Development Command. Linda has been working in aviation in Government service for 20 years, while David just recently completed his internship.

THE SUPERIORITY OF FUTURE ARMY AIRMOBILE SYSTEMS:

THE GOAL OF THE RESEARCH & TECHNOLOGY LABORATORIES

BY DR. RICHARD M. CARLSON, DIRECTOR, US ARMY R & T LABORATORIES, AND COLONEL JOHN FITCH, DEPUTY DIRECTOR, US ARMY R & T LABORATORIES

NEW technology features found in the latest Army helicopters — are they primarily a result of independent manufacturer development, aided perhaps by research of the universities and agencies such as NASA?

On the contrary, although each of these activities plays a very important role in rotorcraft R&D, a large proportion of technology base improvements relating to potential use in Army helicopters owe their existence to programs of the AVRADCOM **Research and Technology Laboratories** (RTL).

RTL-sponsored improvements

Many of the improvements in performance, handling qualities, maintainability, survivability, and similar features of the latest generation of helicopters can be traced to state-of-the-art advances that were a direct fallout from **RTL** conducted or sponsored R&D efforts.

The **Research and Technology Labs (RTL)**, which include a headquarters at the NASA-Ames Research Center, Moffett Field, CA, are comprised of 536 civilian scientists, engineers, technicians, and administrators, plus a small but key group of 24 military pilots, engineers, and technicians. The Laboratories themselves are widely dispersed at four locations across the country.

Three of the organizatons (the Aeromechanics Laboratory, NASA-Ames; the Propulsion Laboratory NASA-Lewis; and the Structures Laboratory, NASA-Langley) operate under a unique arrangement with NASA, enjoying free access to a rich variety of research and support facilties as well as full cooperation with NASA personnel on programs of mutual interest and benefit in the field of rotorcraft technology.

A self-contained capability

The fourth organization, the **Applied Technology Laboratory**, Fort Eustis, VA, operates its own specialized research and support facilities, with emphasis on military application. Additionally, it has a self-contained capability for contractual, financial, legal, and other administrative support which, at the other **RTL** locations, is provided by NASA.

Under the leadership of the Commander, **AVRADCOM**, the Director, **RTL**, focuses laboratory activities primarily in the categories of 6.1 research, 6.2 exploratory development, and 6.3 advanced development in virtually all areas of interest to future air mobility except avionics. The Laboratories have also recently assumed program responsibility for 6.4 engineering development of aircraft weapons and mission support items.

Other important missions of the **RTL** include support to others — especially to project managers and other elements of **AVRADCOM**, independent risk assessment of de-

The Goal of the R&T Labs

velopmental systems and components, and performance of preliminary design of conceptual future airmobile systems.

In 1979, the **RTL** program budget amounted to $38.3 million in total 6.1, 6.2, and 6.3a category RDT&E funds. Additionally, reimbursements for customer work, accomplished primarily at the Applied Technology Laboratory for a wide variety of Army, Navy, and Air Force customers, amounted to nearly $8 million. To place these amounts in perspective, for comparable activities in 1979, the five largest helicopter manufacturers together spent an estimated $77 million on independent R&D, the NASA budgeted $17 million for rotorcraft research and technology, and the Army Research Office furnished aproximately $4 million for related research at colleges and universities.

Two-to-one guideline

The R&D activities of the **RTL** are conducted both in-house and out-of-house. In-house effort is research performed by laboratory employees, using Army and/or NASA facilities and expertise. Out-of-house efforts refer to work accomplished for the **RTL** on a reimbursed basis by other government agencies or by contract to civilian sources. The funds buy not only expertise, but often the use of materials, services, and facilities. Laboratory employees monitor contract performance and receive the end products, which include reports, data, and demonstrator hardware.

An **RTL** self-imposed guideline is to spend two program dollars out-of-house for each one spent in-house. Generally, research and exploratory development programs tend to be more oriented toward in-house effort whereas advanced development, which frequently includes hardware fabrication and technology demonstration, is heavily weighted in favor of dollars spent for contractual support.

Both efforts essential

While the desired ratio for in-house to contract dollars may be open to debate, the need for both kinds of effort is not. The general guideline is that **RTL** in-house research should not only be vital to Army Aviation, but it also should be work that is not readily or satisfactorily available from an outside source. If necessary funds are available and the desired product can be obtained satisfactorily with a contract, that course of action would usually be adopted.

Certain "in-house" functions

There are, however, certain specific functions indispensable to military laboratories which cannot be adequately performed unless there is a substantial in-house capability.

As listed by a former defense official, these:

- Provide the technical expertise to make the Services "smart buyers."
- Participate in test and evaluation of new systems and procedures.
- Provide engineering support of fielded systems.
- Provide a corporate memory in weapons development.
- Assess the state-of-the-art in areas of importance to weapons systems development.

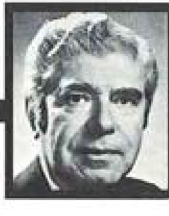
The **RTL** perform all of these functions to varying degrees, not in isolation, but in cooperation and coordination with other elements of DARCOM, and other Services, NASA, TRADOC, domestic industry and foreign interests. The **RTL** are primarily involved in technology base efforts, the results of which may not be adaptable to production systems for five, ten, or more years into the future.

Program selection is difficult

Therefore, R&D programs generally cannot be selected solely on the basis of user perceived needs, except in a broad sense. The principal guidance document used for this purpose is the **DA Science and Technology Objectives Guide (STOG)**. Virtually all **RTL** efforts are responsive to one or more paragraphs of this document; however, because resources are not limitless, programs must be selected, and personnel and funds for their accomplishment must be allocated, on the basis of potential payoff to future needs.

This is not an easy task. It requires laboratory personnel who are aware not only of the latest opportunities for technology advancement, but also of their potential value to the user, to either satisfy or modify future require-

(THE GOAL/Continued on Page 53)



THE ADVANCES IN ENGINE AND DRIVE-TRAIN COMPONENT RESEARCH

BY JOHN ACURIO, DIRECTOR, PROPULSION LABORATORY (AVRADCOM)

TWO of the most important aspects of the Propulsion Laboratory mission at the Lewis Research Center are to provide technical support to Project Managers and systems developers, and to stay ahead of future requirements in helicopter propulsion by pursuing those program elements that will strengthen the technology base.

Propulsion programs concentrate on technology developments for components of turboshaft engines and drive trains, including transmissions. The most significant driving forces are: demands for better component efficiency; lower fuel consumption; improved life-prediction techniques; safety; reliability; reduced weight; and cost.

Internal Aerodynamics

Most of the Army's aircraft engines are much smaller than those used in the commercial fixed-wing transports (turbojets and turbofans) (Figure 1). This size difference inhibits adopting many of the features of the large engines. Furthermore, component arrangement and types are uniquely tailored to an airflow range that is roughly 2% to 5% percent of today's turbofan.

Therefore, emphasis is being directed toward generating detailed aerodynamic treatment of these special combinations of small components. The thrust is to improve efficiency while using the fewest possible parts to reach the compressor pressure ratios and turbine temperatures necessary for good overall performance.

These small components are particularly important because they form the performance "backbone" of an engine. At the same time, they exhibit some of the most complex flow combinations found anywhere. Beyond that, they are subject to wear and deterioration in the dusty, sandy environment in which they must live. Therefore, their ability to survive and perform at acceptable levels will depend on how well we have set the stage in our research programs.

Mechanical Elements

The components in this area include bearings, gears, seals and shafting, along with the associated subdisciplines of wear, lubrication, and materials behavior.

One of the problems is a combination of high rotational speed and small bearing sizes that are difficult to lubricate properly. Holding a lubricant film and preventing failures encompasses investigations in the newly emerging field of tribology, (friction, lubrication, and wear) and hydrodynamic behavior of lubricants under high contact pressure.

In a separate and more applied activity, supported by the Directorate for Product Assur-

Engine Research
(Continued from Page 43)

ance (AVRADCOM), the Army-NASA team at Fort Lewis has successfully conducted an investigation of cost savings possible by refurbishing bearings during the overhaul process. As a result, a significant number of bearings now can be reworked and reinstalled at considerable savings in cost. A facility to accomplish the refurbishment is now in use at the **Corpus Christi Army Depot (CCAD)**.

The high-speed shafts also demand good seals that must prevent oil leakage. To overcome this problem, a new self-acting, lift-pad seal design has been developed. This technology and similar advances in segmented carbon seals have been transferred to the industry and are now being incorporated in new engines and transmissions.

The long, slender shafts in engines often are required to run above critical speeds, and they must be able to operate smoothly at these conditions. Either the entire rotor system must be balanced perfectly or the supports must be capable of damping oscillations in the critical speed regions. Achieving a "perfect balance" is not practical. Until now a "best balance" approach has been pursued, and bearing supports usually are designed to absorb the energy of imbalance, (vibration) through "soft" mounts or dampers.

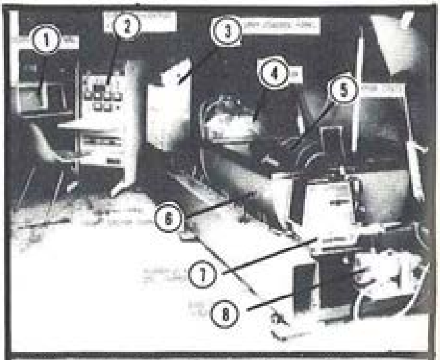
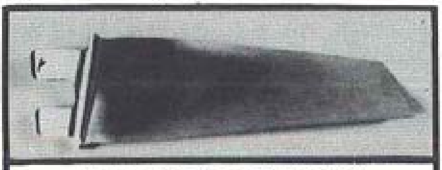
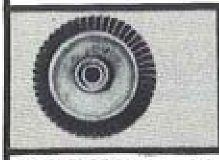
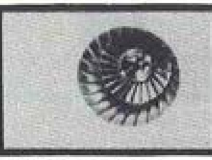


FIG. 2—New Test System Using Computers.
1) CRT Display/Term.. . . 5) Test Rotor (T53)
2) Control Console. . . . 6) Vacuum Chamber
3) Aux Contr Panel. 7)Hydr Pump Vac Cover
4) Gearbox. . . . . 5) Lube Oil Scavenge Pump



Large Engine Fan Blade





Left: T-63 Turbine Wheel; Right: 6:1 Pressure Ratio Impeller. Below: T-700 Combustor.

Assisted by NASA, a new system using modern computer techniques is being installed at **CCAD**. It will be able to compare behavior of a test rotor system with a standard and determine the location and amount of imbalance, thereby avoiding rebalance and retest during overhaul **(Figure 2)**.

Emphasis is also being placed on gearing technology, primarily as related to transmissions. Several significant efforts are underway including full-scale tests of advanced components in an OH-58 transmission and other more advanced efforts such as a traction-drive system, designed to replace gears with pure rolling elements **(Figure 3)**.

Materials

Some of the most impressive gains in propulsion technology have been the result of aggressive materials research programs. Few areas of science have moved so far and so fast as materials development. Because of the thrust toward high turbine temperatures, we have programs in ceramics and protective coatings for turbine components.

Ceramic compounds have potentially high-use temperatures and strengths, and the materials are readily available. Other properties, however, are not yet at needed levels, and ceramics are well below the high-temperature metal alloys in durability and impact resistance.

Working with industry, we hope to eliminate cooling requirements and make a considerable gain in performance and component cost. Ceramics also can be used to provide a thermal-barrier, or insulating coating over high-temperature alloys in cooled components.

We also are pursuing metal-matrix composites for housings and cases, and we expect them to be used in compressor stator vanes in the near future. Polyimide composites also have potential for application to the cool end of the engine, and we expect to continue research that will permit us to use these new materials in compressor blades, vanes, and cases. We foresee an advantage at more than 200°F in temperature margin over conventional designs.

Test Beds and Overall Performance

A program of full-scale engine research is being pursued jointly with NASA-Lewis Research Center. This recently generated activity is aimed at providing insight on aerothermodynamic behavior and component response to various operating conditions.

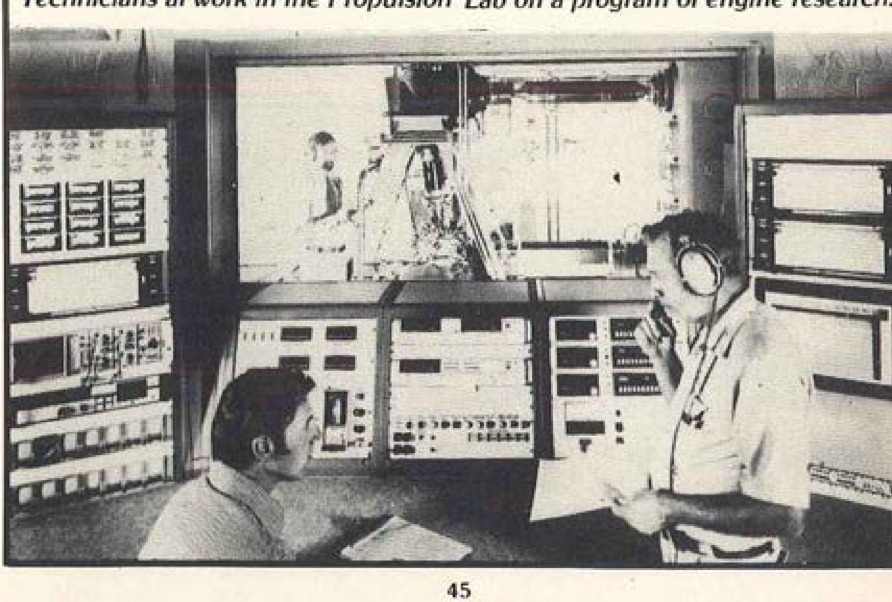
Currently, two Army engines are included in the program; one is the T63 (used in the OH-58) and the other is the T700 used in the **Black Hawk** and the Advanced Attack Helicopter. Work with these engines will focus on the effects of distorted inlet flow, new seal concepts, alternate fuels, heat transfer measurements, system dynamics, and controls.

A "best balance"

As a part of our overall performance investigations of propulsion concepts, we are re-examining power sources with respect to fuel economy. The tradeoffs to reach a "best balance" of performance and cost will be difficult to resolve. We also need to prepare for the potential use of alternate fuels.

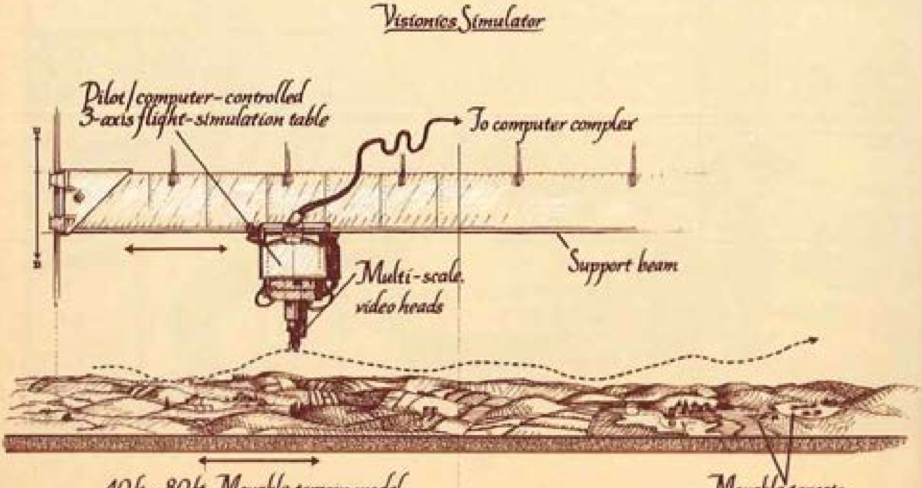
The laboratory effort will continue to face challenges in establishing the technology base for future requirements in Propulsion Systems, but there is the promise that we will continue to expand the state-of-the-art into areas of application that can be transferred to the industry and ultimately to the user.

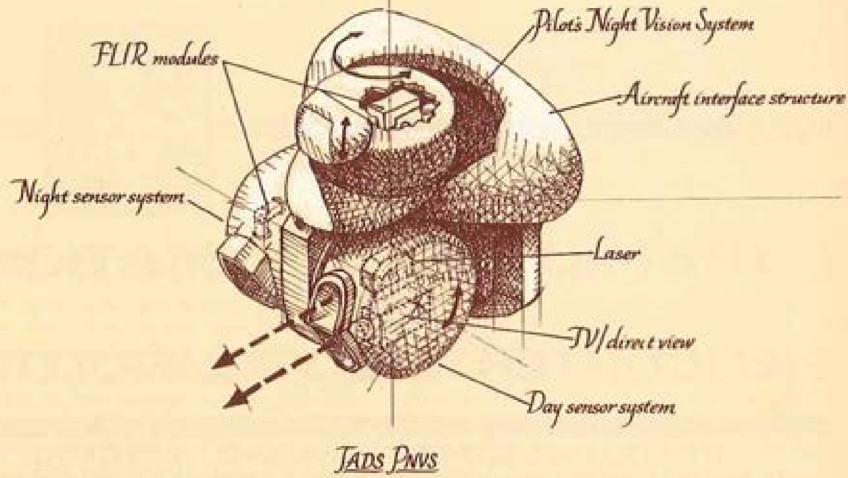
Technicians at work in the Propulsion Lab on a program of engine research.



How do you develop more effective defense systems?

You start with vision.





For three decades we have placed great emphasis on a continuous program of analysis and study to help us foresee the future course of world military strategy.

This vision for projecting military needs, and the development of technical resources to meet them, has significantly contributed to many of the country's first line defense systems.

In fact, a number of systems with vision of their own have grown out of this analytical approach. Paveway, an airborne laser designator, Pave Penny, an airborne laser tracker, and a Target Acquisition and Detection System known as TADS, for example, all required advanced electro-optics in order to search out, mark, and track targets day or night. Our Pilot's Night Vision System (PNVS) required new developments in forward-looking infrared technology.

When analyses also revealed a greater need for first-round accuracy, the military services called for weapons that could "see." Two such are Copperhead, a laser-guided artillery projectile, and Pershing II, a tactical missile that uses radar correlation, terminal guidance to point of impact.

To test systems with advanced technologies we've invested in some of the most sophisticated facilities in the industry. A unique and spectacular one is our multi-million dollar Simulation and Test Laboratory. Its electro-optical simulator includes a mammoth terrain model over which such systems can be "flown" by a pilot or missile.

Through vision, innovation and testing we've helped keep our country abreast of its defense needs. Without question, we're eminently qualified to help analyze and develop our country's future defense systems.

MARTIN MARIETTA

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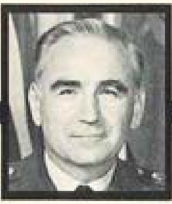


THE MILITARY APPLICATION OF HELICOPTER R&D TECHNOLOGY

BY COLONEL EMMETT F. KNIGHT, DIRECTOR, APPLIED TECHNOLOGY LABORATORY (AVRADCOM)

THE Applied Technology Laboratory (ATL) is responsible for conducting research and development programs leading toward the introduction of advanced aeronautical systems into the Army's inventory.

ATL focuses on advancing technology in a wide range of technical areas, and on building a foundation of knowledge and know-how from which future generations of military systems and equipment will be created. In addition, considerable effort is concentrated on developing improvements for the current fleet.

A detailed understanding essential

The job requires a close working relationship with other Research and Technology Laboratories, AVRADCOM engineering elements, project managers, and the military planner and user. It involves both detailed understanding of requirements and the potential of unfolding technologies so that future requirements can be anticipated.

A major portion of ATL's programs are accomplished through the use of contractual support from aerospace and related industries. In-house projects are initiated where unique capability exists, such as in vulnerability reduction, crashworthiness, or structural testing, to name a few. Results are then systematically crossfed between Government and industry.

This approach ensures maximum coordination of the advancing technology for application to both current and future Army systems. Manufacturers are gaining the hands-on experience essential for appreciably reducing production risks and the Government remains a "smart buyer."

Simply stated, the major mission of ATL is to "take emerging technology and paint it olive-drab" so that when a project is phased into engineering development, it has been demonstrated to be capable of meeting the Army's operational requirements.

During the following discussions concerning work underway and planned at ATL, it is important to keep in mind that the militarization issues of safety, survivability, vulnerability, reliability, and maintainability are being investigated concurrently and as an integral part of each project.

Composite Airframes

There are people in ATL who have been investigating the operational use of composite materials in aircraft for over 15 years. Today, as a result of these efforts and in cooperation with other agencies and industry, these new materials are being used as main structural components on new helicopters. The primary example, of course, is the new family of main rotor blades.

Additionally, a current effort at ATL in the application of composite concentrates on what promises to return the largest dividends — nothing less than total redesign of the airframe utilizing composites for the primary aircraft structure. In keeping with our orientation of "producibility", we are working to make this possible at current levels of technology in the helicopter industry.

The laboratory's credentials in this area are based on an extensive background of experiments. No less than 40 crash tests, three-quarters of them using helicopters, have been completed. These experiments have taught us much about what it takes to survive a crash: the structural strength, the energy absorbing mechanisms, and the restraint systems that will reduce the number of injuries and fatalities in survivable crashes. The **Crash Survival Design Guide** produced by **ATL** is the basis for **Mil STD 1290**, which is the latest and most complete standard for helicopter crashworthiness requirements.

Ballistic tests prove composites

In an effort to understand how well new composite structures will survive in battle, new structures are carefully fabricated out of the latest composites technology and then ballistically tested against high explosive incendiary rounds at the **ATL** test range.

Efforts also are aimed at continually improving our understanding of the realiability, maintainability, and repairability problems associated with the use of composites in Army helicopters. Environmental tests have been completed; nondestructive test and inspection methods and criteria have been evaluated; and field repair techniques have been developed. Much work remains to be done in this area, but confidence is high that answers will be available ahead of major application of composite materials to Army helicopters.

As previously mentioned, we have embarked on the **Advanced Composite Airframe Program (ACAP)** to design, fabricate, and flight-test an airframe constructed primarily from composite materials. A quantity of **ACAP** airframes will be fabricated for laboratory structural test, ground test, and **25** hours of engineering flight test. Through this program we will build the confidence that industry and the Army must have to enter the engineering development effort that will result in a composite primary fuselage structure in operational aircraft.

The potential advantages are substantial: a reduction in airframe weight of more than 20%; a reduction in acquisition costs of approximately 15%; and a reduction in the total "parts count" on the airframe of at least half. We are looking to structures with a much longer fatigue life — so much longer that we can realistically expect achievement of a 10,000-hour airframe. From the Army operator's point of view this boils down to an aircraft that is more efficient, with improved fuel economy and a substantial reduction in the spare parts inventory requirement.

New Engines

ATL's extensive experience in developing the **T700** engine which powers the **Black Hawk** and **AAH**, is now being applied to the construction of a new engine: the **800** horsepower **Advanced Technology Demonstrator Engine (ATDE) (Figure 1).**

Prototype **ATDE**'s are now being fabricated in two versions by different manufacturers. Approximately half the size of the **T700**, yet offering a comparable power-to-weight ratio, the **ATDE** will feature significant improvements, including a reduced infrared signature and full authority digital electronic controls. The new engine's efficiency signifies that the advantages of multi-engine operation can be extended to helicopters of less than 10,000 pound weight.

The propulsion area is full of targets of tech-

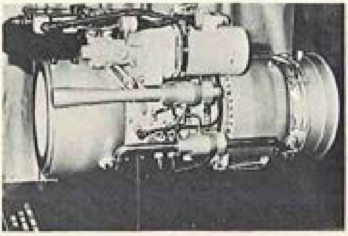
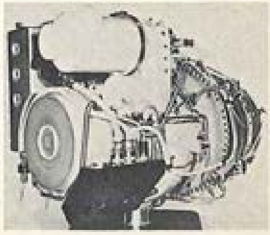


FIGURE 1

Left: Avco Lycoming's 800 horsepower Advanced Technology Demonstrator Engine

Right: The Detroit Diesel Allison Division 800 h.p. ATDE



nology opportunity. Work is planned to translate technologies developed in the **T700** and **ADTE** to engines of different power ranges, to develop more fuel efficient engines, and to continue improvements in transmissions and drive trains.

Advanced Control

The Army is placing greater emphasis on terrain flight. Therefore, research and development along a broad front aims to simplify and improve the cockpit environment, and to provide advanced flight controls and other measures to reduce the pilot's workload to manageable proportions and increase his mission effectiveness.

Part of **ATL's** contribution in this effort concentrates on flight controls, particularly on the advantages of optical or fly-by-wire operations. Such advanced concepts affect every aspect of controls, from the cockpit to the rotor. Sidearm controllers may replace the conventional multiple controls. Computer memory can be used to augment or replace the pilot in portions of flight, allowing him to concentrate on the mission at hand.

Once the desired control signal is generated, fiber optics will provide a better way of communicating commands to the rotor and significantly improve control system reliability, maintainability, and combat survivability.

Work is continually in process to improve

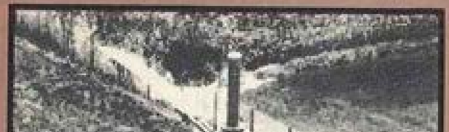


FIGURE 2—The Bearingless Main Rotor (BMR) which promises to reduce the number of parts in a four-bladed rotor hub assembly from 400 parts to approximately 60.

the materials and fabrication techniques for rotor blades, to improve their resistance to ballistic damage, and to make them easier to repair. In an Advanced Rotor Program, we are working toward a rotor that is new from the shaft out. The program is primarily concentrated in two directions: an advance in basic technology sought in the **Bearingless Main Rotor (BMR) (Fig 2)**, and an aerodynamics project, the **Aerolastic Conformable Rotor (ACR)**.

A great reduction in parts

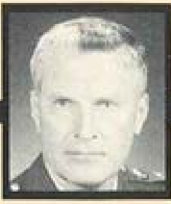
The **BMR** has no pitch bearings and no mechanical flapping or lead/lag hinges. The composite hub and blade assembly is flexible enough to accommodate normal pitch and flapping motions. The **BMR** promises to reduce the number of parts in a four-bladed rotor hub assembly from **400** to approximately **60** — offering major gains in cost, useful life, and maintainability. Reductions in cost of ownership and in the spare parts inventory required will be substantial.

In the **ACR** project blades are being designed to make a tailored dynamic response to various conditions around the azimuth. Successful development of this rotor will itself reduce loads and improve vibration levels, performance, and handling qualities. Findings from this research will assist in helping designers to make better use of aeroelastic responses as they create aircraft of the future.

The projects addressed here are only representative of the research and development work being accomplished at **ATL** in support of Army Aviation. Many other vital programs are being conducted, including the development of mission support equipment, the enhancement of the helicopter's safety and survivability, and the reduction of vulnerability.

Many years of research and development effort have put today's Army helicopter into the sky — effort ranging from fundamental investigations to the thousands of engineering hours spent on the nitty-gritty details that turn a concept into a combat-effective aircraft.

But the bottom line is somewhere else, far from the laboratory. It is the field commander's satisfaction with a piece of equipment that can outfight the enemy, that can survive combat, and that is quickly and readily serviced and maintained — aircraft whose productivity is achieved at lower cost.



THE COMPLEX WORLD OF AVIATION ELECTRONICS

BY COLONEL DARWIN A. PETERSEN, COMMANDER, US ARMY AVIONICS R & D ACTIVITY

MANY articles have been written which describe certain systems or black boxes or a combination of both. In this article, I will emphasize the aircraft cockpit and cover a few areas that will require us, as Army Aviators, to change our way of thinking and operating.

Let's take a look at what technology has done for us and what we can do with that technology while working in the complex world of Aviation Electronics.

We make small strides

Technology has been moving so fast that we find it difficult to place all improved equipments on any one aircraft. We tend to take small strides in each new equipment version or product improvement effort. The complex world certainly allows us to move technologically ahead so it becomes more of a schedule, cost, and integration challenge than a technology challenge.

Not many years ago, the Services were trying to standardize on an airborne computer. This equipment was big, heavy, and expensive. Before complete standards could be adopted, we started to hear about the mini-computer, and now we already have "micro-processors" in almost every aviation subsystem, flight control, engine and fuel control, weapons control, and fire control as well as standard avionics. We have actually seen black boxes disappear and be replaced with a chip smaller than a small coin. The bulk, weight, and cost have been drastically reduced.

Available for us today are the many and varied types of display techniques for use in the cockpit. These include TV-type displays, heads-up displays, and helmet-mounted displays, just to name a few. All of these examples allow the display of many different types of information either on an on-call basis or superimposed upon something else (Figure 1).

Like TV, the display presentations have gone from black and white to the full-color world. To reduce cockpit confusion and the workload of the pilot, it is now possible to eliminate dedicated engine and power instruments, caution and warning panels, and circuit breakers that have long cluttered the cockpit.

Unburdening the crew

The incorporation of display techniques can provide all check list procedures for that aircraft, present engine and power parameters either on-call or automatically, and unburden the crew by taking over routine monitoring of engine or power requirements. The result is a reduction in aircraft weight, increased availability of cockpit real estate, and a much less cluttered cockpit.

The Complex World

(Continued from Page 51)

Everyone can recall looking into an aircraft and seeing miles of big heavy bundles of wire running throughout the airframe. The black boxes were becoming smaller and more sophisticated, but the bundles of wire were still with us. Now with the advent of the MIL STD 1553 data bus, it is feasible to replace the bundle with a twisted pair of wires. This replacement allows much more flexibility in dealing with electronics and cockpit configuration in that one only has to attach onto the twisted pair of wires from anyplace in the aircraft.

We have seen control display units being developed that have greater capabilities. One unit can now control 10 or 12 black boxes which allows for the removal of control units from the cockpit area.

Certainly not new in the communications area, but new to aviation is the **burst-type transmission**. This transmission allows us to digitize messages and, by keying the transmitter, allows a large volume of traffic to be sent in an extremely short time period. No longer are we required to depend on long, confusing voice messages with many "oh's" and "ah's".

A keyboard is utilized to enter the message digitally on a display and once the message has been verified it will be ready to digitize and send in the burst. The receiver will reverse the process and display incoming messages.

There are two programs underway at the present time which may allow us the capability to demonstrate what can be done for the

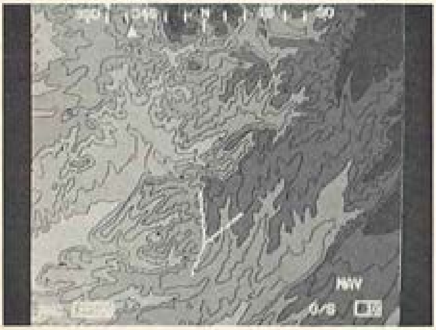


FIG. 1—Topographic map with overlay of flight symbology.

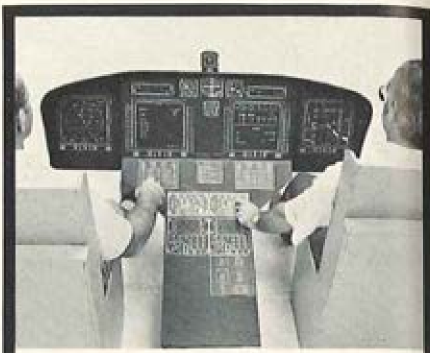


FIGURE 2—The Army Digital Avionics System (ADAS) Cockpit Mock-up.

aviator in reducing the cockpit complexity and confusion. The first is an on-going **R&D** program designed to be used in a **Black Hawk** and incorporates the latest digital avionics on board to include the latest techniques in displays (**Figure 2**). This effort will allow us to start flying some of the equipment in 1982.

The other effort is the current CH-47 cockpit modernization study. In working with this, it appears that a considerable portion of the new technology can be combined to meet a 1982 configuration that will permit giant strides in cockpit configuration improvements. It is a promising, interesting, and challenging study which, hopefully, will materialize into a workable program.

The key is integration

The key to the incorporation of any new technology is integration. The piecing together of electronic black boxes, gauges, and displays into an aircraft electronics system has always caused interface and compatibility problems. Within the electronics community we are striving to minimize these problems, but integration will continue to be the most challenging assignment.

All of us in the Avionics R&D Activity are working hard to insure that this equipment is provided to you, the aviator, in the most economical and operationally effective way. This is indeed a big challenge!

Are we ready for this complex world of electronics? It is here, ready, and available.

THE TECHNOLOGIES OF AEROMECHANICS

BY DR. IRVING C. STATLER, DIRECTOR, AEROMECHANICS LABORATORY (AVRADCOM)

AEROMECHANICS is the study of the motion of bodies in reaction to aerodynamic forces and encompasses the technical disciplines of fluid mechanics, acoustics, structural dynamics, and flight control.

From an aeromechanics point of view, most Army aircraft are limited in their performance capabilities by aerodynamic inefficiency and vibratory loads. They generate distinctive noise signatures that contribute to their detectability and to community annoyance. They impose workloads on the aircrews during typical Army missions that will constrain the pilot from exploiting to the maximum the full capabilities of his aircraft, especially at night or under adverse weather conditions.

There's room for improvement

Although our most modern aircraft, the **Black Hawk** and **AAH**, have made significant advances in these areas, they are still based on 10-year-old technology and there is much room for improvement. The research and development activities in the Aeromechanics Laboratory of the U.S. Army **Research and Technology Laboratories (RTL), Aviation R&D Command (AVRADCOM)**, are directed toward assuring these improvements. The Aeromechanics Laboratory is collocated with and pursues programs in cooperation with the NASA-Ames Research Center.

In fluid mechanics, the current rotary-wing problem is that performance and design optimization are limited to inadequate understanding of the rotor flow-field and, hence, the rotor aerodynamic loads. The complexity of this flow-field constitutes a real challenge to the aerodynamicist's ability to model mathematically.

In dynamics, the R&D efforts are directed to substantially reduce vibratory loads generated by the rotor. The approach includes analyses and tests to define unsteady aerodynamic loads and stuctural dynamics characteristics and to improve prediction of instabilities, evaluation of vibration isolation schemes, and development of new rotor concepts.

Noise still a combat concern

The detectability of helicopters as a result of the noise they generate continues to be an unresolved and significant concern, but community annoyance in a peacetime environment may be an even more important limitation on Army helicopter operations. Research, therefore, is directed toward understanding the fundamental mechanisms by which the helicopter rotor generates noise so that future rotors can be designed knowledgeably to minimize the noise.

The main current objective of research in flight control is to improve controllability and agility, provide a low-level night operations

Aeromechanics

(Continued from Page 52A)

capability, and reduce aircrew fatigue. Inadequate controllability limits the ability to exploit the entire flight envelope capability of the helicopter. This is especially true at low speeds and, therefore, impacts nap-of-the-earth and terminal area **instrument meteorological conditions (IMC)** operations. The Army R&D program is pursuing a technology data base in helicopter handling qualities which will enable us, for the first time, to generate the criteria and the specifications in flying qualities for rotary-wing aircraft to perform military missions.

Research in flying qualities depends in large part on the use of inflight and ground-based simulators. The most advanced ground-based simulators in the world are available to the Army's Aeromechanics Laboratory through agreements with the NASA-Ames Research Center; but even these are not adequate to meet the Army's need to simulate nap-of-the-earth flight operations. Consequently, the Army, in cooperation with NASA, is modifying one of NASA's newest simulators, the **Vertical Motion Simulator (VMS)**, to provide the additional motions and the detailed wide-field-of-view necessary to simulate Army missions.

Colonel Arlin Deel, the Project Manager at the Aeromechanics Laboratory for the AVRADCOM's **Rotor Systems Integration Simulator (RSIS)** is shown in **Figure 1** at NASA's **VMS**. This simulator will be utilized not only in support of the flying qualities research program but also to support development of new concepts of control and display and other man-machine integration aspects of future aircraft or PIPs of current aircraft.

FIGURE 1: COL Arlin "Art" Deel, the Rotor Systems Integration Simulator (RSIS) Program Manager at the Aeromechanics Lab, USARTL, Moffett Field, CA, is shown at the controls of a typical Vertical Motion Simulator (VMS) cockpit.

All of these developments resulting from research in fluid mechanics, acoustics, rotorcraft dynamics, and flight control impact and are integrated into our technology demonstrator programs. The technology demonstrator programs put the technologies on the shelf, available to the user at the appropriate time for engineering development with assurances of an acceptable technical and financial risk.

Most programs are co-op efforts

As a consequence of the strong interaction between developments in aeromechanics and developments in the other sciences and technologies, most of the technology demonstrator programs in which the Aeromechanics Laboratory participates are in cooperation with other elements of the **RTL** or other agencies such as NASA.

For example, the Aeromechanics Laboratory and the Applied Technology Laboratory are cooperating in the Integrated Technology Rotor Program which consists of the design, development, and flight testing of an advanced helicopter rotor system. It is based on integrating the results of current basic research, exploratory development, and advanced development activities into a single rotor system and thereby advance this technology to where it is ready for engineering development programs with an acceptably low level of risk.

The Aeromechanics Laboratory is contributing its expertise to the **Advanced Digital/Optical Control System (ADOCS)** Program which will also be conducted in cooperation with the Applied Technology Laboratory of **RTL**. The thrusts of this program are to develop a pilot-helicopter interface through advanced controllers and displays and suitably tailored **Stability and Control Augmentation System (SCAS)** so that satisfactory flying qualities can be realized in day and night operation; to develop a failure management architecture which is failure tolerant and provides safety and reliability at least equivalent to current generation aircraft; to develop system components such as fiber optic transducers and signal transmission paths that provide ac-

SCIENCE/SCOPE

Production of new long-life rocket launchers for helicopters has begun at Hughes after highly successful tests. The lightweight aluminum launchers are designed to fire 2.75-inch rockets from the U.S. Army's AH-1 Cobra helicopters and the new Advanced Attack Helicopter.

More than 4500 rockets were fired from the ground and from helicopters through five 7-tube and five 19-tube launchers. Although the launcher tubes were designed to be fired 16 times, all withstood twice as many firings. One launcher was even fired 66 times. Hughes is adapting the launchers to fixed-wing aircraft and foreign helicopters.

Exemplifying international teamwork in the defense industry, British Aerospace Dynamics Group is producing U.S.-designed TOW missile systems for the UK's Lynx helicopters. The British firm is licensed by Hughes to build TOW (Tube-launched, Optically-tracked, Wire-guided) equipment for the British Ministry of Defense. The system will enable Lynx helicopters to knock out enemy tanks.

To launch a missile, the gunner locates a target in the sight, fixes the crosshair on the target, and fires. He then holds the crosshair on the target and the missile is guided automatically to impact, receiving steering signals through two wires it unreels in flight. The pilot may fly at any speed, fly a zigzag course, or make sharp turns without affecting the missile's flight.

ceptable levels of survivability; and to integrate these components and concepts into a total system that can be incorporated into a helicopter to demonstrate the improved flying qualities and to develop confidence and experience in fly-by-wire or fly-by-optic design.

As indicated previously, a major problem is the high dynamic loads experienced by the helicopter rotor during cruise operation. Moreover, several of the Army air mobility missions requiring VTOL capability would benefit greatly from the increased productivity that a higher cruise speed could provide and from the self deployablity that could come with improved cruise efficiency. The tilt rotor aircraft offers promise of significant improvement over the helicopter in these areas while providing the desirable VTOL characteristics of the low-disc-loading rotary-wing aircraft.

Therefore, the Army has actively supported a program in cooperation with NASA to develop the technology required to enable the implementation of this type of air vehicle. **LTC Clifford M. McKeithan,** Deputy Program Manager (Army Liaison) is shown in **Figure 2** alongside one of the two XV-15 tilt rotor research aircraft.

The Army and NASA have also joined to develop an extensively instrumented flying test bed, capable of testing new rotor concepts as they become available as well as providing a test capability for existing rotors, offered the best solution. The **Rotor Systems Research Aircraft (RSRA)** will fly as a pure helicopter, a compound helicopter, and as a helicopter simulator where its wings, drag brakes, auxiliary propulsion engines, and elevator will be used to react the main rotor being tested.

The **RSRA** has unique capabilities that make it a versatile research tool for economical rotorcraft testing in the real and dynamic environment of flight. These aircraft have entered operational checkout flights (**Figure 3**) to verify data acquisition and processing systems operation. **LTC John C. Henderson** and **LTC Robert K. Merrill** are the Army test pilots at the Ames Research Center who will be flying the Rotor Systems Research Aircraft.

Research in the technologies of aeromechanics will provide the basis for producing superior Army air mobility systems at minimum cost.

FIGURE 2 — LEFT: Lieutenant Colonel Clifford E. McKeithan, the Deputy Program Manager (Army Liaison), is shown standing alongside one of the two Bell Helicopter XV-15 research aircraft at the Bell facility in Fort Worth, Texas. The tilt rotor research aircraft is one of several programs the Army has supported in cooperation with NASA.

FIGURE 3 — RIGHT: Army test pilots Lt. Colonels John C. Henderson and Robert K. Merrill check a flight schedule in front of the Rotor Systems Research Aircraft (RSRA) in the hangar of the NASA Ames Research Center, Moffett Field, California. Both pilots are with the Aeromechanics Laboratory of the USA Research & Technology Laboratories (AVRADCOM), also located at Ames. As a research tool, the RSRA will fly as a pure helicopter, as as compound helicopter, and as a helicopter simulator.

U.S. ARMY AVRADCOM

MISSION

RESEARCH AND DEVELOPMENT

- PROVIDE MAXIMUM AFFORDABLE TECHNOLOGY FOR ARMY AVIATION SYSTEMS.
- INCREASE RELIABILITY, AVAILABILITY, AND MAINTAIN-ABILITY
- ENHANCE SAFETY SURVIVABILITY AND OPERABILITY
- IMPROVE AIRCRAFT WEAPONIZATION AND AVIONICS INTEGRATION

SUPPORT MATERIEL READINESS

- ACCOMPLISH FIRST PROCUREMENTS
- DEMONSTRATE EQUIPMENT SUITABILITY

MATERIEL ACQUISITION

- TECHNICAL IMPROVEMENTS FOR FIELDED SYSTEMS
- REDUCE COST OF OWNERSHIP

US ARMY AVIAT
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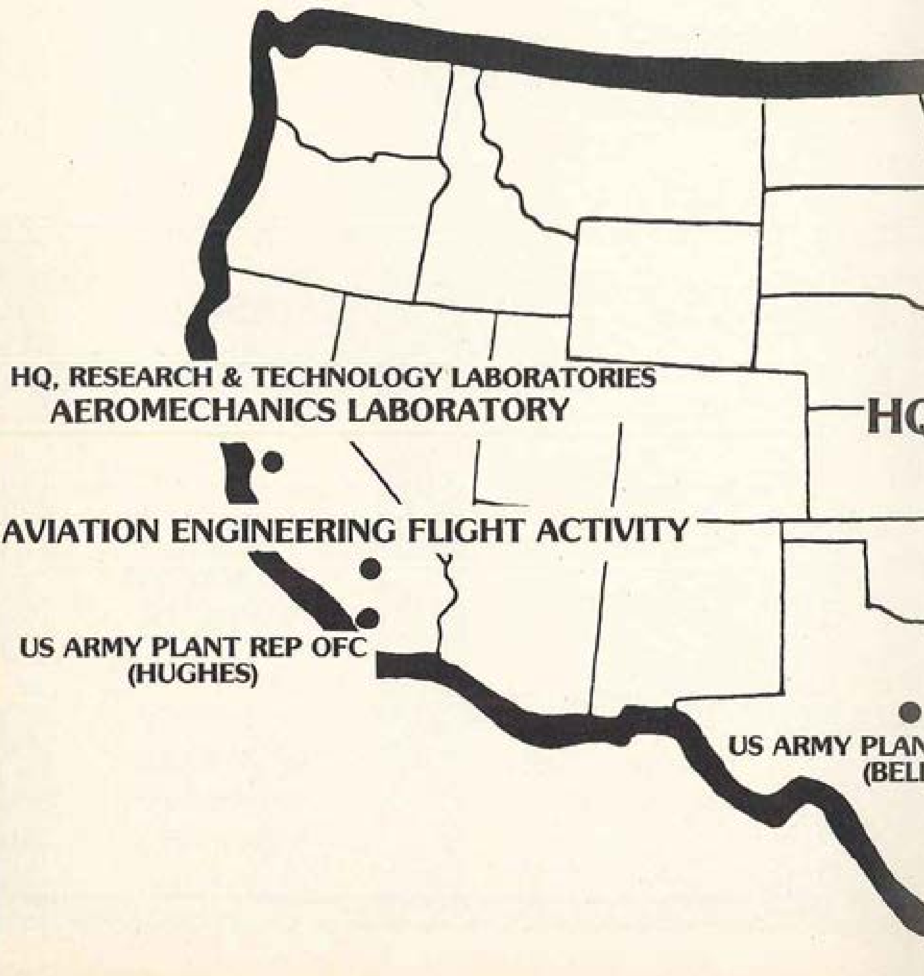

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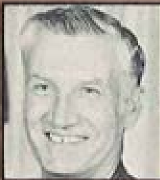

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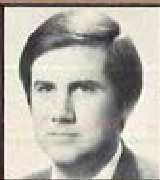

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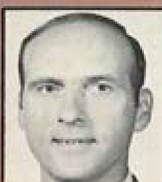

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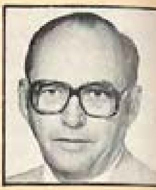

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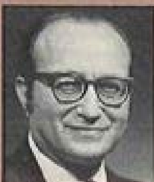

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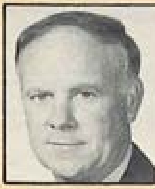

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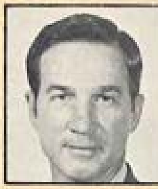

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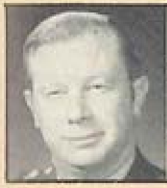

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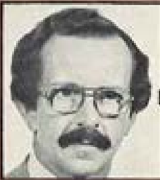

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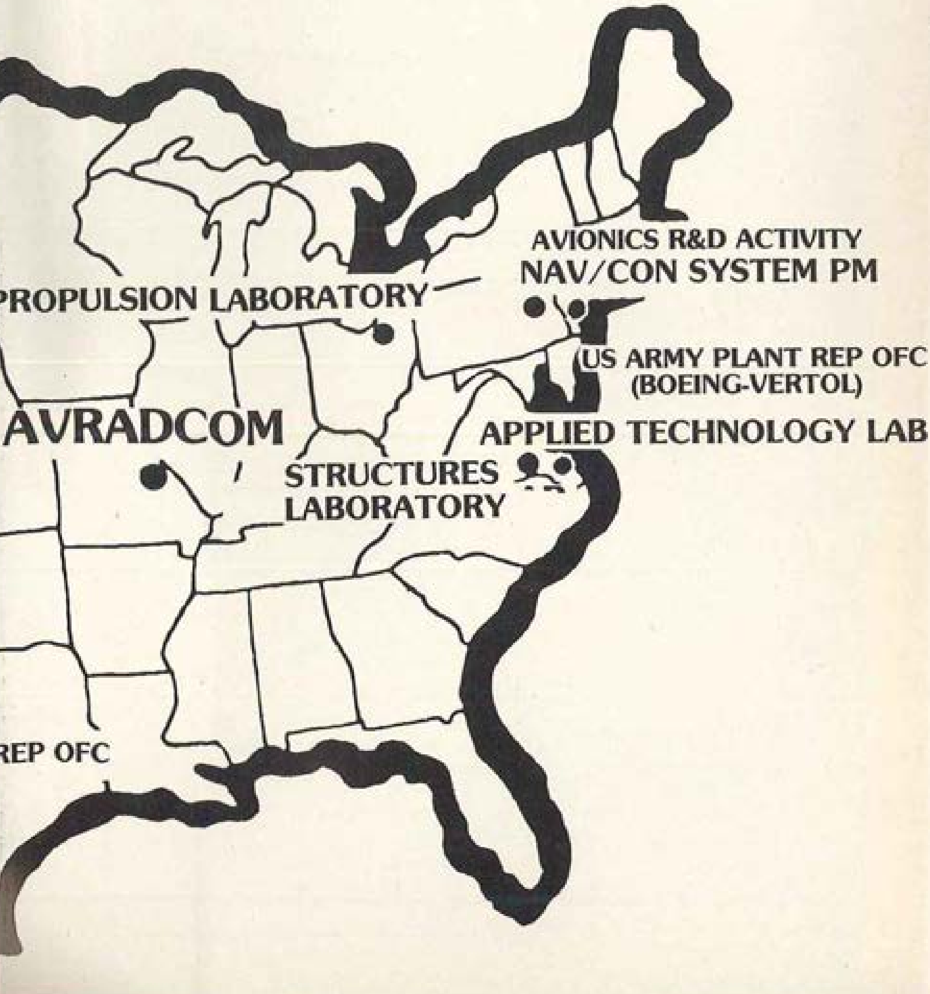

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U.S. ARMY

AVRADCOM

AVRADCOM THE HISTORY AND DEVELOPMENT

A CHRONOLOGICAL REPORT COVERING THE JUNE 1942-JULY 1979 AVRADCOM ORGANIZATIONAL STRUCTURE

June, 1942 — War Department approved organic aviation for the Field Artillery.

1947 — In the reorganization of the Armed Forces in 1947, the Air Force became a separate and equal Service with the Army and Navy. Although the Army Ground Forces were responsible for the operation of their organic aircraft, the Air Force assumed responsibility for research and development, procurement, and logistical support of the Army's aircraft.

TC assumes aviation logistics

Aug., 1952 — All Army Aviation logistical functions were transferred from the Ordnance Corps to the Transportation Corps.

Nov., 1952 — The **Transportation Corps Army Aviation Field Service Office (TCAAFSO)** was established at St. Louis as a Class II activity. Liaison offices were established at Air Force depots to coordinate activities. **TCAAFSO** determined and submitted Army Aviation requirements to the Air Force to act upon.

March, 1955 — The **Transportation Supply and Maintenance Command (TSMC)** was established in St. Louis. **TSMC** was responsible for the supply and maintenance of all air, rail, and marine equipment for the Army, including some for the Navy and Air Force. Merged with the Transportation Command at Marietta, PA.

July, 1956 — **TSMC** assumes responsibility for the storage and distribution of parts, depot maintenance, and technical maintenance.

Oct., 1959 — **TSMC** redesignated the U.S. Army **Transportation Materiel Command (TMC).**

1961 — The Army assumes the responsibility for procuring off-the-shelf aircraft from the Air Force.

Aug., 1962 — In a major reorganization of the Army, the technical services structure was replaced with the U.S. **Army Materiel Command (AMC)**. TMC became an AMC Class II activity under the jurisdiction of the U.S. Army **Mobility Command (MOCOM)**, one of AMC's major subordinate commands.

Aviation-related actions: 85%

April, 1963 — TMC becomes the U.S. Army **Aviation and Surface Materiel Command (AVSCOM)**. Aviation occupied 85% of the command's business at this time.

Oct., 1963 — The first plant cognizant activity was established at the Bell Helicopter Plant in Fort Worth, TX. Two additional plant cognizance activities were subsequently permanently assigned: Hughes Plant Activity, Culver City, CA (1968) and Boeing-Vertol Plant Activity, Philadelphia, PA (1972).

Feb., 1964 — **AVSCOM** is redesignated the U.S. Army **Aviation Materiel Command (AVCOM)** and the surface equipment functions are transferred to another command. The new Command was fully devoted to aviation, with a limited research and development capability, as a result of the assignment of the U.S. Army

Transportation Research Command (TRECOM) — redesignated U.S. Army **Aviation Materiel Laboratories (AVLABS)** March 1965, now **Applied Technology Laboratory (ATL).**

Aug., 1966 — With the disestablishment of **MOCOM, AVCOM** became a major subordinate command of **AMC**. It assumed full responsibility for the development, engineering, and procurement of Army aircraft. The U.S. Army Aviation Test Activity, now US Army **Aviation Engineering Flight Activity (AEFA)** at Edwards Air Force Base, CA, was assigned giving **AVCOM** responsibility for aircraft flight standards and qualification.

Oct., 1968 — **AVCOM** is reorganized and becomes the U.S. Army **Aviation Systems Command (AVSCOM).**

Jan., 1970 — The U.S. Army Air Mobility Research and Development Complex (Research and Technology Laboratories) at NASA/Ames Research Center, Moffett Field, CA, and the U.S. Army Aeronautical Research Laboratories: Ames (Aeromechanics) at Moffett Field, CA, Lewis (Propulsion) at the NASA/Lewis Research Center, Cleveland, Ohio, and Langley (Structures) at the NASA/Langley Research Center, Hampton, VA., were organized and assigned to **AVSCOM.**

July, 1975 — Offices of the Project Manager for Aircraft Survivability Equipment and the CH-47 Aircraft Modernization Program were established at **AVSCOM.**

Jan., 1976 — **AMC** becomes the U.S. Army Materiel **Development and Readiness Command (DARCOM).**

July, 1977 — **AVSCOM** and the U.S. Army Troop Support Command were disestablished. Both the U.S. Army **Troop Support and Aviation Materiel Readiness Command (TSARCOM)** and the U.S. Army **Aviation Research and Development Command (AVRADCOM)** were then established in St. Louis.

Jan., 1978 — **Avionics Research and Development Activity (AVRADA)** and the Office of the Project Manager, Navigation/Control Systems were assigned to **AVRADCOM.**

June, 1979 — Offices of the Project Manager for the **Advanced Scout Helicopter (ASH)** and the Tactical Airborne **Remotely Piloted Vehicle (RPV)**/Drone Systems were established at **AVRADCOM.**

July, 1979 — **AVRADCOM** celebrated its second anniversary.

The Goal of the R&T Labs

(Continued from Page 42)

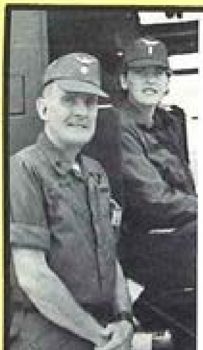
ments. To this end, experienced military personnel are assigned to the Laboratories, as well as highly qualified scientists and engineers.

The first Army/NASA Joint Agreement was signed in 1965, the signers agreeing that they had a common interest in low speed aviation technology and could, by joining resources, "achieve tangible economics and promote efficiency with respect to continuing R&D of aeronautical vehicles."

A unique agreement

Unique to the Army/NASA relationship is the agreement to trade personnel, facilities and administrative support resources, without a direct accounting as to costs or numbers of personnel involved. At each of the three NASA Centers, the Army has full use of the extensive research facilities and a wide range of technical services and administrative support are provided automatically or upon routine request.

This significantly reduces research cost and overhead requirements for the Army, while at the same time it provides benefits to NASA in the form of added expertise for its aeronautical research mission. The prime beneficiary is rotary-wing research, which is strengthened in both its civil and military aspects through the close cooperation of the two agencies.



A FIRST!—WO1 Lyn S. Mason, the first ARNG female to complete WORWAC, recently completed the AMOC as the Honor Graduate. She's pictured with her father, LTC Kenneth A. Mason, Cdr, 42nd Avn Bn, NYARNG. The duo is the first Father-Daughter Army Aviator combination.

NEW TECHNOLOGY IN ROTOR DESIGN AND ADVANCED COMPOSITES

BY THOMAS L. COLEMAN, DIRECTOR, STRUCTURES LABORATORY (AVRADCOM)

LOCATED at the Langley Research Center, the Structures Laboratory, USARTL (AVRADCOM) was formed, as were the other NASA collocated Army Laboratories, to develop in-house expertise for educated Army Aviation systems procurement and to develop rotorcraft technology in the areas consistent with the unique research facilities at the NASA centers.

At the Structures Laboratory these technology areas include basic research and exploratory development in rotor and helicopter aerodynamics; rotor aeroelasticity and dynamic stability; helicopter structural dynamics and vibration; fatigue and fracture mechanics; acoustics; and advanced materials applications to helicopters.

Access to many test facilities

Through the interservice support agreement with the NASA-Langley Research Center, the Army is provided access to a wide variety of test facilities which are essential to the Army's aviation R&D program. These facilities include the V/STOL Tunnel for performance and stability testing, the **Transonic Dynamics Tunnel (TDT)** for aeroelasticity and rotor dynamics testing, two-Dimensonal Airfoil Tunnels, Fatigue Laboratory, Structural Dynamics Laboratory, Structures and Materials Laboratory, Noise Reduction Laboratory, and the Impact Dynamics Facility as well as a wide range of sophisticated computer and flight simulation facilities.

To take full advantage of the research capabilities offered by these facilities, the Army and NASA have developed generalized rotor research models for both the **TDT** and **V/STOL** tunnels (**Figure 1**). These models have been designed with the capability of testing the fuselage and rotor system of each of the Army's current inventory of single rotor helicopters.

Mission requirements

,Recently, there has been significant advancement in the development of technology for improved rotor designs. Analyses and experiments have shown that there is considerable potential for rotor improvements provided the airfoil design, blade geometry, vehicle mission, and performance requirement are treated as an integrated system. In order to exploit this technology potential, an analysis is used to define the airfoil operating requirements as a function of mission profile and spanwise station.

Analyses have also shown that to realize improved performance over the entire mission profile, airfoil characteristics must be varied along the rotor radius. Therefore, families of airfoils are designed and tested which will provide this capability while maintaining smooth

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New Technology
(Continued from Page 52M)

transition regions.

The resulting data from the airfoil tests are used in performance analyses to iterate around the total rotor system while varying such parameters as blade twist, taper ratio, location of taper, and tip shape for a specific helicopter requirement. Tip shapes are included since in related efforts, recent tests on the UH-1 have also shown that performance, acoustics, and vibratory loads can be significantly improved for some flight conditions by changes in the tip shape geometry **(Fig. 2, opposite column).**

Substantiation of the improvements in these redesigned rotors, while avoiding the cost of full-scale development requires scale models of the most promising designs as well as the baseline rotors. To verify this technical approach, a baseline UH-1 rotor and an advanced design replacement rotor have been fabricated and are undergoing tests in the Langley V/STOL tunnel. Improved airfoils for the YAH-64 rotor are also undergoing tests, and if the UH-1 tests are successful, a scale model of the advanced YAH-64 system will be fabricated and tested. Future plans also include fabrication of baseline and advanced design systems for the UH-60 and ASH.

In addition to development of rotor design technology, the acquisition of scale model

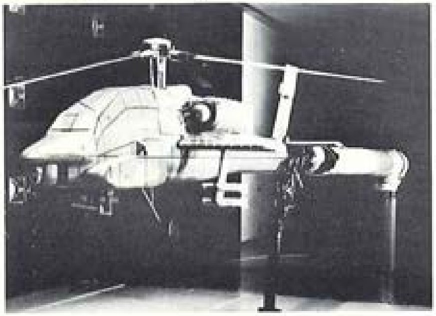


FIGURE 1 — The YAH-64 V/STOL Wind Tunnel Research Model is shown undergoing hub/pylon drag investigations and evaluation of the relocated horizontal tail. The tests, undertaken at the Langley Research Center, employ design models that have the capability of testing the fuselage and rotor system of each of the Army's current inventory of single rotor helicopters.

FIGURE 2
ADVANCED TIP SHAPES
Rotor blade tip shapes have evolved from several current helicopters based on research efforts in industry and the Government. A full-scale Ogee Tip Rotor has been tested by the Army/NASA on a UH-1 and has shown reductions in impulsive noise, power required, and control loads. This Ogee Tip technology is currently being evaluated on the Improved Main Rotor Blade for the AH-1. Swept tips as used on the YAH-64, UH-60, and S-76 rotors are designed to increase helicopter performance while reducing vibratory loads.

baseline rotors of each of the Army's current inventory of single rotor helicotpers provides the Army with the unique capability for rapid resolution of problems with existing or developing systems. Once the inventory of scale fuselages and rotors is complete, the Army will have the capability to evaluate **ECP's** and **PIP's** from a total systems standpoint, prior to commitment to full scale hardware.

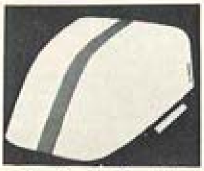
Composite materials

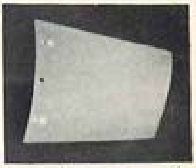
The advantages of these changes in rotor geometry could not be possible without the introduction of composites to helicopters. These advanced composite materials offer a number of significant benefits to the helicopter manufacturer and operator. In addition to providing the capability for aerodynamic contouring of the rotor based on performance requirements vs manufacturing considerations, they also provide for reduced weight, cost, and the potential of reduced maintenance.

However, until sufficient flight time is accumulated to demonstrate that composite components are in fact as serviceable, maintainable, and durable as the metal components they replace, there is a reluctance on the part of the manufacturer to propose and the user to accept, widespread composite applications.

In order to establish the durability of composites in a helicopter service environment, the Structures Laboratory, in joint participation with NASA, has established several flight service programs of both primary and secondary composite structures **(Fig. 3, opposite page).**

Flight Service of Composite Components





These programs will fabricate and place in service a sufficient number of ship sets of each component to provide a statistically significant evaluation of the effects of exposure to various operating environments on the composite components. These flight service programs will also provide manufacturing cost data for composite components, production and inspection experience, repair techniques, and repair criteria.

Environmental exposure programs

One of these programs includes the evaluation of 45-ship sets each of a Kevlar/epoxy and KLEGE-CELL core forward fairing; a two-skinned, hollow section Kevlar/epoxy fabric litter door; a honeycomb sandwich fabric epoxy baggage door, and a graphite/epoxy vertical fin on the 206L. These components and similarly manufactured composite specimens will be evaluated during exposure in the Gulf of Mexico, Alaska, and Southeast Canada. A program will include the evaluation of the graphite/epoxy bearingless tail rotor and the Kevlar/graphite composite stabilizer on the S-76.

In both programs the composite components and companion specimens will periodically be removed from service and tested to determine any degradation in the strength, durability, or service life. Civil helicopters are being selected for these evaluations in order to accumulate a high annual flight hour usage.

Relatively conservative start

Being a new material, the current application of composites in helicopters is relatively conservative in order to ensure adequate strength margins. These excess margins can be safely reduced and the potential of composites enhanced with the development of improved fatigue prediction techniques.

In order to provide realistic composite fatigue predictions, failure mechanisms and math models which predict these mechanisms for both the individual fiber and the combined fiber/matrix have to be established. Basic research and exploratory development programs are being conucted so that the fatigue processes can be characterized and the results used to develop a predicted capability for these procedures. This research should produce a generic understanding for a wide range of composite systems and lead to semi-empirical rules that will reduce testing requirements and conservatism in composite components.

With the potential widespread use of composites in helicopters, there has also been some concern expressed that the energy absorption capability of composites may be less than the aluminum construction it replaces. A variety of composites and structural concepts are being continually tested by the Structures Laboratory to evaluate their energy absorption capability.

Preliminary results from these tests show that this capability can be as good in composites as aluminum if the component is designed around composite characteristics instead of trying to use composites as a direct substitute for metals. The design and fabrication of components entirely around the composite characteristcs will also improve the costs, producibility, and weight savings; therefore, new techniques for developing this capability are continually being explored.

Successful development of the technology for improved rotor design and advanced composites will enhance the Army's potential with regard to product improvement programs for existing systems as well as the next generation of Army Aviation vehicles. As with all of AVRADCOM's R&D efforts, these programs are designed to reduce the time for implementation, cost, and the risk in applying those technologies necessary to be responsive to the users' requirments.

LONG REACH

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ALMOST THERE . . . AND LESS THAN A YEAR TO GO!

STILL A GREAT DECISION!

BY COLONEL TERRY L GORDY, PROJECT MANAGER, CH-47 MODERNIZATION PROGRAM

A year from now, the CH-47D will be entering its first production year. A fleet of totally remanufactured CH-47 **Chinooks** will start a new 20-year life of faithful and even more productive and reliable service for the U.S. Army.

In 42 short months, totally new transmissions, rotor blades, hydraulics, electrical, **Auxiliary Power Unit (APU)**, advanced flight control, and cargo handling systems have been designed, fabricated, tested and qualified. Safety, survivability, reliability, and maintainability have been intensively engineered and worked to produce the best **Chinook** ever.

More than a PIP!

Understanding of the extent of the CH-47 Modernization Program is a frequent misconception in Army Aviation today. It is **not** a typical Product Improvement Program (PIP) with several modifications. It is a total remanufacturing effort. All aircraft will be completely stripped of all components, systems, wires, tubes and controls — right down to the bare skin and stringers. Structural modification to incorporate new and higher power components, and changes to permit operation at heavier gross weights and to repair prior damage will be incorporated.

All CH-47As, Bs, and Cs will become a common configuration and will be zero-timed. The Army is saving over $1 million per aircraft with this proven approach compared to the price of a new development aircraft.

Update from our last article reflects a lot of activity and many accomplishments. Since the roll-out of the first CH-47D prototype on 6 March 1979, its flight envelope has been completely expanded and developed. Flights in excess of 50,000 lbs., speeds to 180 knots, testing with multi-point suspension of external loads, etc., have been accomplished (**Figure 2**).

Major testing ahead

By press time, the final Preliminary Airworthiness Evaluation by the USA **Aviation Engineering Flight Activity (AEFA)** test pilots and crews will have been completed and the Army's **Development Tests (DT II)** will have been started at the **Aviation Development Test Activity (ADTA)** at Fort Rucker, AL. Following **DT II, Operational Tests (OT II)** will be initiated by the **Operational Test and Evaluation Agency (OTEA)** at Fort Campbell, KY, and completed in May 1980.

A strong Army - industry team is working hard and at a fast pace to make this powerful and durable workhorse available to the soldiers in the field as quickly as possible. We are happy to report that the CH-47 Modernization Program is still on cost, ahead of schedule, and meeting all requirements.

Looking back at the many alternatives that

Still a Great Decision!

(Continued from Page 55)

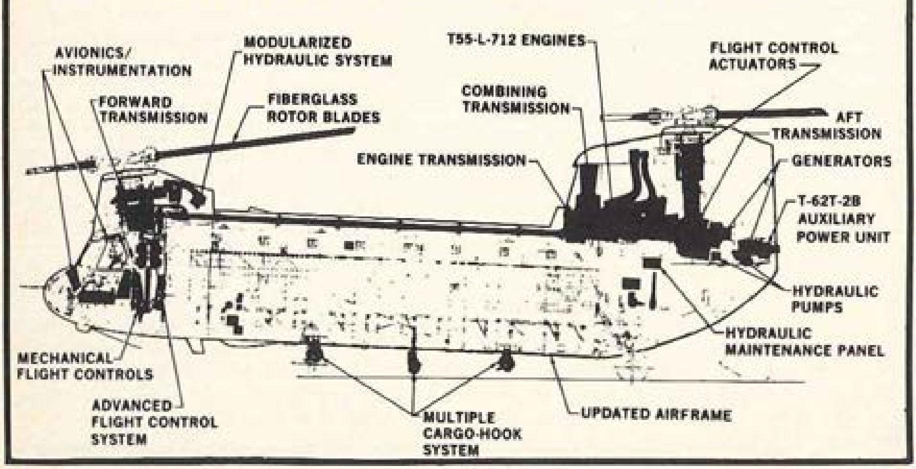
could have been taken to provide the Medium Lift Helicopter capability, there is convincing evidence that we made the best and most prudent decision to modernize our existing fleet. This decision allows continued use of our available **Chinook**-trained crews, training facilities, and basic maintenance procedures and facilities.

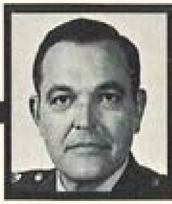
The CH-47D approach greatly improves the fleet operational readiness without penalties of introducing a new model aircraft. The years of **Chinook** learning and experience can continue to be utilized to operate even more efficient aircraft.

Better funding distribution throughout the Department of Defense can be achieved as a result of the remanufacturing modernization efforts. A proven logistics wholesale supply system capable of high speed and responsive delivery of heavy, outsized, and non-divisable loads to sustain the battles across wide fronts can economically be provided at near **Authorized Acquisition Objectives (AAO)** levels without bankrupting the Defense budget.

Less than a year to go before production. A lot of work by many people got the CH-47D here. The best **Chinook** yet — Still a Good Decision!

YCH-47D INBOARD PROFILE





NEW EYES FOR THE ARTILLERY

BY COL GEORGE F. CHRISTENSEN, PM, TACTICAL ABN REMOTELY PILOTED VEHICLES/DRONE SYSTEMS

WHAT is over the next hill? An accurate answer to this question has eluded battlefield commanders down through history. Whether armed with yesterday's cannon, today's modern artillery piece or tomorrow's **General Support Rocket System (GSRS)**, the artilleryman still has the capability to shoot farther than he can see.

In response to this frustration, the artillerymen climbed trees, later used balloons, and during World Wars I and II, used observation aircraft. These methods provided a means of target acquisition but lacked the ability to accurately adjust the artillery in real time.

Introduced in 1974

In 1974 the U.S. Army spearheaded the introduction of **Remotely Piloted Vehicles (RPVs)** for the battlefield with the **"Aquila" System Technology Demonstration Program.** The program determined that sufficient technology was available to field a tactical **RPV** system. The success achieved convinced the user community that the **RPV** would see over the next hill and beyond!

The **"Aquila"** demonstrator was evaluated by the Army in field operations to measure its utility in performing field artillery missions. It demonstrated the potential of **RPVs** to satisfy a critical operational requirement in the areas of:

- Target Acquisition
- Target Location & Artillery Adjustment
- Laser Target Designation
- Real Time Surveillance

The majority of the Army field tests were conducted by enlisted personnel at Fort Huachuca, AZ. More than **218** flights of the technology demonstrator system were conducted, and the system successfully demonstrated the potential of a tactical system to perform the required missions.

High degree of survivability

Perhaps the most impressive demonstration took place during tests in early **1978.** At White Sands Missile Range, the air vehicle designated a tank target for an incoming Copperhead round fired from a **155mm** howitzer at a standoff range of **11.5 km.** The Copperhead scored a direct hit on the tank. During tests at Fort Bliss, TX, more than **2,000** rounds of radar-directed anti-aircraft fire, and nearly **1,000** rounds from a **50** caliber gun were fired at the air vehicle without a single hit, demonstrating its high degree of survivability under fire.

An **RPV** can place the artilleryman's eyes on the total battlefield using highly survivable unmanned aircraft. Using state-of-the-art miniaturized communications and data transmission systems and computer technology, the artilleryman can see and put steel on the target to his maximum range.

New Eyes for the Artillery
(Continued from Page 57)

AVRADCOM contracted with Lockheed Missiles & Space Company on 31 August 1979, for the full scale engineering development of the required militarized tactical system. The contractor has conducted preliminary wind tunnel tests, payload integration studies, and constructed soft mockups depicting the system. First flight will be in August 1981, and in April 1983, the Army will begin production of its "New Eyes for the Artillery".

An **RPV** Section will be able to set up and be ready for launch in less than one hour after arrival at a tactical location. At the completion of a mission or other notification, the system can be broken down and ready for transport in 30 minutes. The section presents no unique convoy signature. Launcher and recovery systems fold and collapse and will be obscured from observation under canvas supported by standard bows.

The heart of the **RPV** system **Nuclear Ballistic Chemical (NBC)** hardened **Ground Control Station (GCS).** It houses the system computer, TV displays, x-y plotters, automatic tracking system, control and display consoles for the air vehicle and payload sensor operators, mission planning area, and integral Training Interface Unit. Through a remote ground terminal the operators communicate with the air vehicle and receive information back from the airborne mission equipment and air vehicle status sensors.

Shown above is a full scale mockup of the 6.5 foot long, 13 foot wing span, 200 lb. air vehicle. The vehicle is mounted on a prototype shuttle that is pneumatically propelled along the launch rail. The engine is a 26 horsepower, 2 cycle, 2 cylinder "pusher" surrounded by a circular propeller shroud. A dummy 'Mission Payload Subsystem' is shown on the forward underside of the RPV's fuselage. Also shown under the wing is a small white radome covering one of the two tracking, anti-jam data link antennas.

WHAT'S NEW WITH THE ASH?

BY COLONEL IVAR W. RUNDGREN, PROJECT MANAGER, ADVANCED SCOUT HELICOPTER (AVRADCOM)

ALTHOUGH it's only been a short time since the ASH program was presented in totality in the Special ASH Issue of **Army Aviation (October 1979)**, activity has not diminished.

First and foremost, the ASH **Special Study Group (SSG)**, through extensive utilization of the CARMONETTE and **Aviation Wargames (AVWAR)** computer models and other techniques in the **Cost and Operational Effectiveness Analysis (COEA)** has reaffirmed the need for an ASH on the modern battlefield. As of this writing, the **ASH COEA** is nearing completion, and I think I can safely say that never before has the requirement for a weapon system been examined in such depth and with such close scrutiny.

Mission package identified

The **ASH SSG** identified the mission equipment package that is essential in the scout to perform its required mission. This mission package includes the following: **Mast Mounted Sight (MMS)** to provide day and night target acquisition, laser tracking and target designation, night vision capability for the pilot, NOE communication, navigation capability to include target location and hover hold, armament hardpoints and video recorder.

The above mission package would equip the ASH to perform the following missions: hunter/killer role with the attack helicopter, field artillery observation, battlefield management, and area and convoy security. The armament hardpoint will accomodate air-to-air self-protection, air defense suppression, and air-to-ground anti-armor, if required.

Decreased detectability

A special test of a **MMS** on a helicopter performing the scout role has confirmed that the **MMS** affords a significant decrease in detectability and vulnerability of the scout helicopter in the NOE environment. The ASH **Required Operational Capability (ROC)** now in the approval cycle, includes the requirement for the **MMS** and the mission equipment capability listed above.

An ASH **Test Integration Working Group (TIWG)** is being established to facilitate the coordination, interface, and integration of the program test requirements and expedite the **Coordinated Test Program (CTP)** and the **Test and Evaluation Master Plan (TEMP)** process. An additional major thrust of the ASH **TIWG** will be to reduce the duplication of tests and to maximize the utilization of test results from prior aviation programs as they relate to the ASH program.

The development test and evaluation program will be formulated for an agile helicopter,

(WHAT'S NEW/Continued on Page 89)

ASE — THE FREE WORLD'S STANDARD FOR INCREASED COMBAT EFFECTIVENESS

BY COLONEL DANIEL J. DeLANY, PROJECT MANAGER, AIRCRAFT SURVIVABILITY EQUIPMENT (AVRADCOM)

THE Aircraft Survivability Equipment (ASE) Project Manager's Office and a close knit DARCOM/TRADOC/Navy/Air Force management team, successfully develop urgently needed items and field them in record time, within the "system."

The ASE Program

Aviation missions on the modern battlefield have added the requirements for vastly improved weapons effectiveness, intelligence collection, and electronic warfare. This same modern battlefield with all of its sophisticated hostile air defense systems dictates the need to emphasize aircraft survivability — a critical dimension of "staying power."

In response to this need and to pursue a systems approach, the Secretary of the Army established centralized management of ASE under a single charter. This approach, unique among all of the services, has been one of the major contributors to the mission accomplishment for Army Aviation.

The ASE Project Manager is chartered to:

- Develop and provide appropriate countermeasure equipment against all air defense threats. This encompasses the entire threat spect um of **Infrared (IR)** radar, laser, and optically controlled guns and weapons. This equipment is for application to the current aircraft fleet and all new development aircraft.
- To ensure that Army Aviation is prepared to meet and maintain a viable **ASE** technology base.

The Project Manager is assigned to AVRADCOM in St. Louis, MO. However, in order to execute its charge, many technological disciplines are needed, therefore dedicated laboratory and functional support is being provided from several commodity commands, depots and agencies. Electronic items are managed by the Electronic Warfare Laboratory, Fort Monmouth, NJ of the USA **Electronics Research & Development Command (ERADCOM).**

The USA **Armament Research and Development Command (ARRADCOM)** manages the development of chaff and flare systems. AVRADCOM provides the development of infrared suppression equipment, ballistics hardening, and the aircraft integration of all **ASE** systems. This allows the supporting organizations to provide the day-to-day management of the hardware items and free the **ASE** PM to concentrate on program planning, budgeting and macro management in co-ordination with the **ASE Permanent Steering Group (PSG).**

The **ASE PSG** was formed at the direction of DA from the Joint Working Group which generated the **ASE ROC**. The **PSG** is a management team consisting of represen-

ASE

(Continued from Page 61)

tatives from all of the TRADOC agencies, FORSCOM, USALEA, the intelligence community, and DARCOM subordinate commands. The PSG is the epitome of, and a real-time functional example of, the combat developer/materiel developer team concept.

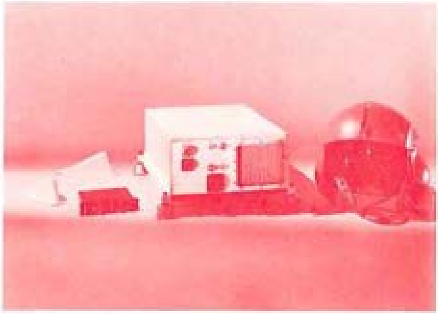
The ASE PSG has been operating throughout the total life cycle of all ASE hardware items. It has been possible to quickly and efficiently formalize user requirements, make rapid and effective trade-offs during development, significantly reduce development times and ensure user satisfaction with the materiel developed and fielded.

System fielding in 3-5 years

Development times for ASE have been reduced to two to three years total, resulting in lead times between development initiation to actual fielding of three to five years. The ASE PSG meets formally every four to five months, but the members participate almost daily in test coordination, technology and threat updates, logistics reviews, and financially and program status reviews. Every major ASE project has satisfied the appropriate formal decision process and all IPR's have been satisfactorily consummated.

The program overall has met or bettered technical, cost and schedule goals. During the past few years, the ASE project has experienced only a few technical problems, although most tasks have explored complex technologies and have been pursued on an expedited basis.

The advanced hot metal plus plume infrared (IR) suppressor and AN/ALQ-144 IR Jammer shown in close up on the new AH-1S Cobra.



The AN/ALQ-136 small radar jammer for the AH-1S Attack Helicopter.

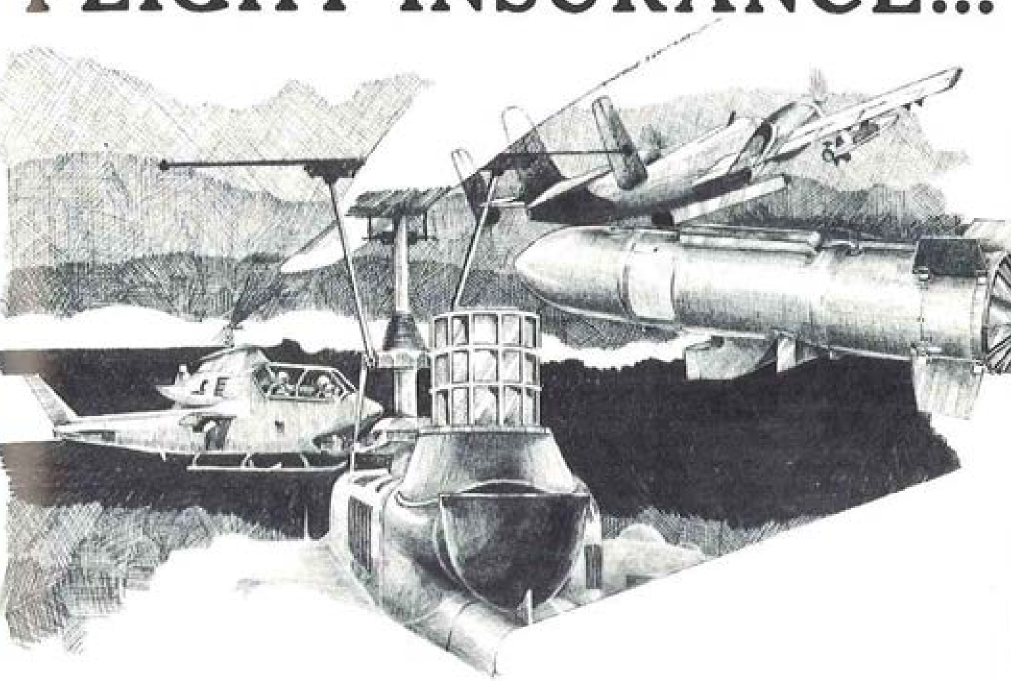
In fact, the performance has led the way in new areas of technology demonstrating major breakthroughs in the state-of-the-art. Those have established the U.S. Army as the leader in infrared and radar countermeasures survivability from the standpoint of effectiveness cost/weight, reliability and potential for growth.

ASE in the Field

The results of the Army's efforts is measured best by examining what the field armies have and are getting. For high-priority, tactical units deployed worldwide, infrared (IR) suppressors and paint provide protection for Army aircraft against surface-to-air missiles. The APR-39 radar receiver is presently being installed on the aircraft.

Special Electronic Mission Aircraft (SEMA) units, which received more sophisticated IR jammers and radar warning receivers, got more attention last year as aviation units were given updated training devices, and equipment improvements were started to meet the threat and field environment.

Improved IR suppressors were qualified and are entering, or have entered, production for the OH-58, AH-1, RU-21, and OV-1; and IR jammers were developed for the AH, UH, AAH, Black Hawk, and OV-1/RV-1 (Figures 1 and 2). The dual mode M-130 chaff fire dispenser was qualified and entered into production to protect the CH-47 and RU-21. Later, this system will be joined with the automatic



missile detector, now entering its final major stage of development and testing.

In the radar area, the M-130 was also qualified for the chaff mode, entered production, and was fielded with the first **Guardrail** unit deployed to U.S. Army, Europe. After operational evaluation and qualification is completed, it will be added to applicable tactical front-line aircraft. For attack helicopters and other aircraft, the radar jammer now completing engineering development should afford the necessary protection for "stand-and-fight" missions.

Tri-Service and Allied Interests

The **ASE** Program is not limited to the U.S. Army. The three services (USA, USN, USAF) maintain a central office and organization in Washington, D.C. which encourages the sharing of technology, test facilities, and appropriate equipments. PM—ASE is the Army's principal member of this organization and became the Tri-Service Chairman in January 1979.

This Tri-Service organization, the **Joint Technical Coordinating Group on Air-craft Survivability (JTCG/AS)** sponsored a joint service **Memorandum of Agreement (MOA)**, on **ASE** for helicopters and selected fixed wing aircraft. The **MOA** which was signed at the Service Headquarters level assigned the following responsibilities:

■ The Army will be the lead service and will be responsible for development and procurement of the following **ASE** for all service users:

- **Infrared (IR)** jammers for small helicopters and designated fixed wing aircraft.
- Lightweight, low cost radar warning receivers for helicopters and selected fixed wing aircraft.
- Radar jammers for application to attack helicopters and other selected aircraft.
- Missile Detection System — pulse doppler (ALQ-156).
- Laser Warning Receiver for application to helicopters and selected fixed wing aircraft.

■ The Navy as lead service for the following:

- **IR** jammers for large helicopters.
- Radar jammer to counter CW radar-controlled weapons.
- Missile detector that uses an **ultra-violate** (UV) sensor for detection.

■ The Air Force as lead service for a missile detector that uses an **IR** sensor for detection.

Since the signing of this MOA, progress on cooperative programs has expanded and accelerated. The services are in the process of expanding the MOA to include many new technological areas with emphasis on the early stages of development (e.g., 6.2, 6.3 phases of R&D).

As can be seen from the above, there is a very close cooperation within DOD on all **ASE** programs. Further, it clearly demonstrates that the other services agree with and have confidence in the Army's approach since they are in the process of adopting much of the Army's **ASE** for their own aircraft. **ASE** cooperation is not limited to the U.S. Department of Defense. **PM ASE** has been chairman of a **Special Working Party (SWP)** on survivability as a part of the Quadripartite Working Group on Aviation. (Members are the U.S., United Kingdom, Canada, and Australia.)

The **SWP** is devoted to the exchange of information with the potential of adopting selected items of **ASE** for common use. In November, PM **ASE** was again invited to provide an information briefing to Panel X (Aviation) at NATO Headquarters. The purpose of this briefing was both to provide information exchange, and to discuss the potential of adopting selected items of **ASE** for common NATO use.

In September 1978, (U.S./German talks along with U.S./U.K. talks,) **ASE** briefings were provided at the request of the host countries and it is possible that the future will bring about a NATO level program for selected items of **ASE**. In addition, there are continuing efforts on a bi-lateral basis with the, U.S./U.K., U.S./Germans, and with individual FMS cases.

Future for ASE is Today

ASE is fully funded and supported by DA, DOD, and Congress because it has proven itself quicker than any other "-ility" in the Army . . . "and the winner is" . . . Combat Aviators with improved Combat Effectiveness!

ASE Multi-Display

A major area of the Exhibit Hall at the April, 1980 AAAA National Convention is expected to be devoted to displays featuring current Aircraft Survivability Equipment.

THE AIR TRAFFIC MANAGEMENT CHALLENGE IN A LOW VISIBILITY ENVIRONMENT

BY COLONEL ROY WHITE, PROJECT MANAGER, NAVIGATION/CONTROL SYSTEMS (AVRADCOM)

THERE are many individual ideas and schools of thought in Army Aviation about how we should deal with operations in low visibility conditions, bad weather. No doubt, many are valid.

Some are simplistic. Others are complex. Many have been formulated without benefit of actual operational experience under very low visibility conditions. Other schools of thought are pre-conditioned by long-term exposure to the ways the **Federal Aviation Administration (FAA)** prescribes civil operations in bad weather. Others say the problem is solved if one signs up to the idea of **nap-of-the-earth (NOE)** flight.

Another perspective

Without subscribing to or disavowing any of the foregoing, the ensuing discussion invites a look at this subject from another perspective — one that includes the function of command and control. The need for good aircraft instruments and flight control systems for flying in bad weather is not ignored, but that should be the subject of another article.

The air traffic management challenge is the realization of efficient and reasonably safe aviation operations during periods of low visibility.

Everyone who has ever flown in these conditions knows that operational efficiency degrades sharply. One becomes almost totally immersed in flying the aircraft and in landing at a safe haven. "See and be seen" becomes a meaningless concept.

During the time one is in these conditions, little thought can be given to mission responsibilities such as delivering supplies, firing guns, evacuating wounded, or to the job of surveillance and reconnaisance. Keeping up with the situation and knowing where you should be along with other nearby aircraft and what you should be doing next is outranked in priority by the need to keep the aircraft upright without benefit of outside cues.

Effective employment defined

This does not have to be the case, nor should it be, if we collectively want to see an operational pay-off for the substantial investment the Army has made in aviation.

Specifically, effective employment of Army Aviation should permit the following:

- Almost complete freedom of movement of aircraft anywhere on the battlefield.
- Effective employment of aircraft in the mission area.
- Up-to-date information for aviation com-

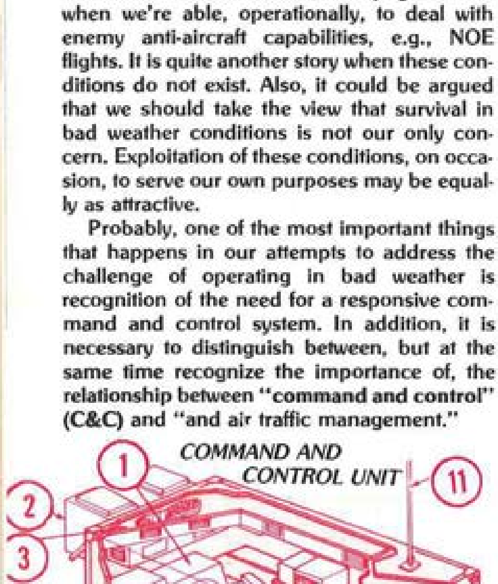
Air Traffic Management
(Continued from Page 65)

manders on the whereabouts of his aircraft and the ability to control them, both in real time, e.g., divert them to a different location or to another, higher priority mission.

- Recovery (landing) of aircraft at home base or some other desired location.

Some of the foregoing is possible now, when the weather is reasonably good and when we're able, operationally, to deal with enemy anti-aircraft capabilities, e.g., NOE flights. It is quite another story when these conditions do not exist. Also, it could be argued that we should take the view that survival in bad weather conditions is not our only concern. Exploitation of these conditions, on occasion, to serve our own purposes may be equally as attractive.

Probably, one of the most important things that happens in our attempts to address the challenge of operating in bad weather is recognition of the need for a responsive command and control system. In addition, it is necessary to distinguish between, but at the same time recognize the importance of, the relationship between "command and control" (C&C) and "and air traffic management."



A partial cutaway of a command and control master unit to be tested. 1) Display and control station. 2) Climate control unit. 3) Air distribution. 4) Cartridge magnetic tape unit. 5) Command & response unit. 6) Keyboard printer. 7) Radio mtg provisions. 8) Power control. 9) AN/UYK computers; Not shown. 10) AN/UYK-7 computer. 11) Radio antenna.

Neither individual aircraft crews nor aviation units can expect to operate on a completely discretionary basis on the battlefield while out of contact and, consequently, isolated from the control of their commanders. If Army Aviation is to keep up with the remainder of the maneuver elements of the Army, command and control, in real time, must be provided.

Implicit in this capability is the ability of the commander to communicate with his crews, to pinpoint their location of all times, and to know how their operations are meshing with the overall scheme of maneuver.

The overlapping functions of air traffic management with that of C&C, then, are readily discernible. Air traffic management, of course, involves the mechanics of actually moving aircraft about in a safe and efficient manner and in recovering them when that time arrives. This process in Army operations is often complicated by the fact that many aircraft are flying around the battlefield at the same time, and often en masse.

The call for a real time command and control capability for Army Aviation is immutable. One only has to look at what the artillerymen, infantrymen, and tankers are doing in order to advance their C&C capabilities; TACFIRE, TOS, PLRS, JTIDS; to recognize the necessity for aviation to do the same.

The Armor, Artillery, and Infantry Schools and Centers, in coordination with the Signal School and Center and CACDA, are devoting some of their best talent and much of their time to the command and control problem. In addition, they are working closely with the development community in solving the problems. Indeed, some among their number are now serving as project managers for command and control systems.

These schools and centers, together with their developer counterparts, are working on systems that will permit commanders to know precisely where every unit, tank or artillery piece is at all times and what they are doing. More importantly, they'll will give them the ability to direct their units' actions in real time.

In some cases, transfer of data throughout the system will be done automatically without being "touched by human hand." Army Aviation elements are more mobile, potentially as lethal, and as much needed in the total operation; but that will not be realizable if we are in the wrong place, at the wrong time, or even worse, sitting on the ground somewhere, weathered in and not in the communications net.

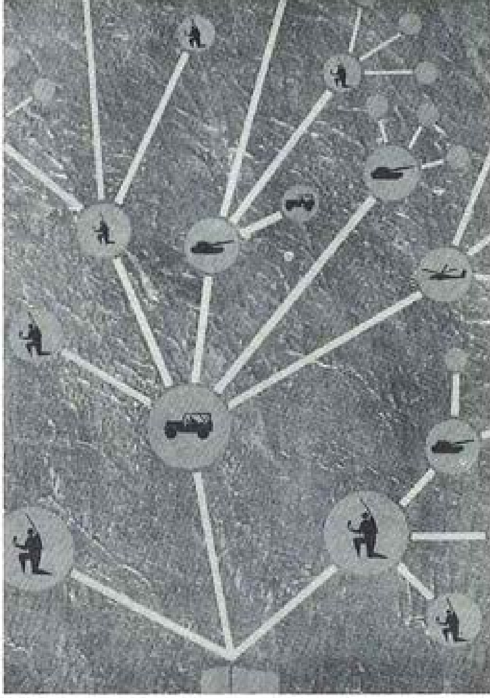
The solution to Army Aviation's command and control problem may well contain much of the solution to our air traffic management problem; therefore, solving them should be viewed as one challenge. Avoidance of similar, if not duplicate, black boxes on the aircraft is one reason. Cost, weight, and power savings are other reasons. Often overlooked but one of the foremost reasons is to reduce further demand on the use of the frequency spectrum. Anyone who has ever operated on an FM radio net, or tried to, requires no further reminder.

Technologies and approaches are varied and are many. AVRADCOM, along with other development commands of DARCOM and of the other Services, are deeply involved in several programs. Broadly stated, transfer of data, communications, manipulation of data, and displaying of data are the prime areas of R&D. In the first two, the need for speed is very important.

Burst transmissions ahead

For instance, if one realizes that much of the communication in a C&C and air traffic management system does not have to be by voice, one can, by burst transmission, in the space of one thousandth of a second, transmit what would otherwise take minutes to do by voice. Time slotted communications, as in time-division-multiple-access systems, unbelievably fast data manipulation by today's and tomorrow's computers, and highly flexible data displays could all be cornerstones of Army Aviation C&C and air traffic management system in the future.

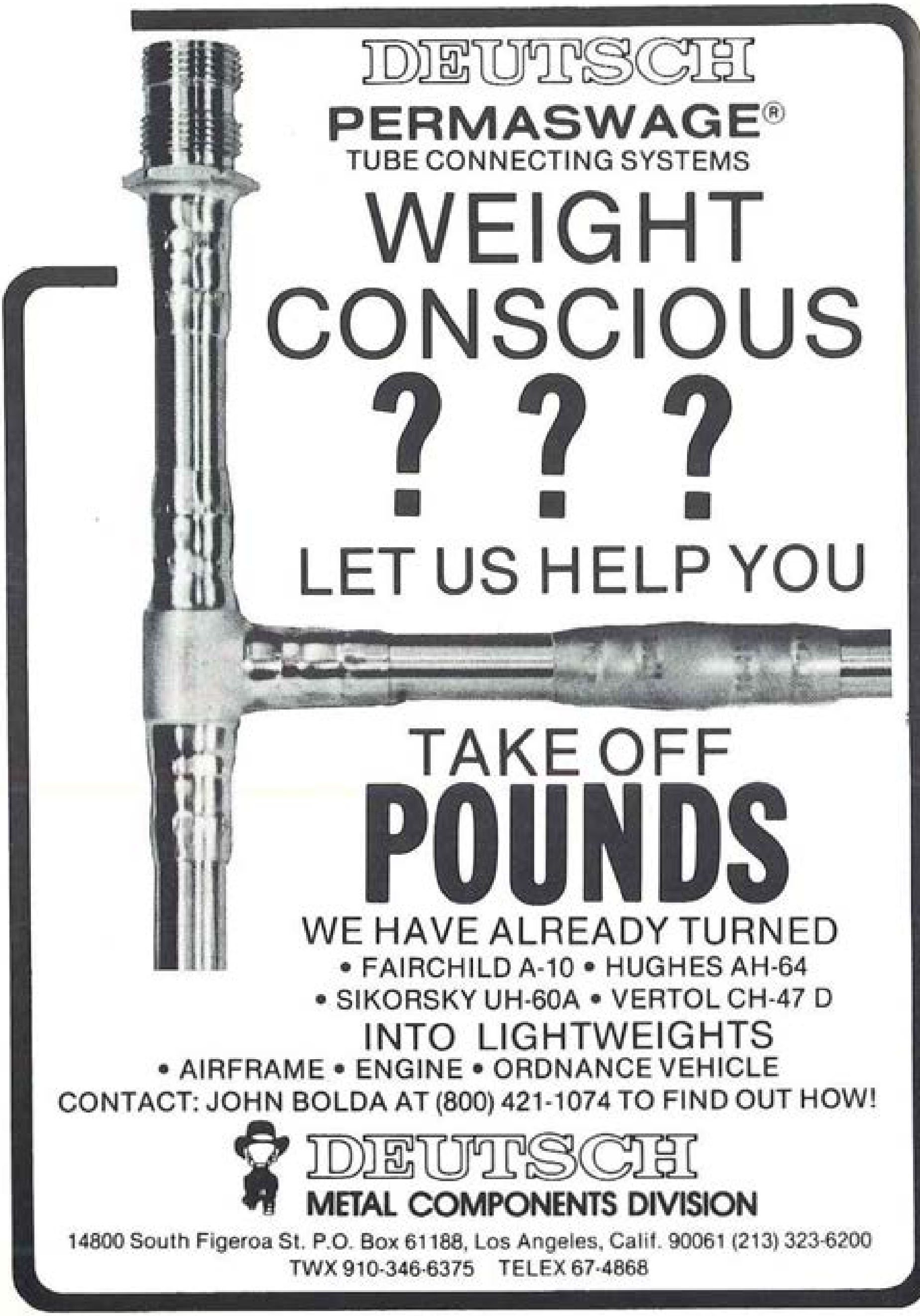
Solving our C&C and air traffic management problems must be done in close coordination with those on-going efforts of the combat arms elements. Obviously, we do not operate in isolation from them. In fact, some of the technologies being developed and used by them may well speed us along to an earlier realization of our goals.



A typical network of a time-division-multiple-access system. Coverage of a whole battlefield is achieved with automatic relaying between individual users and the master unit where every user's position is determined and displayed.

This article began on the theme of aviation operations in low visibility conditions and moved into a short discussion of command and control and air traffic management. The relationship between the two subjects is inseparable. Attempts at operating efficiently and effectively in very low visibility conditions dramatizes the need for an effective C&C and air traffic management system. Development of one part of this system should not occur without development of the other.

Without question, development and implementation should be evolutionary. If we are to stay abreast of the ground maneuver elements and be where they need us when they need us in the future, development of both must be realized. AVRADCOM is vitally concerned with its responsibilities in all aspects of Army Aviation. Definitely, air traffic management and command and control are important areas of concern.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THE DEVELOPMENT AND QUALIFICATION DIRECTORATE

AVRADCOM'S FAA

BY CHARLES C. CRAWFORD, JR., DIRECTOR, DEVELOPMENT AND QUALIFICATION (AVRADCOM)

MANY of you may not realize that even today most of our front line helicopters were developed for the U.S. Army by our sister services or they are essentially commercial helicopters type-certified by the FAA.

The UH-1 series, through the -D model, was developed under the engineering management of the Air Force as was the case for the CH-47.

Our OV-1A and OV-1B **Mohawks** were engineering products of the U.S. Navy. Both of our light observation helicopters and the **Flying Crane** were type-certified by the FAA.

More recently, management recognition of the unique requirements of Army helicopters, combined with user operational innovations, have led to a concerted effort by the Army to obtain authority to develop and qualify its own air items. From the regulatory point of view, Defense Procurement Circular 32 opened the door for this effort in 1966.

The Cobra was our first effort

The Army's maiden development effort was the **Cobra**, followed almost immediately by the CH-47B/C modifications. The real technical gains, by utilizing an engineering development team dedicated to insuring that our helicopters are optimized for the military environment, will not be realized until operational units are equipped with the **Black Hawk**, the **AAH**, and, as economics permit, a modern **ASH**.

The FAA serves a vital role, not only in the U.S., but in the entire world, in the all-important matter of regulating air commerce to foster aviation safety. In the simplest of terms this means insuring the airworthiness of all commercial aircraft flown within this country and by this country throughout the world, licensing pilots and mechanics, and establishing and managing safe air traffic control procedures. The safety record of aviation in this country and international acceptance of U.S. aeronautical products would indicate a job well done.

Airworthiness qualification

Within the Army, AVRADCOM's Directorate for Development and Qualification has full responsibility, as authorized by AR 70-62 entitled "Airworthiness Qualification of Army Aircraft Systems" effective 15 September 1978, for the first of the FAA responsibilities mentioned above. This regulation implements Army policy for airworthiness qualification of systems, subsystems, and allied equipment undergoing new development or for major modifications of standard and nonstandard Army air items.

What does airworthiness really mean?

It is a demonstrated capability of an aircraft or aircraft subsystem or component to function satisfactorily when used within prescribed limits. The key word is "satisfactorily," not

AVRADCOM'S FAA

(Continued from Page 69)

just "safely." Helicopters designed to civil safety standards may be a potential death trap in the combat environment where the ballistic threat ranges from catastrophic flight control system damage due to small arms fire to total destruction of the vehicle from a single medium caliber round. Operational and flight performance standards for air taxi services in New York, Chicago, or Los Angeles may be totally unsatisfactory in the jungles of Africa, the mud of Southeast Asia, the sands of the Middle East, or the ice covered Arctic regions.

For instance, the ground effect take-off capability from the Denver airport in the heat of the summer, is difficult for most non-miltary helicopters. Therefore, greater emphasis is placed on weight and flight performance to allow the Army helicopters to operate satisfactorily, and to excel under extreme environmental conditions throughout the world.

The key areas

The special engineering efforts that go into the development of the white sheet of paper "aircraft" with regard to the configuration that can survive in the combat environment are rather obvious. Consequently, I will not dwell on them but only mention a few key areas.

From the **structural integrity** point of view, every set of predicted loads, every stress analysis, every static test, every fatigue test, every drop test for crashworthiness is of crucial importance to basic airworthiness. Verification of material processes, ballistic invulnerability testing, out-of-balance testing to establish maintenance limits, and vibration testing to detune sensitive components, all lead to more soundly designed vehicles.

From the **performance and flying quality** view point, the detail effort to reduce empty weight and external drag, the redundancy of flight control system components, the failure analysis of electrical and hydraulic elements of the flight control system, and the proper optimization of automatic stabilization equipment are keys to reducing the flight crew workload under the pressures of combat. The need for durable transmissions, even after massive lubrication failures from battle damage; low fuel consumption; engines that are highly dependable and forgiving under less than perfect maintenance; and fuel systems that are completely reliable are a must for the military helicopter.

It is "penny wise, pound foolish" not to have engine redundancy when operating in a combat environment when mission equipment approaches or exceeds a million dollars in value (be it ordnance, visionics, communications, or related equipment). "Fly it home to fight another day" must be the soldiers' byword.

Therefore, the benefits to the Army in having its own military development and qualification team during new developments are straightforward. However, affordability problems impacting not only the entire DOD, but specifically, Army Aviation, are such that the same emphasis must be placed on the engineering and qualification of modificatons to existing helicopters in order to insure that only the most combat durable air items are provided within cost and schedule restraints.

Towards this end, the airworthiness regulation has a new impact on operational units with fielded aircraft, in that any aircraft which has a major modification must be subjected to major re-qualifications. These major modifications which are subject to a design to re-qualification are modifications which could measurably effect structural integrity; propulsion or drive system operation; aerodynamic characteristics, including drag; electromagnetic characteristics; navigational system effectiveness; weight and balance; and flight control system authority and effectiveness.

There is a tremendous tendency for units making such modifications to request an airworthiness release at the last minute. However, when modifications are initially planned, involvement of the development team with the skills in the disciplines described above can be of immeasurable value. Therefore, the AVRADCOM airworthiness team welcomes the opportunity to provide airworthiness qualification and development support of aircraft systems, aircraft subsystems and allied equipment. This support is most effective if introduced at the design stage.

Our goal is a dedication to insure that the Army user community has "airworthy" aircraft in every sense of the word.

AEFA — THE ARMY'S ENGINEERING FLIGHT TESTER

BY COLONEL LEWIS J. McCONNELL, COMMANDER, USA AVIATION ENGINEERING FLIGHT ACTIVITY, AND JAMES S. HAYDEN, AEFA TECHNICAL DIRECTOR

ENGINEERING Flight Testing is a limited and specialized portion of the total Development Testing (DT) effort. This mission is performed by the U.S. Army Aviation Engineering Flight Activity (AEFA), a subordinate activity of the U.S. Army Aviation Research & Development Command (AVRADCOM). The tests encompass handling qualities, vibration and performance. Handling qualities and vibration are assessed in terms of pilot effort, crew comfort and effects on cargo or ordnance.

"Performance" defined

"Performance", as we use it, refers to aircraft capabilities in terms of how heavy, how high, and how fast in addition to the broad interpretation - "does it do the intended job." The testing supports the airworthiness qualification portion of DT.

AEFA is located at Edwards Air Force Base, CA as a tenant organization on the Air Force Flight Test Center (AFFTC). This location in California's Mojave Desert provides excellent year-round flying weather, almost unlimited positively controlled airspace and adjacent access to extensive weapons firing ranges. Co-location on Edwards AFB also provides for joint use of extensive flight test support facilities.

The AEFA-AFFTC relationship is a model of interservice cooperation with the Department of Defense and the taxpayers being the ultimate beneficiaries. The AFFTC provides access to engineering flight test support facilities unavailable anywhere else in the world. As a result of the close harmonious relationship developed over 19 years of association, AEFA is treated as a tenant privileged far beyond its size alone would justify. Edwards' geographical location between the Imperial Valley and the Sierra Nevada/Owens Valley/White Mountain area provides test sites at field elevations from below sea level to over 12,000 feet within a radius of 190 nautical miles; a feature unique within CONUS.

Remote testing sites available

The relative proximity of the various remote sites is a key factor in the economy of AEFA's flight testing even though more than half of our testing is conducted away from Edwards AFB. In addition to high and low altitude tests conducted at remote sites in the Edwards vicinity, AEFA performs many tests at contractor plants and more than thirty other specialized sites. Locations for these tests span the United States and several foreign countries from the Argentine Andes to Cold Lake, Canada; from West Palm Beach, FL to Fairbanks, AK.

While the vast majority of the workload is in direct support of Army aircraft development and qualification by AVRADCOM, AEFA has

TADS/PNVS

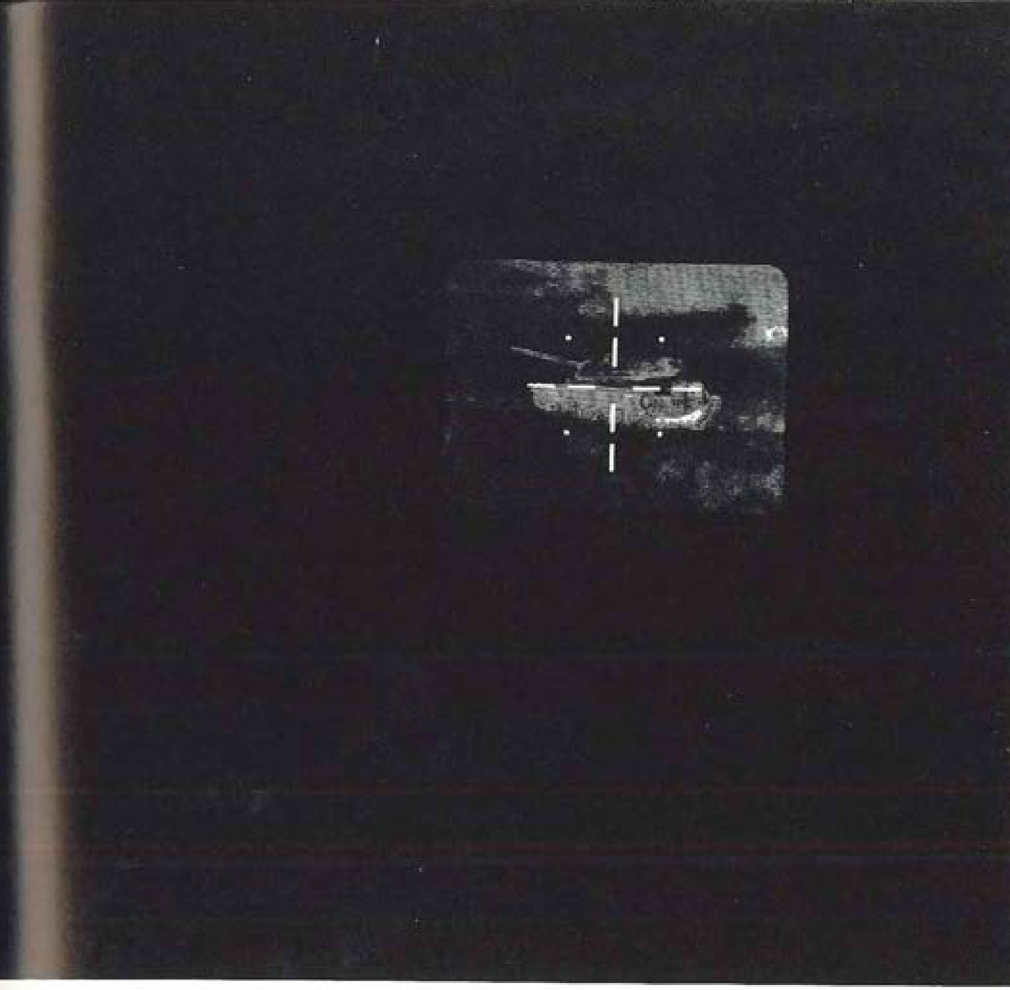
Northrop's TADS/PNVS for U.S. Army's Advanced Attack Helicopter (AAH) permits AAH to attack and survive at extended standoff ranges, day or night, under adverse weather conditions.

TADS (Target Acquisition Designation System) allows direct view target detection and tracking. Night and long-range target recognition. Laser tracking and range finding.

PNVS (Pilot Night Vision System) provides forward-looking infra-red imagery allowing nighttime nap-of-the-earth flight.

Northrop TADS/PNVS designed specifically for Army AAH. Proven technology derived from Northrop's broad range of electro-optical experience. More than 500 Target Identification Systems delivered to U.S. Air Force for F-4 Phantom. Northrop producing Television Sight Unit for U.S. Navy F-14 Tomcat. Developing electro-optics for Seafire fire control system for Navy surface ships.

Northrop Corporation, Electro-Mechanical Division, 500 East Orangethorpe Avenue, Anaheim, California 92801.



The Army's Flight Tester

performed tests for a variety of customers. These "other" customers have included, The Army Security Agency, The U.S. Forest Service, The Government of Iran, The Foreign Science and Technology Center, The USAF, NASA, and FAA. AEFA has also provided remote site support for most U.S. manufactures, The Royal Navy of the United Kingdom, and the Royal Canadian Air Force.

Unique resources required

Accomplishment of the mission requires unique resources. AEFA has an inventory of specialized test instrumentation, data acquisition systems, calibration facilities and special equipment valued at more than $11 million dollars. Tremendous savings in required fixed inventory of unique engineering flight test related support equipment are effected by the co-location with the AFFTC as previously mentioned. Our most important resource however is our staff of 158 skilled dedicated professionals, including 15 highly qualified and experienced test pilots.

AEFA has a distinguished history and has established a free-world reputation for excellence in engineering flight test. The Activity was established with a staff of three at Edwards AFB as the Aviation Test Office of the Transportation Materiel Command (TMC), St. Louis, MO in March 1960. Except for a short three-year period when the Activity reported to the U.S. Army Test and Evaluation Command, the parent headquarters has remained with the successors to TMC, currently AVRADCOM.

A history of accomplishments was climaxed in 1977 when the Activity was awarded the coveted **Grover E. Bell Award** by The American Helicopter Society for outstanding achievement in conducting concurrent competitive fly-off evaluations on the **Black Hawk** and **AAH** programs.

Emphasis is placed on "engineering" in AEFA's testing as quantitative results are used as the basis for airworthiness and procurement decisions, and provide the basis for data presented in the aircraft operator's manual. This is done with specific engineering test techniques, in contrast to some forms of DT where system characteristics are evaluated by performing typical mission profiles. It is also in contrast to most operational tests or user tests where mean performance (broad interpretation) is assessed throughout the full range of conditions (tactical deployment, field conditions, average skill mechanic) expected.

Two tests peculiar to Army Aviation are the **Preliminary Airworthiness Evaluation (PAE)** and the **Airworthiness and Flight Characteristics Test (A&FC).**

Early risks to test personnel

During the early development phases or following significant modification, aircraft present a potential risk to test personnel. This early development risk is recognized in regulations which require that an airworthiness release be issued by AVRADCOM before Army personnel fly any new or highly modified aircraft (AR 70-62). The normal procedure is to task the manufacturer to perform first flights and early flight envelope expansion.

The flight data gathered by the contractors,

(AEFA/Continued on Page 89)

The facilities at the Army Engineering Flight Activity (AEFA) at Edwards Air Force Base, California

ENGINEERING THE FLEET

BY COLONEL JAMES D. POTEAT, DIRECTOR, SYSTEMS ENGINEERING (AVRADCOM)

THE Directorate for Systems Engineering and Development, the largest St. Louis based element and the third largest organization within AVRADCOM, provides readiness oriented engineering support for the Army's fielded aircraft and aviation subsystems.

This support is provided to the entire Army Aviation community, more specifically to TSARCOM and the using aviation units. While this article is being read, engineers from the Directorate are providing on-site "hands on" engineering support to Army Aviation units at CONUS and overseas locations. This user support consists of analyzing the causes of aviation equipment and component failures, determining the appropriate fix for the problem, and assisting, as required, with the application of the fix.

Specialized engineering support

The Directorate's **Aircraft Systems Engineering Division** provides this specialized technical engineering support for the fielded aircraft. The support is affected by a dedicated Branch for each type of fielded aircraft, i.e., Attack Helicopter, Observation and Transport Helicopter, UH-1, **Black Hawk**, and Fixed Wing Branches.

In addition to the above direct field support, the engineers of these specialized branches participate in concept formulation and contract definition of aviation systems under development; provide engineering input to safety-of-flight and maintenance/technical advisory messages to the field; and provide technical management and control of fielded aircraft systems and related equipments with respect to Quality Deficiency Reports, revised or new information in technical/maintenance publications, **Engineering Change Proposals (ECP)**, testing, establishment of maximum allowable operating times, repair limits, and inspection criteria.

A high degree of involvement

A brief description of some of the other projects which the **Aircraft Systems Engineering Division** has been, or is, supporting will help to bring its varied functions into focus. The Division's engineers are providing extensive support to the **Nap-of-the-Earth (NOE)** Communications Product Improvement Program and to the flight simulator developer (PM-TRADE) in tasks from development through completion of the production contracts. After transition of the simulators to the readiness command, TSARCOM, the Division will continue to provide engineering support to the flight simulator **Readiness Project Officer (RPO)** for the fielded systems.

Division engineers custom designed two special support systems which were needed on

Engineering the Fleet

(Continued from Page 75)

an expedited basis for the recent **CH-47D** deployment to Europe, a rescue hoist for aircraft retrieval of personnel who may be downed in water, and a manual method for replenishment of engine oil while in flight.

Neither the above discussion nor the title of this article should lead the reader to assume that the Directorate is only concerned with the presently fielded Army aircraft fleet. The fleet we "engineer" also includes future aircraft, which explains the "development" part of the Directorate's title. The Directorate provides major aviation developmental projects, e.g., **AAH, Black Hawk**, and **RPV**, with engineering support.

Providing life cycle support

The **General Systems Engineering Division** provides life cycle support to the aviation Project Managers in such specialized areas as aircraft survivability equipment, ground support, cargo handling, and diagnostic equipment. One of the most visible programs being executed by this Division is **Aviation Life Support Equipment (ALSE)**.

Some of the items under development are a floatation kit for helicopter aircrewmen and passengers, an oxygen system for helicopters, a crash attenuated pilot/copilot seat, and an inflatable body and head restraint system.

The **floatation kit** is a vacuum packed standard USAF life raft which is easily attachable to the leg of the aircrewmember or passenger **(Fig. 1)**. This compact raft will allow for

FIGURE 1—Flotation Kit for Helicopter Aircrewmen and passengers (USAF life raft).

FIGURE 2—The armored crash attenuated pilot/copilot seat undergoing final qualification.

immediate access and easy egress from the downed aircraft, and will not interfere with aircrew duties. The **helicopter oxygen system** will consist of a properly restrained oxygen tank, with appropriate crashworthy features, and will allow increased use of helicopters within the high altitude envelope.

The **armored crash attenuated pilot/copilot seat** is undergoing final qualification tests **(Fig. 2)**. This high quality steel seat will meet the crash attenuation criteria, provide multi-hit ballistic protection and present a substantial cost reduction over the present armored seat with a negligible weight penalty. The **inflatable body and head restraint system** is a joint development project with the U.S. Navy **(Figure 3)**. A crash sensor will automatically inflate the air bags on the two upper torso restraining straps, preventing whiplash and/or impact on gunsights by essentially driving the aviator back into his seat.

The **Military Adaptation of Commercial Items (MACI)** is another major program within the **General Systems Engineering Division.** Two items currently in this program are the **Self-Propelled Elevating Maintenance Stand**

and the **Self-Propelled Crane**. These commercial items are modified and tested to military specifications and will provide safer, more efficient aircraft maintenance equipment for use on future battlefields.

Safety is always of big concern in the aviation community and is logically so within our business at AVRADCOM. The Systems Safety Officer is the AVRADCOM focal point for all systems safety engineering program activities. This office should not be confused with unit/installation safety offices nor with the job performed by an aviation flight safety officer.

Aircraft system safety activities

This office directs aircraft system safety activities during equipment design and development, and it ensures that system safety engineering criteria, principles, and techniques are fully considered in the development of new aircraft systems, and that similar system safety techniques are present in the life cycle management of AVRADCOM managed items.

There are several other important programs which fall within the responsibility of the Directorate, one being the conduct of AVRADCOM's assigned portion of the Defense Standardization and Specifications Program. The general mission of this program is to standardize items used throughout DOD by developing and using single specifications, thereby eliminating overlapping, duplicate specifications and reducing the number of Army Aviation items that are generally similar.

The coontribution of the FIO

The **Foreign Intelligence Office (FIO)** performs a vital function for both AVRADCOM and TSARCOM. The **FIO** is charged with the acquisition, analysis, and dissemination of threat, scientific, and technical intelligence, and insuring its use in support of AVRADCOM's aviation research, development, test, and evaluation process. We are aware that the development of aviation doctrine, tactics, and the evolution of the technology base to support future Army Aviation systems development is driven by the enemy threat to be encountered on future battlefields.

The **FIO** made a significant contribution to Army Aviation recently by writing, publishing, and distributing the **Threat to U.S. Army Aviation Systems** which has been validated by DA as the threat to the AAH, ASH, **Black Hawk**, CH-47, RPV, SOTAS, SEMA, and ASE programs.

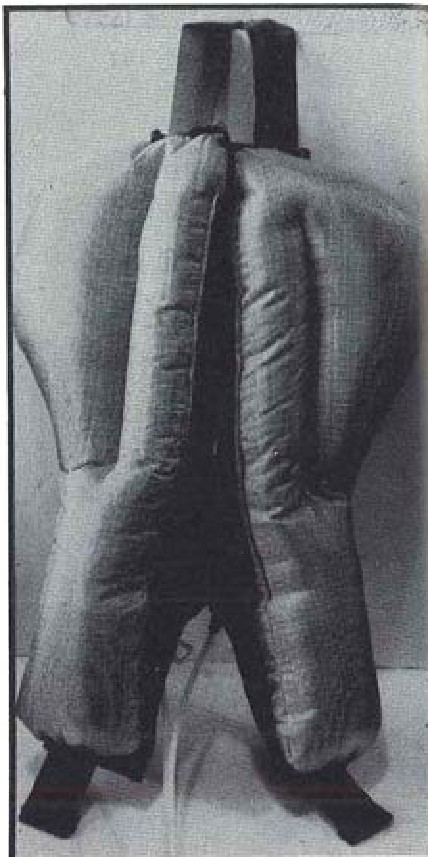


FIGURE 3—The inflatable body and head restraint system, a joint development project with the U.S. Navy, is shown inflated. The system prevents injury by inflating and essentially driving the pilot back into the seat.

Yes, Army Aviation, you do have a R&D team which is vitally interested in the aircraft with which you will fight. The **Systems Engineering and Development Directorate** is a vital part of the AVRADCOM team and the men and women of the Directorate are proud of the job they perform in "Engineering the Army Aviation Fleet."

THE 50/50 WARRANTY

BY EDWARD J. HOLLMAN, DIRECTOR, PRODUCT ASSURANCE (AVRADCOM)

THE role of product assurance in the development and acquisition of materiel is continuing to evolve.

Although the objective of providing the user with high-quality weapon systems that he can afford to operate has remained the same, the emphasis has shifted towards providing the contractors with the techniques and the motivation to design in these attributes as opposed to trying to inspect them once the weapon systems are in production.

50 seconds or 50 feet?

A product's quality in a free market is reflected in large part by the warranty that's offered by the manufacturer. The terms of the warranty provide a "real time" assessment of quality of the product. To some marketeers a 50/50 warranty means 50 seconds or 50 feet, whichever occurs first.

It's obvious from this type of warranty that the seller has little confidence in his product and, consequently, no product assurance program.

The point is a manufacturer has to thoroughly understand and control the reliability and quality aspects of the product before he can offer any sort of warranty program. The issues associated with understanding the risks of warranting the product are all developed in the product assurance arena.

The fact that warranty programs are becoming part of the DOD acquisition process is an indication that product assurance disciplines are involved with the system development. Without a viable product assurance program during engineering development, it is next to impossible to discuss any type of warranty program. If a manufacturer states that his system entails too much risk to warrant, one has to wonder if the engineering development program has been completed.

Management techniques provided

In Government contracts, the product assurance program provides management techniques and resources to minimize problems with the production hardware. The traditional program elements include **Reliability, Availability, and Maintainability (RAM)**, Critical Parts, and Quality Engineering Programs.

In addition, work is being done to provide a new technique for industry to understand the relationship between the quality control function and produceability. This technique recognizes there are limits to the efficiency of the quality control procedures, which have to be considered during the design process to insure that a piece of hardware will consistently conform to specification. This technique has been coined as **Reliability Based Quality (RBQ)**. The following provides an explanation of the

The 50/50 Warranty

(Continued from Page 79)

major aspects of a product assurance program.

The first impact of product assurance on an engineering development program came in the form of **RAM.** It was recognized that the characterists of reliability and maintainability had to be designed into the system in order to achieve the desired affect on the production hardware.

The engineering development contract had to include a fully integrated **RAM** program with sufficient resources to impact the design process. To set **RAM** requirements for the new weapon systems, an assessment of existing systems had to be made to determine the **RAM** characteristics. This resulted in extensive efforts toward analyzing the field data on our operational fleets.

The impact of RAM

As these tools improved, the impact of **RAM** on the design process became more significant During the **Black Hawk** Program, the **RAM** characteristics were a key element of the requirements document. Since an accurate assessment of **RAM** characteristics had to be made during the competitive fly-off, a **RAM/ LOG** data system was developed to provide high-quality information by which the source selection board could make decisions of the **RAM** characteristics.

The information obtained from this data system will form the basis by which the **RAM** requirements for future helicopter systems will be developed. The need for this type of data system was recognized at the DARCOM level and currently is being refined into a DARCOM common test data collection system. The **Black Hawk** helicopter is the first system fielded by AVRADCOM to have a fully-integrated **RAM** program. The lessons learned on this Program will be used to improve **RAM** tools to do a better job on future systems.

The second area of a dedicated product assurance program is a quality engineering program with the objective to assure that "improved production procedures" do not adversely affect the **RAM** design and prototype test validation. To accomplish this, production acceptance test procedures must be developed which will verify the acceptability of production hardware.

To put the reliability risks in priority AVRADCOM Product Assurance recommends the contractor's quality assurance plan include an **Reliability Based Quality (RBQ)** Program. Flight safety risks are reduced with an **RBQ** Critical Parts Program that places stringent controls over manufacture and inspection of critical parts, which are defined as a non-redundant item where a single mode of failure could prevent a safe autorotation.

Need for product integrity

The need for product integrity in weapon systems has never been greater. Poor quality is never acceptable, and in this time of increasingly sophisticated technology there is a high risk in solving field reliability/quality problems with the logistics system. There is little doubt that the DOD contractors want to provide products with the best quality available. However, the main competitive issue has been acquisition cost and even though low acquisition cost and good quality are not mutually exclusive, a manufacturer who may spend a little more to improve product integrity might compromise his competitive position. A warranty program, included in the procurement, can result in a much more reliable product.

The risks can be quantified

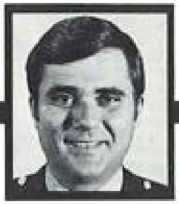
A warranty program is not without risks. The risk to the contractor is that he may overestimate the levels of reliability and quality in the production hardware. On the Government side, filing a defendable warranty claim will truly test the logistics management system. These risks can be understood and quantified. The product assurance program during engineering development includes management techniques to control the risks.

Attempts are being made to include enough flexibility in the Request For Proposals to allow innovative approaches to improving the effectiveness of the engineering development product assurance program.

* *

The "AVRADCOM Special Issue" is the first of four 1980 "theme-oriented" special issues. Later issues will cover the **AAAA Convention, AA Equipment**, and the **1980 AAH Program.**

PROCUREMENT AND PRODUCTION . . .



THE ARMY AVIATOR'S INTERFACE WITH INDUSTRY

BY COLONEL MICHAEL J. PEPE, DIRECTOR, PROCUREMENT AND PRODUCTION (AVRADCOM)

THE role of procurement is often taken for granted and not fully appreciated by the soldier in the field. Yet, it is vital to Army readiness and the Nation's defense to insure the Army Aviation team has the best equipment money can buy.

Materiel Acquistion — A Challenge

Contrary to a popular myth held outside the materiel acquisition community, the nature of research and development programs dictates we cannot be just "order placers". Think about it! How does one go about placing an order for a vision? Visions lack configuration. It must be determined if the desired weapons system capability is achievable within the current state of the art.

True, basic textbook procedures have evolved over the years for acquiring major weapon systems. A multitude of new weapon systems have been developed and procured. But the timing and uniqueness of each acquisition creates new challenges which require unusual flexibility and innovation to overcome.

Weapons technology is continually on the move! The procurement process must be responsive to capitalize on state-of-the-art breakthroughs. Special terms and conditions must be incorporated into contracts to cover technical uncertainties and economic risks associated with growing materiel leadtimes and spiraling costs of labor and material. New faces appear in the DOD acquisition heirarchy bringing with them new philosophies. Emphasis is continually redirected to varying aspects of the acquisition cycle and the procurement process. And we are continually plagued with the age old challenges of time and funding constraints.

Consequently, though a basic framework exists, each research and development procurement is unique and must be tailored accordingly. The **Procurement and Production (P&P)** Directorate is the acquisition team tailor which fashions contracts to Army requirements, threads them with legal and technical sufficiency, and fits them to philosophical molds of the times.

The ultimate in teamwork

The Army research and development acquisition process is highly regulated, complex and dynamic. Its success cannot hinge on one individual or one activity. It is a team effort, requiring the close, concentrated and coordinated efforts of many people and many agen-

Realistic training against hostile radar ...in the classroom!

Realistic.

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MCDONNELL DOUGLAS

Army Aviator's Interface
(Continued from Page 81)

cies, in both Government and industry, to initiate and execute a viable acquisition program, and bring it to a successful conclusion.

The Procurement and Production Directorate plays an important role on the materiel acquisition team. It is the interface between the Army and industry to bring dreams, concepts, and ideas to reality.

The special team

AVRADCOM is authorized a **P&P** staff of 149 multi-disciplined, highly-skilled professional military and civilian men and women. For ease of management, it is organized into functional divisions: Contract Cost; Industrial Management/Production; Policy and Compliance; and Procurement, all supported by a small Administrative Office.

Typical of the acquisition process itself, our operational modus operandi stresses teamwork. Only one Contracting Officer, warranted to bind the Government and obligate Government funds, is assigned to each procurement program. The rest of the **P&P** specialists are matrix organized into special units called Contracting Officer Teams. This insures dedicted, specialized support to the Contracting Officers and procurement programs.

Though not within the Directorate's manning, legal representatives are assigned to each procurement program, hold membership on the Contracting Officers' Teams, render counsel and advice, and generally insure all we do is legally sufficient — the importance of which cannot be overemphasized in the sensitive, fishbowl-like procurement environment.

Procurement Game Plan

On the average, the AVRADCOM **P&P** Directorate manages 300 active contracts, valued at over $2 billion for aviation systems and subsystems. Over $500 million in additional contracts are awarded annually.

Some of the major aviation programs under our procurement cognizance are the UH-60A **Black Hawk, Advanced Attack Helicopter (AAH), Advanced Scout Helicopter (ASH), CH-47D Modernization, AH-1 Modernization,** and **Remotely Piloted Vehicle** and **Target Acquisition Designation System/Pilot Night Vision System.** This is an impressive statistical profile and array of programs.

The big picture in perspective

The acquisition process is a deliberate sequence of specified program activities and decisions which logically transitions a system from concept through deployment. Procurement and production are two of the important considerations which are identified, analyzed, and quantified in specifications, program plans, and estimates essential to decision making.

The process has its roots in the recognition of a need by the Army aviator or Army planners to counter real, or perceived threats, or to satisfy changing mission requirements.

Concept formulation

The objective of this phase is to define the system concept. Nevertheless, **P&P** becomes actively involved in developing alternative acquisition and procurement strategies and approaches to management and competition. As required, **P&P** also solicits industry inputs and participates in in-house study initatives.

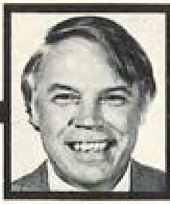
Concept validation

The determination that the program has sufficient technical and operational support to warrant commitment of resources signals the beginning of the validation phase of the acquisition process. Both in-house and out-of-house efforts are initiated to develop, refine and validate the system concept and define the operational, technical and logistical aspects of the system. This phase can require the fabrication and testing of competitive prototypes or paper designs for consideration. All efforts requiring industry participation are executed through the **P&P** Directorate.

Engineering development

Assuming all goes well during validation, the need is reaffirmed and the decision will be made to commit development resources. At this decision point, the system transitions to Engineering Development. Here, the total system is designed, fabricated, and tested for operational worth to establish the basis for the

(INTERFACE/Continued on Page 90)



ARMY AVIATION'S IN-PLANT WATCHDOG: THE ARPRO!

BY JAMES R. BRENNAN, CHIEF, INDUSTRIAL MANAGEMENT & PRODUCTION DIVISION; DIRECTORATE FOR PROCUREMENT AND PRODUCTION

LEAN, mean, hard working, and loyal all describe the on-site organizations known as the Army Plant Representatives Offices.

In all of the DARCOM community, only AVRADCOM has been assigned DOD cognizance for on-site contract administration services, and aviation has only three plants — "the biggees", Bell Helicopter Textron, Fort Worth, TX, Boeing-Vertol Company, Philadelphia, PA, and Hughes Helicopters - Summa Corporation, Venice, CA.

When reviewing Army Aviation, you need to pay special attention to this unique segment of the acquisition process; the organization, the people, and the effort which contribute, as no other can, to the success of a major weapon system program.

"Downright hardnosed"

By all measures of efficiency, these ARPROs perform with less manpower and budgets than their 62 Air Force, Navy, and DLA counterparts. They have been known to get downright hardnosed in order to protect the contract of the DOD customer. Whether you are a contracting officer with a problem at Hughes, a project manager with a need for assistance at Bell, or a foreign government depending on the United States aviation expertise at Boeing-Vertol, AVRADCOM's civilian and military personnel are in the field working on your behalf.

The key to the way in which Army Aviation executes its DOD cognizance assignment lies in the complete reliance on the Commander to use his organization and personnel as part of a total aviation team. Currently, **COL Albert B. Luster**, Commander at Boeing-Vertol; **COL Charles U. Vaughan**, Commander at Hughes Helicopters; and **COL Donald W. Ferguson**, Commander at Bell Helicopter Textron, are integrating their efforts to accomplish the aviation R&D mission.

They're on-site eyes and ears

These commanders and their predecessors have been repreatedly recognized for their outstanding support of contracting officers, project managers, and allied governments, not only in providing the keen on-site eyes and ears of the Government for Army programs, but also for any foreign government or any U.S. agency which has contracted for their services.

While there is a list of 69 DOD contract administration services being offered on a non-reimbursement basis to DOD organizations, and on a reimbursement basis to other agencies and foreign governments, the ARPROs also handle both large and small, but always important, jobs which can only be done efficiently by on-site Army Aviation personnel.

The ARPROs execute their support through various divisions, and although the organiza-

In-Plant Watchdog
(Continued from Page 85)

tions often are tailored to the contractor's current programs or commodity mix, certain standard divsions are uniformly present. These standard divisions include **Contract Services, Engineering, Production/Industrial, Quality Assurance, Administrative Services,** and **Flight Test.**

The ARPROs' **Contract Services Division** is initially involved in all DOD contracts awarded to one of our DOD facilities. The work of this division also continues throughout the length of the contract as it has responsibility for such ongoing activities as contract accounting and final payment.

Seeking contractor compliance

This division, staffed with warranted Administrative Contracting Officers, Contract Specialists, and Pricing Analyst, reviews proposals submitted by the contractor and provides the recommendation to the Procuring Contracting Officer. These advisories are made with input from the ARPROs' technical, quality assurance, and production staffs, as well as the local supporting Defense Contract Audit Agency.

Once a contract is signed and work begins, the ARPROs spring into action. With dogged determination, they insure that the contractor complies with the terms and conditions of the contract. Utilizing the expertise from **Engineering, Quality, Production,** and **Contract Services Divisions,** the following tasks are performed to assure the taxpayer is getting that for which he bargained and paid.

Direct technical interaction

ARPROs' **Engineering Division** provides the direct technical interaction between the government and the contractor. Engineers provide the direct interaction with the contractor's technical staff. For example, the ARPROs' **Engineering Division** provides the engineering surveillance of the contractor's design, development, and production effort. It also evaluates the contractor's engineering organization and monitors resource utilization including planning, scheduling, and expenditures of labor hours.

The ARPROs' **Production/Industrial Division** monitors the early planning phase of the precontract award. This surveillance verifies that production and delivery schedules are realistic. The division acts as a watchdog by overseeing the contractor's production activities and remaining alert for any potential production difficulties. In addition, the division monitors the Government Property Unit and always keeps one eye on the contractor's proper use of government-owned and supplied items. Also, government-provided industrial plant and tooling equipment are not let off the leash by this division.

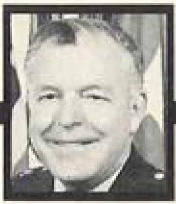
Stringent quality control measures

Since military industrial production is very similar to that in the private sector, all end products require quality control monitoring. This is especially true of aviation end products, which, because of the nature of their use, depend on the most stringent quality control procedures known. The responsibility for this type of product monitoring rests with the ARPROs' **Quality Assurance Division.** This group of trained quality assurance specialists insures that all government procured products are engineered and assembled to meet their specific contractual designs. This division has final acceptance, responsibility, and approval of all items prior to delivery to the user or depot.

As in conventional field military commands, these offices generate and respond to U.S. Army administrative requirements from higher headquarters. These tasks are handled by an **Administrative Services Office** which is inherent to the proper functioning of the ARPROs. This includes security, teletype communications, file and regulation upkeep, budget, financial, official visitor control, and personnel activities.

Acceptance of the end items

The final effort and certainly one of the most visible and important of the ARPROs' contract compliance effort is the acceptance of the end item by the **Flight Test Office.** This office is staffed with qualified military acceptance pilots whose responsibility, in conjunction with the overall quality assurane effort, is to verify by flight test, each helicopter that has been contractually produced for the Government. This effort culminates in the signing of the DD 250



THE GATEWAY AVIATION INTERFACE

BY MAJ. GEN. RICHARD H. THOMPSON, COMMANDER, USA TROOP SUPPORT & AVN READINESS COMMAND

COLOCATED in St. Louis, MO, are two very dissimilar Army commands, each with different missions, functions, and organizational structures. These subordinates to DARCOM are engaged in a daily interface toward the common goal of fielding new and improved aircraft systems.

Major General Story C. Stevens, Commander of AVRADCOM, and I have the challenge to insure these aviation systems satisfy specific requirements, and just as important, reach the soldier in the field in a minimum time frame. To meet this challenge **"The Gateway Aviation Interface"** was created.

The transition to TSARCOM

AVRADCOM has the system management responsibility for all new aircraft systems through the initial fielding and until feedback is received from the user that the system meets or exceeds requirements. Once user satisfaction is assured, the system management responsibility transitions to my Command. Specifically, AVRADCOM is responsible for the entire R&D effort for aircraft systems. This effort includes the first production contract, initial fielding, and assuring that users' requirements are satisfied.

Meanwhile, TSARCOM continues to provide an important support role during this R&D effort.

TSARCOM's role is to provide the logistics expertise required to develop the supply support and maintenance concepts designed into the aircraft systems early in the materiel acquisition cycle.

These logistical requirements are updated frequently and coincide with the development of the aircraft system. This interface is a necessity because the logisticians are located at TSARCOM, the National Inventory Control and National Maintenance Points. The TSARCOM role for this coordination is provided by the **Integrated Logistics Support Office (ILSO)** and this insures the **"one voice"** concept.

Fundamental: Working in harmony

AVRADCOM and TSARCOM have proven that two dissimilar commands working in harmony toward a common goal is not only possible, but fundamental for successful system transition. However, to be successful, proper organization, constant visibility, and management approaches that focus on the interface are prime requirements. For example, **General Stevens and I have established ILSO offices as special staff elements dedicated to this purpose.** These personnel meet periodically to incorporate improvements.

A **Memorandum of Agreement (MOA)** that details the interface functions of each command provides guidelines for the accomplish-

Gateway Aviation Interface

(Continued from Page 87)

ment of selected management actions which are the responsibility of AVRADCOM and the functional mission inherent to TSARCOM. These formulated actions address the responsibilities of each command and tasks that must be accomplished to assure an orderly transition of the aircraft system from the R&D program to the readiness side of materiel acquisition.

A major role in the acquisition cycle

TSARCOM plays a major role early in the acquisition cycle by identifying the total logistics support requirements necessary to support new systems entering the Army inventory. One example of this major role is the **Remotely Piloted Vehicle (RPV).**

The TSARCOM input involves several staff elements, each equally important and necessary, and each encompassing a particular area of responsibility. This input begins with the **Request For Proposal (RFP).** Among others, TSARCOM personnel participate in this action as members of the Source Selection Board, thereby having the opportunity to make recommendations early in the process. Once the source is selected from the **RFP's** the acquisition of materiels begins.

The "Statement of Work"

A **Statement of Work** is incorporated into the **RFP** for the full scale engineering development phase of the acquisition cycle. This statement of work includes provisions for contractor supply support during the test phase, maintenance support and training plans, identification of requirements, a list of required equipment and tools, review and acceptance of technical manuals, identification of required repair and spare parts, determination of facility requirements, and the development of handling and transporting of materiels.

The Logistic Support Analysis and the Logistic Support Analysis Record are also part of the **Statement of Work.**

Another example of this teamwork is the current effort to support the **UH-60A Black Hawk** helicopter program. My staff, employing the Integrated Logistic Support Management Team concept, is actively participating with AVRADCOM and the DARCOM **Black Hawk** Project Manager in planning for life cycle support of this new aircraft system. The achievement of this planning effort was brought into sharp focus during the recent Full-Scale Engineering Development phase of the program.

In concert with AVRADCOM and the Project Manager, we developed the planning documents necessary to successfully deploy and support this system. During the current Production and Deployment Phase, this planning is being implemented to assure that adequate training, tools, test equipment, repair parts, and publications have been provided to the user.

So long as the aircraft system remains in the Army inventory, AVRADCOM provides engineering support to TSARCOM. This support includes design engineering services on product improvements or proposed changes to configuration baselines. However, TSARCOM as the new system manager, is responsible for additional procurements, configuration management, technical data package management, and readiness.

An MOA keeps us informed

To insure the involvement of all personnel after a system is transitioned, an **MOA** that covers the interface prior to transition keeps these personnel in the communication loop.

In summary, the interface requires a joint agreement and common goal by the commanders to be effective. They must, as we have, dedicate their personal time and available resources toward this goal.

General Stevens and I have met this challenge head-on and the result is an unbroken transitional delivery of responsibility of new aircraft from one command to another.

ANOTHER MAYOR!

We'd like you to know that COL Luther G. Jones, Jr., is the second aviator and AAAA member now serving as a Mayor. He won the Corpus Christi, TX, mayoralty vote by a landslide in April and joins COL (Ret.) Ted Crozier, Clarksville, TN's Mayor, who was AAAA's first. We, in Corpus Christi, are quite proud that Army Aviation leadership is fully recognized for important positions of political responsibility.

—COL(P) Charles F. Drenz

The Army's Flight Tester

(Continued from Page 74)

and data from ground tests form the basis for issuing a preliminary airworthiness release. The AEFA test results are then used as the basis for airworthiness releases for other elements of the Army to fly the aircraft. Each PAE will have certain objectives tailored to the specific program but general objectives are to confirm that the aircraft is safe to fly within the released envelope, and to identify any deficiencies or shortcomings requiring correction, as early in the development cycle as possible. Corrections, prior to hard tooling, long lead item and production commitments can effect major cost avoidance and reduce the risk of program overruns. The PAE is a major tool in the management of programs in the early development phases.

The end of the development phase is the A&FC program. These tests are extensive and examine the entire flight envelope to provide data to determine whether the Prime Item Development Specification has been met and provides the data basis for the Operator's Handbook.

Current major programs are:

- UH-60A, Black Hawk, A&FC, and Icing Qualification
- YAH-64 Engineering Development Test (EDT)
- CH-47D PAE and Icing Qualification
- AH-1S with OGEE Tip Blade
- OH-58C with Improved Tail Rotor and Three Axis SCAS

AEFA, then, supports our aviation development by providing one of the finest engineering flight test capabilities in the Free World.

What's New with ASH?

(Continued from Page 59)

equipped with an MMS and capable of flying NOE during day and /night and adverse weather conditions. Key test requirements will be drawn from the approved ASH ROC and included in the RFP. Detailed test planning will be finalized as a result of final acquisition approach/source selection for the ASH.

Overall development testing will measure compliance with contractual specifications, demonstrate that technical risks have been resolved, and assure that development results support readiness for production initiation.

An in-house Development/Readiness Integrated Logistics Support Management Team has been established and will be expanded to include outside agencies in early 1980. Concepts for the maintenance/supply of the ASH are being formulated. Planning for personnel and training, support and test equipment, training devices, and transportation has been initiated.

Affordability continues to haunt the ASH program, and as this article goes to print, we are in the process of preparaing alternatives for both near and far term ASH requirements.

In-Plant Watchdog

(Continued from Page 86)

effort culminates in the signing of the DD 250 which are pedigree papers signifying the government's acceptance of the contractor's work.

This final phase of contract compliance, the act of verifying every flight characteristic, capability, and aerodynamic specification, results in the issuing of the aircraft to military line units. Strict adherence to a rigid and definite set of acceptance criteria and accepting nothing less, will insure a lasting and favorable impression by the pilots and crews of the field unit.

Current Army Aviation R&D support via the ARPROs' is being provided various programs. Under the watchful eye of COL Albert B. Luster's Boeing-Vertol Company ARPRO are 88 contracts and 1,605 delivery orders having a cumulative dollar value of over $927 million.

COL Charles Vaughan currently handles DOD responsibilities for 37 contracts and 109 delivery orders amounting to over $562 million dollars. An even greater workload is COL Donald Ferguson's 524 contracts and 4,964 delivery orders at Bell at over $2.78 billion dollars in contract value.

ARPROs are the AVRADCOM and the other DOD customers' "best friends" when it comes to in-plant DOD Acquisition Management.

New Eyes for the Artillery

(Continued from Page 58)

cle state sensors.

During a typical operational scenario, the control station, launcher recovery subsystem and support equipment are positioned in a secluded area, taking full advantage of local terrain and foliage to minimize detection. The air vehicle is then assembled (attach wings, add fuel), placed on the launcher and an end-to-end check performed. The engine is started and the catapult launch is initiated by the ground control station operators.

The operators, during the prelaunch activity, have pre-programmed the computer to send the air vehicle to selected navigation waypoints. They may command the air vehicle to loiter or conduct specified maneuvers and sensor activities at or between such waypoints. Secure **command, control, and communication** (C^3) is accomplished by a jam resistant data link consisting of a narrow-band uplink to transmit vehicle and payload commands and a wide-band downlink to return vehicle status and real-time video data.

The tracking antenna at the remote ground terminal automatically tracks the air vehicle, enabling the computer to display the air vehicle course and position on an x-y plotter. Planned and actual air vehicle positions are compared and commands are sent to correct position errors caused by drift or other factors.

The operators can manually command the air vehicle to change headings, airspeeds, and altitudes; to go into various search or loiter modes; to conduct specified sensor functions; to measure artillery burst offsets; and to return

Calls for fire and artillery target intelligence are disseminated from the **GCS** via a digital message device into TACFIRE and the **Battery Computer System (BCS)**. Intelligence is passed to the supported unit via secure communication means for entry into **Tactical Operations Systems (TOS)**.

Upon completion of a mission, the air vehicle is guided down a glide slope using TV imagery and IR sensors and into the recovery window and subsequently retrieved by a vertical net recovery subsystem. While on the glide path, the relative position of the computer and necessary corrections are automatically transmitted to the air vehicle autopilot. The recovery is automatic.

The introduction of the **RPV** System into the Army's inventory promises to solve the age-old "over-the-next-hill" problem of the battlefield commander and significantly improve FA effectiveness on tomorrow's battlefield.

Army Aviator's Interface

(Continued from Page 82)

production decision and the use of production resources. Normally, one or more of the "contract validation" contractors will be selected for Engineering Development.

The contract for Engineering Development requires a huge effort as the task is formidable. The contractor must design the weapon system and build the test models. He must translate the conceptual to the physical. The ideas and analyses which thus far were only on paper must now take physical form. In doing this, there will be problems.

It must be remembered that this is still a R&D contract. It may become necessary to deviate from preconceived notions and change past plans. It may be found that certain performance parameters impose too strict conditions and as such they must be relaxed. This phase is the core of the program for it encompasses the full scale R&D effort which the acquisition and user communities anticipate will lead to the successful production of the new system. Such testing is a prerequisite to any go-ahead for production and deployment — the final phases of the materiel acquisition process.

Concluding note

For simplicity, the foregoing discussion outlined the acquisition process in terms of precise steps — the book solution. However, the process is usually different for each acquistion. There is no universal standard for strict application of these steps in every case. Each acquisition requires tailoring within the process, and precision teamwork to bring it to a successful conclusion. Success comes only when every team member's performance is responsive, coordinated, and effective.

The one constant in the acquisition process is the **P&P** Directorate — the vital link in the acquisition chain between the Army Aviator (user) and industry (developer and producer).

DEPARTMENT OF THE ARMY
HQ, US ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND
P O BOX 209, ST. LOUIS, MO 63166

Last summer, when the opportunity to dedicate this issue of Army Aviation to the US Army Aviation Research and Development Command (AVRADOM) materialized, I enthusiastically accepted the offer.

I believe AVRADCOM has made significant progress in aviation research and development, such as the work in composite materials, the advanced technology engine, ballistically-tolerant components, and in new compound rotary wing/fixed wing aircraft.

There is no doubt that Army Aviation will continue to grow and AVRADCOM will continue to play an important part in the growth process. We are excited about the prospects for future developments in aviation through research and development.

I thank Art Kesten and his editorial staff for their cooperation and outstanding work in the publication of this issue.

Special thanks also go to Ms. Linda Braun and Mr. David Knepper of my staff for imagination and dedication throughout the preparation of our editorial material.

Though they pulled it all together, I regret I am unable to acknowledge by name the contributions of all who made this AVRADCOM Issue possible.

Story C. Stevens

STORY C. STEVENS
Major General, USA
Commanding

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(Continued from Page 2)

OTHER FEATURES

Army Aviation Association (AAAA)

JANUARY-FEBRUARY 1980 ADVERTISERS

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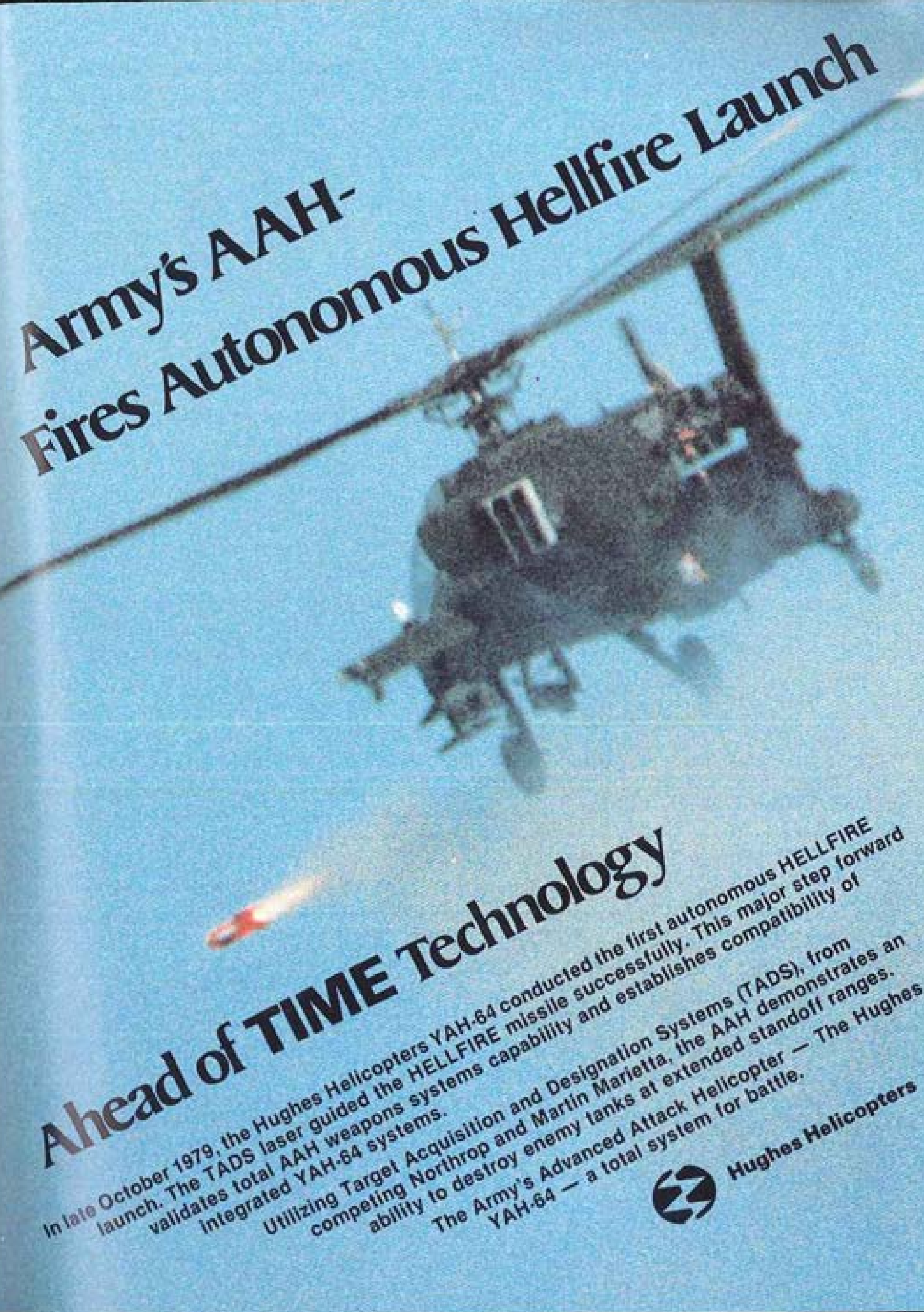
Army's AAH-
Fires Autonomous Hellfire Launch
Ahead of TIME Technology
In late October 1979, the Hughes Helicopters YAH-64 conducted the first autonomous HELLFIRE launch. The TADS laser guided the HELLFIRE missile successfully. This major step forward validates total AAH weapons systems capability and establishes compatibility of integrated YAH-64 systems.
Utilizing Target Acquisition and Designation Systems (TADS), from competing Northrop and Martin Marietta, the AAH demonstrates an ability to destroy enemy tanks at extended standoff ranges.
The Army's Advanced Attack Helicopter — The Hughes YAH-64 — a total system for battle.
Hughes Helicopters

EIGHT DRAWINGS! NO PURCHASE NECESSARY!
ENROLL ONE NEW AAAA MEMBER TO COMPETE!

1980 AAAA SWEEPSTAKES

AIRCRAFT MODELS, TRIPS, MANY OTHER PRIZES!
HELP AAAA REACH ITS 1980 GOAL OF 10,000!

PRIZES!

The "starter" list of Sweepstakes' Prizes includes many hard-to-get models of the aircraft employed in Army Aviation, an expense-paid trip to AAAA's 1981 National Convention site, AA rings, 19" aluminum wings, an aviation "library", and other prizes to be announced in subsequent months. Help AAAA reach its Dec. 31, 1980 membership goal of 10,000 members by participating in the 1980 National Sweepstakes!

GRAND SWEEPSTAKES' FIRST PRIZE!

As Grand Sweepstakes' winner, fly round-trip accommodations for two between any two points served by Delta Air Lines in the continental U.S. on or before Dec. 31, 1981. The new members you enroll may also win **substantial** prizes! Their coupons will be entered in a separate **End-of-Sweepstakes' Drawing** for new members only. It's easy to enter! Just complete one or more of the opposite page coupons, and have your new members complete the other side, and remit them with the appropriate AAAA dues.

NINE CHANCES TO WIN!

Sign up **ONE** new AAAA member using the application form provided, and your coupon will be entered in **NINE** separate Sweepstakes' drawings . . . You'll be competing for prizes in six **Bi-Monthly Drawings** during the 1980 calendar year, the **Mid-Year Sweepstakes' Drawing** on July 15, and the **Grand Sweepstakes' Drawing** on January 15, 1981. That's **eight** drawings, and if you want to enter the **"Top Gun Drawing"** for AAAA's **Top Recruiter**, that's a **NINTH** opportunity to win!

GENERAL RULES

No purchase is required. An AAAA member may submit as many entries as he wishes, and is not limited in the number of prizes he or she wins. All Federal, State, and Local Regulations apply, and an entry is void where prohibited by law.

1980 AAAA NAT'L SWEEPSTAKES

1 CRESTWOOD ROAD, WESTPORT, CT 06880

As a member of AAAA and in accordance with the Sweepstakes' general rules, I enter this Coupon in the 1980 AAAA National Sweepstakes. I've enclosed the first year dues of the new member whose application appears on the reverse side. I understand I need not be present at any drawing to win.

Print Name..

Address..

City ....State .... ZIP ....

GENERAL RULES

An entrant must be an AAAA member at the time of entry. Renewals of January-December, 1979 memberships are not considered as "new memberships." Entry constitutes full approval to publish name, address, and/or photo without add'l compensation. Additional '80 Sweepstakes' forms available on request, or a same size facsimile may be utilized.

Recruiter's Coupon

1980 AAAA NAT'L SWEEPSTAKES

1 CRESTWOOD ROAD, WESTPORT, CT 06880

As a member of AAAA and in accordance with the Sweepstakes' general rules, I enter this Coupon in the 1980 AAAA National Sweepstakes. I've enclosed the first year dues of the new member whose application appears on the reverse side. I understand I need not be present at any drawing to win.

Print Name..

Address..

City ....State .... ZIP ....

GENERAL RULES

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Recruiter's Coupon

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1 CRESTWOOD ROAD, WESTPORT, CT 06880

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Print Name..

Address..

City ....State .... ZIP ....

GENERAL RULES

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Recruiter's Coupon

ARMY AVIATION ASSOCIATION

1 Crestwood Road, Westport, Conn. 06880

I wish to join the Army Aviation Ass'n of America [AAAA]. My past or current duties affiliate me with U.S. Army Aviation and I wish to further the aims and the purposes of AAAA. I understand that the annual membership includes a subscription to the AAAA-endorsed magazine, ARMY AVIATION, and that my membership starts on the subsequent 1st of the month.

RANK FIRST NAME LAST NAME

STREET ADDRESS

CITY STATE ZIP

FOR HOME OFFICE USE. Rk Cat Chap Name R PZ Geographic St

AAAA ANNUAL DUES

New & Renewal Dues for other than below:
[ ] 1 Yr, $12-[ ] 2 Yr, $23-[ ] 3 Yr, $33.50

New & Renewal Dues for Enlisted; GS-6 & below; and Wage Board 12 DACs & below:
[ ] 1 Yr, $8 - [ ] 2 Yr, $15 - [ ] 3 Yr, $22

This is the only application form accepted by the AAAA. It may be reproduced locally.

TO USE MASTER CHARGE OR VISA:

BILL MY [ ] MASTER CHARGE: [ ] VISA CREDIT CARD

MY CARD NO. IS.......................

ITS EXPIRATION DATE IS.......................

INTERBANK NO. (Master Charge Only).......................

SIGNATURE.......................

ARMY AVIATION ASSOCIATION

1 Crestwood Road, Westport, Conn. 06880

I wish to join the Army Aviation Ass'n of America [AAAA]. My past or current duties affiliate me with U.S. Army Aviation and I wish to further the aims and the purposes of AAAA. I understand that the annual membership includes a subscription to the AAAA-endorsed magazine, ARMY AVIATION, and that my membership starts on the subsequent 1st of the month.

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ARMY AVIATION ASSOCIATION

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RANK FIRST NAME LAST NAME

STREET ADDRESS

CITY STATE ZIP

FOR HOME OFFICE USE. Rk Cat Chap Name R PZ Geographic St

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TO USE MASTER CHARGE OR VISA:

BILL MY [ ] MASTER CHARGE: [ ] VISA CREDIT CARD

MY CARD NO. IS.......................

ITS EXPIRATION DATE IS.......................

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SIGNATURE.......................

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The contract for AN/AVR-2 laser warning receivers has been awarded to Perkin-Elmer by ERADCOM-EWL, Fort Monmouth. This integrated radar/laser warning system combines the Army's AN/APR-39 radar detector with a Perkin-Elmer laser sensor to meet the requirements of AVRADCOM-ASE.

There's a good chance our capabilities can support your mission survivability goals. We're ready to meet your needs for smart optical sensors, integrated warning systems, and low-cost, low-power, modular packaging.

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8655 Gateshead Road
Alexandria, VA 22309

FYE, RICHARD S., BG
4 Barry Avenue
Fort Riley, KS 66442

Colonels

JOHNSON, WILLIAM H.
535 Kensington Rd., Apt. 8
Lancaster, PA 17603

MATTHEWS, RALPH A.
CO, HQ, USAG, Yongsan
APO San Francisco 96301

MOORE, DOUGLAS E.
HHD, 62nd Medical Group
Fort Lewis, WA 98433

PULLIAM, NATHAN M., Box 817
USAREUR & 7th, ODCSOPS
APO New York 09403

SMITH, DUANE N., ACofS
Materiel, Hq 3rd Support Cmd
APO New York 09757

Lt. Colonels

BERLINER, DANIEL S. (P)
531-A Simonds Loop
San Francisco, CA 94129

BRYAN, EDWARD R., III
P.O. Box 2575
Universal City, TX 78148

CURBOW, ELMER E.
252 Robinson Drive
Newport News, VA 23601

DONNELL, VICTOR L.
484 Turner Loop
Fort Campbell, KY 42223

DORR, CHARLES D.
4108 Marble Lane
Fairfax, VA 22030

DREW, JOSEPH E., JR.
1185 Drennan Park
Fort Campbell, KY 42223

DRYDEN, DAVID D.
USA MEDDAC
Fort Riley, KS 66442

GEHLSEN, EMROY M.
HHC 7th Army Trng Cmd Opn
APO New York 09114

GOODBARY, ROBERT A.
19th Aviation Battalion
APO San Francisco 96301

Lt. Colonels

GRUSHETSKY, PHILIP J.
2305 Allen Court
Philadelphia, PA 19112

HANNON, JAMES P.
2540 Claremont Dr., Apt 108
San Diego, CA 92117

HARRIS, LYMAN B., JR.
3415 Ross Drive
East Point, GA 30344

INNES, DOUGLAS D.
PSC Box 662, Albrook AFS
APO Miami 34002

JONES, WILLIAM S., RFD #2
13 Winding Hollow Road
Hudson, NH 03051

KEMP, FREDDIE L.
HHC, EUSA J-5
APO San Francisco 96301

KUPPICH, JOSEPH W., JR.
407 Old Mill Road
Savannah, GA 31406

LEINS, DAVID V., JR.
644 Ridgefield Court
Glen Burnie, MD 21061

McCLEMORE, MELVIN J.
252-6 Timberbrook Circle
Augusta, GA 30909

OWENS, BOBBY L.
55 Greenleaf Terrace
Stafford, VA 22554

PRESTIPINO, SAMUEL A.
USAREUR&7th OIG Box 1448
APO New York 09403

SWEENEY, ROBERT F.
111 South Ivy Lane
Glen Mills, PA 19342

THURGOOD, LEON C.
9718 Water Oak Drive
Fairfax, VA 22031

WALBURN, RICHARD L.
1250 Lauhala St., Apt. 305
Honolulu, HI 96813

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5422 River Boat Way
Fairfax-Glencove, VA 22032

ANCELIN, DONALD R.
1401 Medina Street
College Station, TX 77840

BILLINGS, MERLIN D.
Hq UNC/USFK JCIS Division
APO San Francisco 96301

Majors

BODELSON, PATRICK J.
4430 Majestic Lane
Fairfax, VA 22030

BRISTOW, WILLIAM D., JR.
10175 Marshall Pond Road
Burke, VA 22015

CLARK, JAMES E.
V Corps, G-4
APO New York 09079

COLE, CHRISTOPHER C.
3835 W. Fairmount Avenue
Milwaukee, WI 53209

DAVIS, EUGENE J.
1342 Talbert Terrace, S.E.
Washington, D.C. 20020

DELGADO, RICHARD
HHC, 24th Aviation Battalion
Hunter AAF, GA 31405

EDWARDS, JOHN P.
1902 Page Court
Bowie, MD 20716

ELLIS, ROBERT
3529 Barron Way
Fayetteville, NC 28301

ESMAY, JERRY D.
414 Avenue B
Plattsmouth, NB 68048

FOSTER, MICHAEL W.
22 Kirby Street
Fort Rucker, AL 36362

GREEN, LORANE
Hq 4th Trans Bde Box 171
APO New York 09451

HOLCOMB, LARRY D.
8514 Queen Elizabeth
Annandale, VA 22003

ILER, GEORGE A.
c/o Mrs. Hay, 500 Ladd Ave.
Kewanee, IL 61443

ISRAEL, JAMES L.
7825 Fair Oaks Drive
Clemmons, NC 27012

JACKSON, THOMAS K.
547 N. Bayberry
Corpus Christi, TX 78418

JONES, HERBERT W., JR.
Hqs Japan, Box 3672
APO San Francisco 96328

KENNEDY, OLLIE D.
408 Antler Drive
Enterprise, AL 36330

KUNSTEL, KENNY J.
9220 Kristin Lane
Fairfax, VA 22032

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LASH, WALTER J., II
2525 Gulf of Mexico Drive
Longboat Key, FL 33548

LEHRTER, JOHN B.
1030 Rue Toulouse
Slidell, LA 70458

MAY, JOHN W.
101 Omega Circle
Enterprise, AL 36330

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7215 Oliver Avenue, S.
Richfield, MN 55423

MITCHELL, RICHARD R.
Hq, 2nd MI Battalion (AE)
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Macon, GA 31204

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82 Coachman Circle
Newport News, VA 23602

OSBORN, ROGER J.
321 Pennsylvania Avenue
Fort Lauderdale, FL 33312

POPE, ARTHUR L.
112 3rd Infantry Road
Fort Leavenworth, KS 66027

PULLANO, JOSEPH F.
7507 S.W. Forest Avenue
Lawton, OK 73505

REED, NATHAN K.
2616 Frances Avenue
Leavenworth, KS 66048

ROOP, TROY J.
101 Karen Drive
Enterprise, AL 36330

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Myrtle Beach, SC 29577

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Hinesville, GA 31313

ST. JOHN, DALLES
16819 Bougainvilla
Friendswood, TX 77546

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10204 Whitlock Drive
Overland, MO 63114

SULLIVAN, DAVID E.
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Alexandria, VA 22306

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286 Hancock
Fort Leavenworth, KS 66027

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APO Miami 34002

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Fort Hood, TX 76544

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2008 Black Friar Road
Fayetteville, NC 28304

WILLIAMSON, DAVID D.
Quarters 2652
Fort Lewis, WA 98433

Captains

ARCHER, HARRY R.
MILPERCEN-K Rcptn/Repl Det
APO San Francisco 96301

ARENZ, JAMES E.
HHC, 12th Aviation Group
APO New York 09457

BEAUCHEMIN, RICHARD R.
1791 Valley Side Drive
Frederick, MD 21701

BRACEY, HUGH M.
820 Pecan Court
Bel Air, MD 21014

CARDER, RONALD D.
2270 Criston Drive
Newport News, VA 23602

CASPER, LAWRENCE E.
19536 Creekside Court
Salinas, CA 93908

COMBS, NICHOLAS T.
D Trp 4/7th Cav 2nd Inf Div
APO San Francisco 96251

DANDRIDGE, WAYNE L.
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Fort Campbell, KY 42223

DUNN, JAMES C.
S1(A) 11th ACR, Box 348
APO New York 09146

GLASS, CHARLES W.
3rd Infantry Road, Apt. 75
Fort Leavenworth, KS 66027

GOODRICH, STEPHEN E.
1106-H Thompson Circle
Fort Eustis, VA 23604

HARMES, MICHAEL H.
207 Coral Way
Enterprise, AL 36330

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Captains

HAYLES, RALPH E., JR.
400 Melbourne
Enterprise, AL 36330
HEUSER, GARY
A Btry, 05B, FAOAC 1-80
Fort Sill, OK 73503
JABLECKI, JOSEPH S.
1209 Meadow Drive
Killeen, TX 76541
JOHNSON, PHILLIP G.
35 Rose Hill Drive
Clarksville, TN 37040
KITCHENS, GEORGE L.
USAAVNDTA
Fort Rucker, AL 36362
LAMBRIGHT, ODIS J.
52341-1 Biloxi Circle
Fort Hood, TX 76544
LEE, JAMES M.
304 Noble Oaks Drive
Savannah, GA 31406
MANN, PAUL A.
HHC, 503rd Avn Bn (Cbt)
APO New York 09165
McDUGALD, JOHN C.
Dept of ES&GS, USMA
West Point, NY 10996
MOULDER, E. DENNIS
15 Howland Place
Long Branch, NJ 07740
NAIGLE, ALFRED J.
62nd Avn Co, 11th Avn Bn
APO New York 09039
OGLES, JERRY L.
P.O. Box 325
Fort Rucker, AL 36362
PERRICH, ROBERT A.
DRCPM-BH-L, P.O. Box 209
St. Louis, MO 63166
PETERSEN, ROBERT P.
1718 Schulte Hill Drive
Maryland Heights, MO 63043
PIRKHAM, MARTIN C.
14315-E Deloice Cres.
Newport News, VA 23602
REINCH, ROBERT F.
20 Verna Circle
Daleville, AL 36322
SCHMIDT, DENNIS R.
117 Tennyson Drive
Wheaton, IL 60187
SKIPPER, DONALD B.
805 West Bramble Oak Drive
Woodstock, GA 30188
STANLEY, FRANK W., JR.
6815 Timbercroft Lane
Fayetteville, NC 28304
STEELE, DONALD W., JR.
207th Aviation Company
APO New York 09102
SUMNER, ROBERT M.
205th Aviation Co, Box 56
APO New York 09185
VOGEL, WILLIAM L.
25 Royce Lane
Fort Rucker, AL 36362
WEHNER, RANDOLPH B.
609th Transportation Co (ADS)
Hunter AAF, GA 31409

Captains

WHITE, DONALD J., JR.
Route 7, Box 154
Elizabethtown, KY 42701
WILLIAMS, JOSEPH
1613 3rd Street, N.W.
Birmingham, AL 35215

1st Lieutenants

GROGAN, KENNETH J., Apt. 121
1451 W. Lincoln Trail Blvd.
Radcliff, KY 40160
KAUFMANN, JOSEPH G., JR.
2910 Richmond Hill, Apt 12D
Augusta, GA 30906

2nd Lieutenants

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10716 Leavelland Place
El Paso, TX 79924

CW4's

GAY, ALBERT G.
242 Ardennes Circle
Fort Ord, CA 93941
HOWARD, CONRAD R.
1602 Dean Forest Rd, LotB24
Savannah, GA 31401
JOHNSON, JIMMIE E.
62 Avn Co, FW c/o 173 AHC
APO New York 09165
JONES, WALTER E.
45th Trans Co (AVIM)
APO San Francisco 96271
MILLER, RICHARD D.
P.O. Box 368
Fort Belvoir, VA 22060
PARNELL, JAMES L.
2018 Hilltop Street
Belton, TX 76513
RUSSELL, JOHN G., JR.
Hq VII Corps GI
APO New York 09107
SCHWEIKERT, RONALD W.
382 Westover Circle
Hamilton AFB, CA 94934

CW3's

ANDEL, MICHAEL H.
3009 Cindella Lane
Manhattan, KS 66502
BODWELL, ROGER A.
809 Morgan Lane
Enterprise, AL 36330
BURBANK, RICHARD W.
P.O. Box 145
Dupont, WA 98327
BUSBY, BERNARD H.
36 Graham Avenue
Wayne, NJ 07470
CURTIS, GRANTSON R.
10537 Clearwater
El Paso, TX 79924
GUNNING, DON S.
60 Red Cloud Road
Fort Rucker, AL 36362

CW3's

HAYDEN, FRED R., III
1038 Dogwood, Apt. 3
Fort Wainwright, AK 99703
HUTCHINS, JIM (FATE), JR.
3000 Spanish Court, Apt. 13
Raleigh, NC 27607
KEY, LARRY W.
1008-2 Beechnut
Fort Wainwright, AK 99703
KILBORN, DAVID C.
180th Aviation Company
APO New York 09025
LIMA, RICARDO V.
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Enterprise, AL 36330
MAYS, FRANCIS
PCS Box 2800
APO Miami 34002
MORRIS, LEON P.
USAAC, WOSC 80-1
Fort Rucker, AL 36362
ROBICHAUX, JOHN C.
Route 1, Box 254
Bell City, LA 70630
ROE, FLOYD T.
CMR 2, Box 5473
Fort Rucker, AL 36362
SHEEHAN, JOHN P.
101 Evergreen
Ozark, AL 36360
STANSELL, ROBIN L.
Co B, 503rd Avn Bn (Cbt)
APO New York 09076
STEWART, STEVEN K.
8th M.I. Company
APO New York 09111
TOLBERT, RALPH V.
712 Stewart
Killeen, TX 76541

CW2's

BATES, TIM, III
P.O. Box 763
Iowa City, IA 52244
FRANKLIN, GERARD F.
Air Troop, 2nd ACR
APO New York 09093
GRABLIN, MARK
102 Sanford Place
Ozark, AL 36360
HARRIS, ALVIN R.
16410 Spruce Cove
San Antonio, TX 78247
RUSK, FRANKIE R.
345 Gohart Drive, Apt. 1
Colorado Springs, CO 80916
WILLIAMS, JOHN W.
6556 Meadowview Lane
Watauga, TX 76148

WO1's

ALLEN, MICHAEL L.
CMR 2, Box 5097
Fort Rucker, AL 36362
GARRIOTT, LARRY
2026-B Werner Park
Fort Campbell, KY 42223

WO1's

HARTNETT, GENE R.
911 Richardson
Clarksville, TN 37040

WOC

FOURNIER, DAVID G.
CMR 2, Box 16063
Fort Rucker, AL 36362

Enlisted

HEATH, HULMER J., CSM
200 Baltzell Avenue
Fort Benning, GA 31905
KRUEGER, WALTER W., CSM
Box 56, Hq USAREUR
APO New York 09403
AREND, LELAND R., SGM
1840 Lima Avenue
Findlay, OH 45840
BICKFORD, GERALD J., MSG
1850 Gerald Avenue
East Meadow, NY 11554
BURTON, WILLIAM, SFC
5042-A Hammond Heights
Fort Campbell, KY 42223
MYERS, RICHARD T., SFC
US Army Aeromedical Center
Fort Rucker, AL 36362
VULLO, NICHOLAS M., SFC
211 Texas Avenue
Alamogordo, NM 88310
McNUTT, JAMES W., SSG
R.R. 3
Indianola, IA 50125
BROWN, WALTER, SGT
5917 Bush Avenue
Columbus, GA 31904
HICKMAN, STEVEN D., SGT
233 Prairie
Sierra Vista, AZ 85635
STOUT, FRANK, SGT
B Troop, 4/7th Cavalry
APO San Francisco 96358
RACHKISS, PATRICIA, SP4
590th Transportation Co.
APO Miami 34006
BROWN, JESSE, E3
801 Biglen Road, Apt. A
Clarksville, TN 37040
HILES, CYNTHIA, PFC
245th ATC Company Fwd
Fort Bragg, NC 28307

Civilians

ACKERLEY, JAMES M.
730 South 12th Street
San Jose, CA 95112
EVANS, JULIAN
1909 Greenbriar
Euless, TX 76039
HADDER, MARION
13530 S. Gaffney Lane
Oregon City, OR 97045
MANGRAM, ABB W.
6245 Wilmette Drive
Burke, VA 22015

Civilians

O'NEAL, RUSSELL D., DR.
897 Greenhills Drive
Ann Arbor, MI 48105
SKROBARCEK, EUGENE V.
Route 1, Box 129-A
Sinton, TX 78387
SLAGLEY, GEORGE E.
2903 Tarboro Street
Dothan, AL 36303
SOKOLOWSKI, STANLEY J.
2204 Appleby Drive
Wanamassa, NJ 07712
SPRINKLE, EDITH C., MS
456 Eldon Drive, Apt. B-2
Corpus Christi, TX 78412
ZINK, ROBERT
E-Systems, Box 12248 MS-5
St. Petersburg, FL 33733

Retired

ADESSA, ANTHONY J., COL
26 Evergreen Drive
North Caldwell, NJ 07006
ALBINO, ROBERT A., CW2
405 Flamingo Drive
Apollo Beach, FL 33570
BOWMAN, JAMES E., LTC
2213 Middlecoff Drive
Mesa, AZ 85205
CAMPBELL, JAMES T., MAJ
906 Harmony Drive
Statesville, NC 28677
CRAWFORD, GARRETT, MAJ
2627 Oakton Glen Drive
Vienna, VA 22180
DANIELS, G.M., COL
2211 Racquet Club Court
Arlington, TX 76017
GOFF, RICHARD D., LTC
7312 Rolling Hills Boulevard
Montgomery, AL 36116
GOULD, ROGER K., CW4
6452 Blarney Stone Court
Springfield, VA 22152
HANKINS, ROBERT S., CPT
Route 1, Box 76
Holland, TX 76534
MONTGOMERY, H.T., LTC
5517 Golf Club Dr., Diamond
Head Bay St Louis, MS 39520
RUSH, ROBERT P., LTC
14415-A Club Villa Drive
Colorado Springs, CO 80908
SARNECKI, ALOYSIUS P., LTC
15453 North 30th Drive
Phoenix, AZ 85023
SEAGER, KENNETH W., CW3
406 Redwood Drive
Wamego, KS 66547
SHIELDS, ROGER J., COL
Air Base Constructors
APO New York 09673
SHONERO, GEORGE D., LTC
R.R. 3, Box 40, The Pines
Harlingen, TX 78550
ST. LOUIS, ROBERT P., COL
1215 Suffield Drive
McLean, VA 22101

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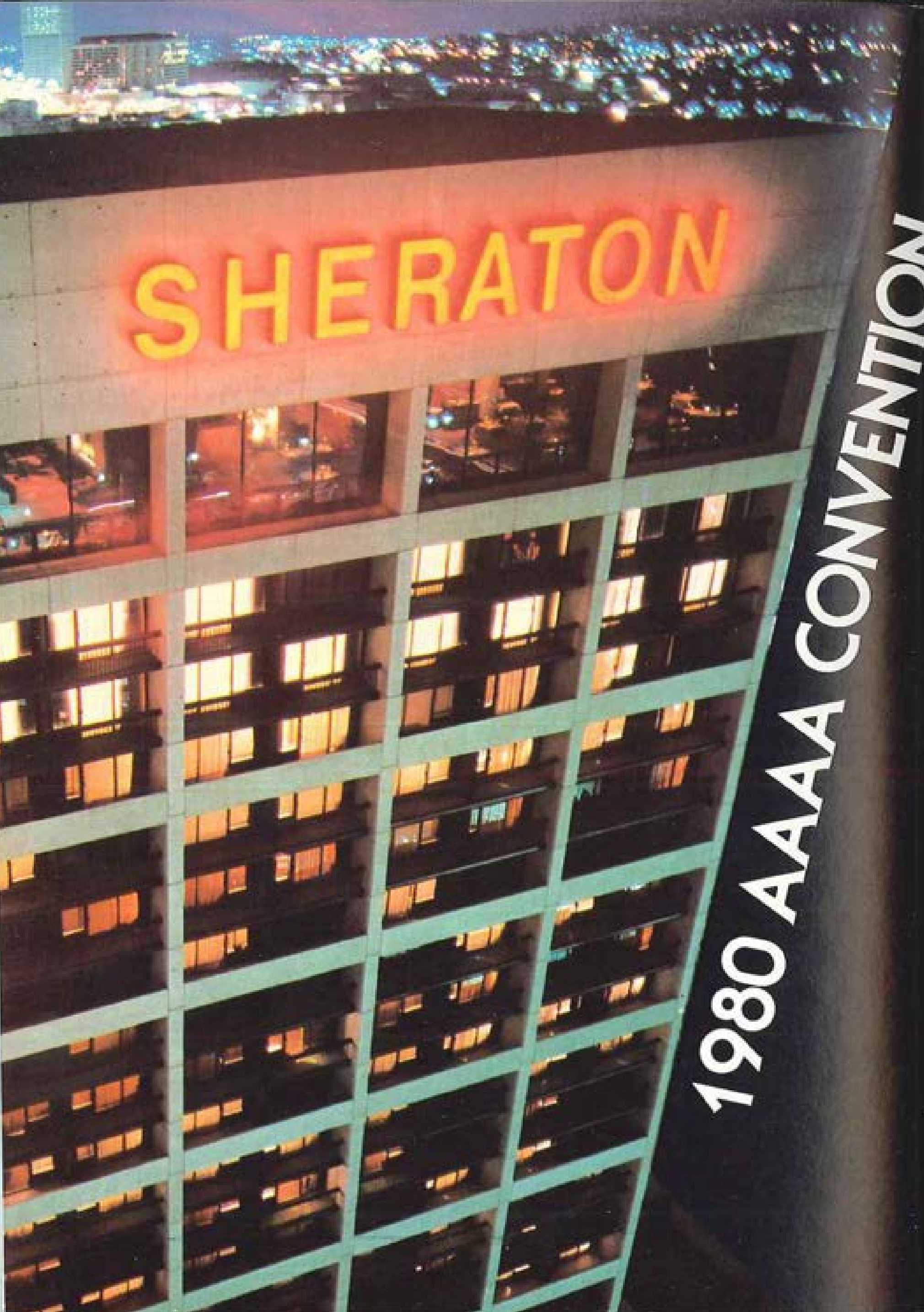

SHERATON
1980 AAA CONVENTION

SHERATON-ATLANTA

THURSDAY,

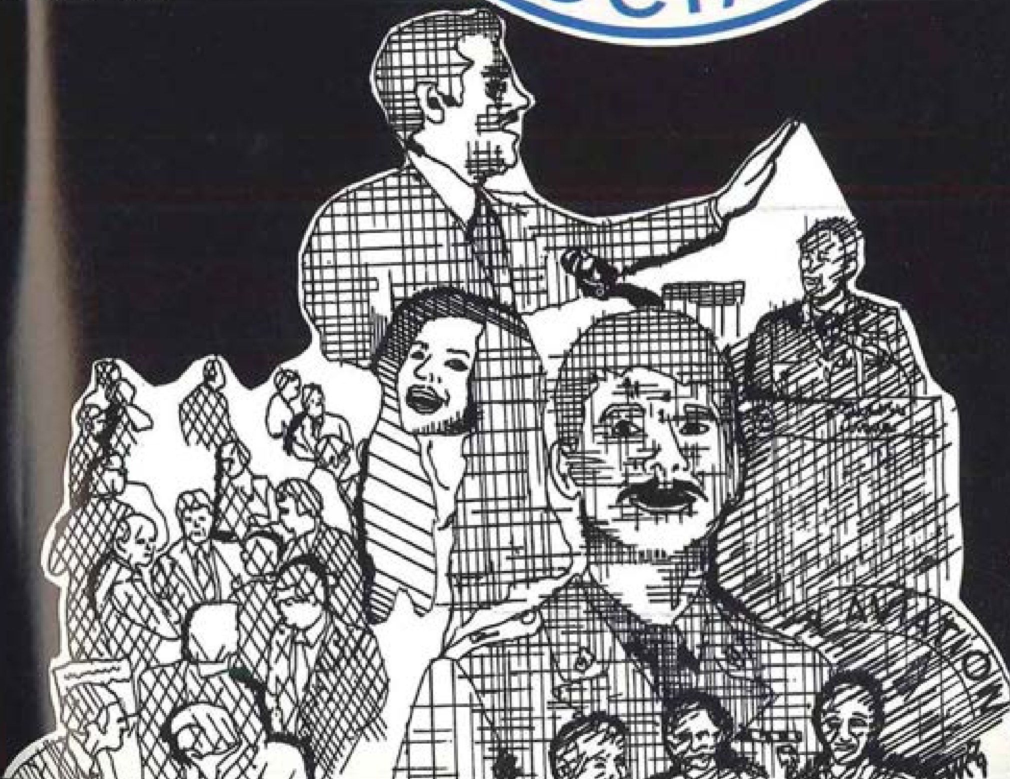
APRIL 10

THROUGH

SUNDAY,

APRIL 13

ARMY AVIATION ASSOCIATION



Advance Registration Form for AAAA's 22nd National Convention, 10-13 April

SHERATON-ATLANTA HOTEL, 590 W. PEACHTREE ST., ATLANTA, GA. 30308 – THURSDAY, 10 APRIL 1980 THROUGH SUNDAY, 13 APRIL 1980

I plan to attend the functions of the 1980 AAAA NATIONAL CONVENTION indicated below and have enclosed a check made payable to "AAAA" to cover the costs of my attendance and the function tickets. I understand that I may receive a full refund through 24 March 1980.

1980 AAAA NATIONAL CONVENTION FUNCTION	MILITARY ATTENDEE	CIVILIAN ATTENDEE	MILITARY DELEGATE	CIVILIAN DELEGATE	MEMBER'S SPOUSE	NON-MEMBER*	COST TOTAL
REGISTRATION (NECESSARY FOR ADMITTANCE TO AAAA) PROFESSIONAL SESSIONS	☐ $10.00	☐ $24.00	☐ $6.00	☐ $20.00	———	☐ $36.00	$_____
FRIDAY, APRIL 11, 1980 LADIES COFFEE & EXHIBIT TOUR	———	———	———	———	☐ $1.00	———	$_____
FRIDAY, APRIL 11, 1980 HALL OF FAME LUNCHEON	☐ $12.00	☐ $16.00	☐ $8.00	☐ $12.00	☐ $12.00	———	$_____
FRIDAY, APRIL 11, 1980 PRESIDENTS RECEPTION	☐ $8.00	☐ $12.00	☐ $5.00	☐ $9.00	☐ $8.00	———	$_____
SATURDAY, APRIL 12, 1980 SNACK LUNCHEON	☐ $5.00	☐ $7.00	☐ $3.00	☐ $5.00	☐ $5.00	———	$_____
SATURDAY, APRIL 12, 1980 ATLANTA SIGHTSEEING TOUR	———	———	———	———	☐ $11.00	———	$_____
SATURDAY, APRIL 12, 1980 1980 HONORS RECEPTION AND DINNER	☐ $22.00	☐ $37.00	☐ $17.00	☐ $32.00	☐ $22.00	———	$_____
SUNDAY, APRIL 13, 1980 DIEHARDS BRUNCH	☐ $7.00	☐ $12.00	☐ $5.00	☐ $10.00	☐ $7.00	———	$_____
TOTAL - ALL FUNCTIONS	$64.00	$108.00	$44.00	$88.00	$66.00	$36.00	$_____

NAME .... NAME AS DESIRED ON BADGE ....

UNIT OR FIRM ....

ADDRESS ....

CITY .... STATE .... ZIP ....

NOTE: "Military Member" Fees apply to active U.S. Army, Retired, Reserve Component, and DAC personnel, except those retired, Reserve Component, or retired DAC in the employ of defense contractors or suppliers who are to register and attend functions at the "Civilian Member" rate. Please make checks payable to "AAAA."

*INCLUDES $12.00 First-Year AAAA Membership Dues with the New Member Registrant to then pay the appropriate Military Member or Civilian Member "Function Fees" shown in the table. Please return your Registration Form and check to: AAAA, 1 Crestwood Road, Westport, CT 06880.

Early bird

. . . That's RCA . . . for YAH-64 Support 24 Hours a Day

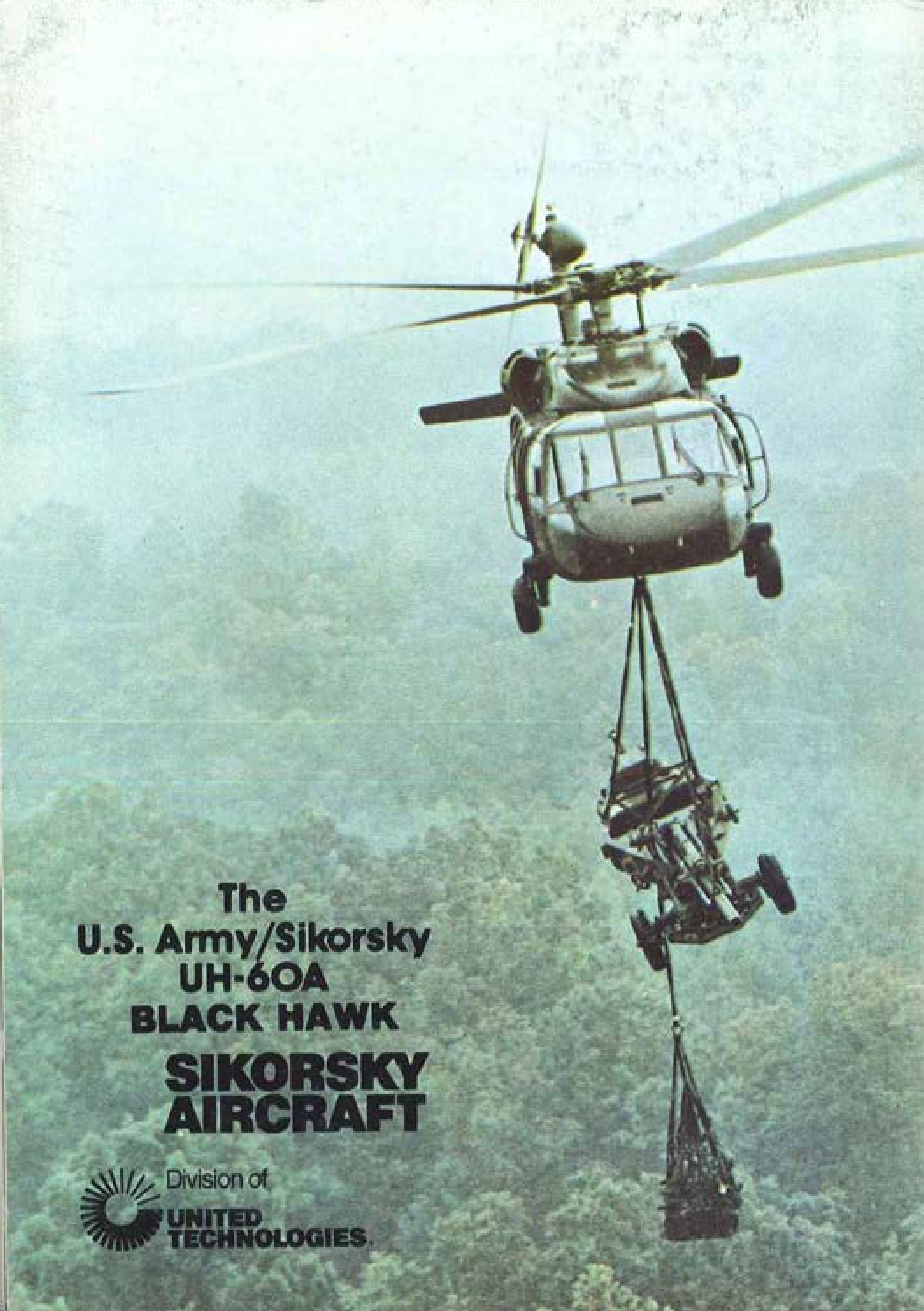
RCA's automatic test equipment provides total system support to the YAH-64. The test system will reduce maintenance training requirements while improving the YAH-64's combat availability and missile effectiveness. Scheduled for intermediate and depot level maintenance, the YAH-64 ATE will also support the operational test (OT II).

The YAH-64 ATE is one configuration of the RCA-developed AN/USM-410. The test system can be configured to meet your specific ATE requirements.

For more information contact:
Director, Marketing
RCA Automated Systems
Burlington, MA 01803

ENGINEERS interested in career opportunities, forward your resume to: Roger Bishop, Dept. AA, P.O. Box 588, Burlington, MA 01803

RCA Government Systems Division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