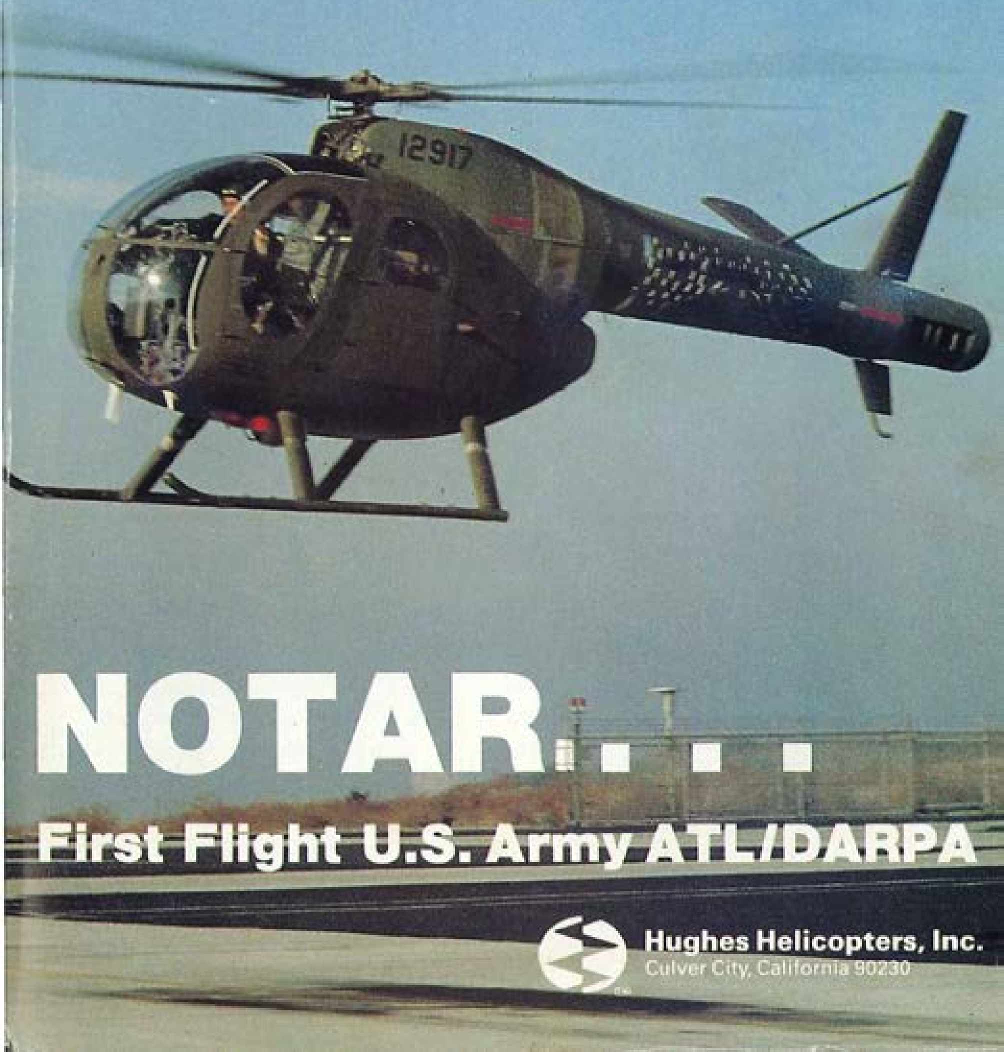
SPECIAL FEATURE — USA AVRADCOM-1982

1982 AAAA NATIONAL CONVENTION DETAILS

Army Aviation

FEBRUARY-MARCH 1982



NOTAR. . . .

First Flight U.S. Army ATL/DARPA

Hughes Helicopters, Inc.
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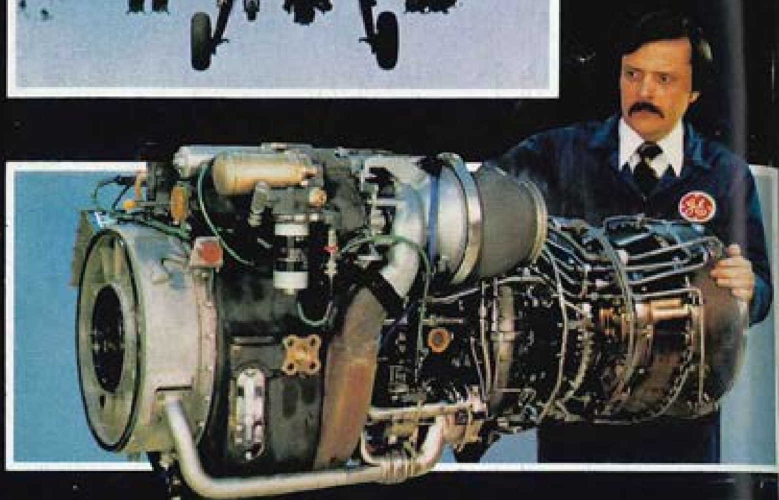
Apache Power



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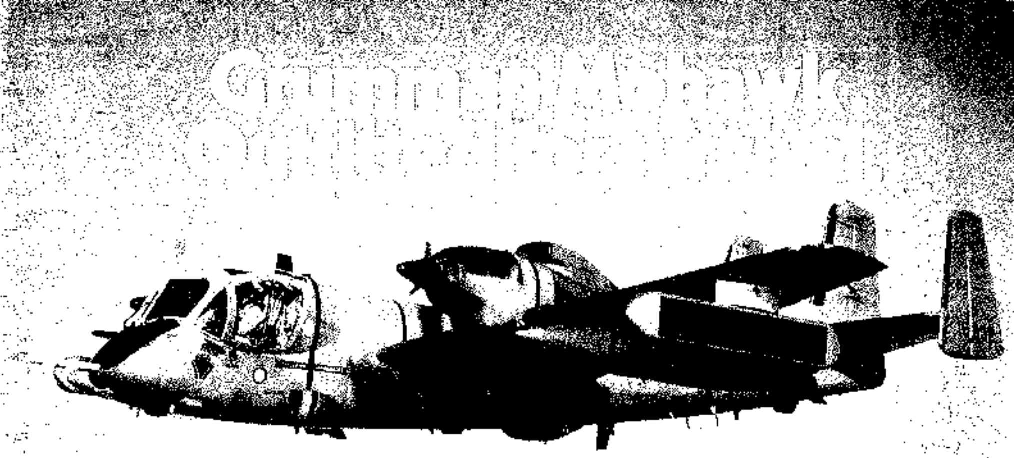

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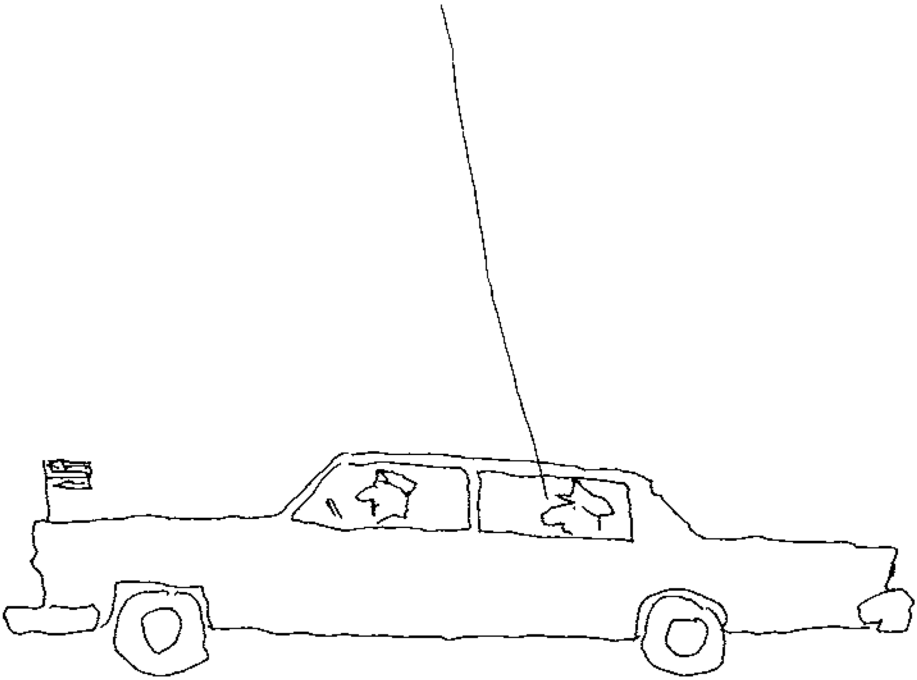
U.S. ARMY AVRADCOM

King who?



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In mid-February, I was privileged, as your National President, to "sit in" on the AAAA National Awards Committee deliberations, those that concern themselves with the selection of the winners of the Association's national awards for calendar year 1981. As an ex officio member of the Committee, I wasn't eligible to vote nor was my viewpoint solicited on any award category or nomination.

While the constituency of this 18-member committee must remain confidential — other than knowing that Brigadier General "Bob" Leich is its Chairman — the exceptional efforts of this voluntary committee should not go by unsung. Sixteen of the 18 members were present for duty for two full days. The six general officers, eight colonels, three aviation warrants, and the industry member who comprise your Awards Committee annually face the unenviable task of reviewing more than 75 scholarship award "files" on one day, and then selecting "The Best of the Best" from within Army Aviation on a second day. You should know that each nomination is reviewed individually; that there is often an extended period of advocacy prior to balloting; and that majority voting by secret ballot prevails.

Sometimes the choices are exceptionally difficult, and the advocacy exceptionally heated. While it is quite easy to sharpshoot the decisions of any awards committee (or any promotion board), being a part of the decision process and having knowledge of the whole picture gives the committee or board the "leg up" that all others simply do not have. I watched these people at work; they do an outstanding job in representing our interests — yours and mine, and I commend them here.

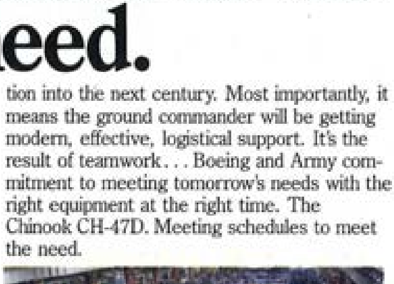
John W. Marr
COL, USA (Ret.)
President, AAAA

The CH-47D. Meeting schedules to meet the need.

From the beginning, the Army's new CH-47D Chinook helicopter has met or beaten every developmental schedule… cost, time, performance. First flight was under budget and ahead of schedule. Developmental program completion continued the pattern. And prototypes met or exceeded every design goal.

Now, production is underway, upgrading Chinook As into new, high performance, high reliability models. It will continue until the entire fleet of 436 A, B, and C models is remanufactured with more reliable engines, new transmissions, fiberglass rotor blades, and modern electrical, hydraulic, and avionic systems.

Not only will the Army be getting the increased performance it needs at lower operating costs, but American taxpayers will be saved millions of dollars in investment cost. Upgrading this well-conceived and thoroughly proven design means the Army's workhorse helicopter will continue to serve with distinction into the next century. Most importantly, it means the ground commander will be getting modern, effective, logistical support. It's the result of teamwork… Boeing and Army commitment to meeting tomorrow's needs with the right equipment at the right time. The Chinook CH-47D. Meeting schedules to meet the need.



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By RICHARD HALLORAN

Reagan Choice for Nation's Top Military Post

JOHN WILLIAM VESSEY, JR.

WASHINGTON, March 4—On the Anzio beachhead in Italy in May 1944, John W. Vessey, Jr. was the first sergeant of an artillery battery. Next July 1, after 41 years of military service, General Vessey is scheduled to become the nation's top soldier as Chairman of the Joint Chiefs of Staff.

General Vessey, who is currently the Vice Chief of Staff of the Army, has spent much of his career out of the Washington limelight as a combat commander of ground forces. He has a particular interest in Latin America, according to those who know him, and a quiet empathy for allies.

How the 59-year-old general came to the attention of the Secretary of Defense Caspar W. Weinberger, who recommended the nomination to President Reagan, was not immediately clear. The President disclosed the nomination, which caught Washington largely by surprise, as he headed for a vacation in California.

As Vice Chief of Staff, General Vessey had the job of running the Army's day-to-day operations while the Chief of Staff, General Edward C. Meyer, has planned for the Army of the future and dealt with the Defense Secretary as a member of the Joint Chiefs of Staff.

Praise From Army Chief

Whatever the case, perhaps the officer most enthusiastic about General Vessey's nomination, which must be approved by the Senate, was the general's boss, General Meyer. In a brief telephone interview, General Meyer said, "He's a selfless individual who really does put nation ahead of self."

When President Carter reached well down into the ranks of lieutenant generals to appoint General Meyer Chief of Staff in 1979, the President in effect passed over General Vessey, then General Meyer's senior. But General Vessey, at General Meyer's request, took the job as Vice Chief of Staff. "It was a very selfless thing for Jack to do," General Meyer said. "I've used that as an example for all my soldiers out there."

General Meyer continued; "He understands the big picture. He understands the broader issues of policy and interrelationships that are absolutely essential in that job. He's not going to permit himself to become an operations sergeant."

"General Vessey will do the kinds of things that the chairman ought to be doing, which are looking at broad policies and being able to articulate the issues so that we make the right decisions in the very critical period ahead," General Meyer said.

'Cool, Calm and Meticulous'

"He's a very cool and calm man," said a general who has worked with General Vessey. "He's very meticulous about detail. He has a fantastic memory and once he reads or hears something, he can pull it out in an instant."

Said another general who asked not to be identified: "When he has something to say, it makes infinitely good sense. He speaks in simple, declaratory sentences. He has a remarkable capacity to size up a situation with common sense."

General Vessey's record shows that he was something of a late bloomer. After he was promoted from first sergeant to second lieutenant for distinguishing himself on the battlefield, he worked his way up through ranks in the Army. But he did not get his college degree, a bachelor of science from the University of Maryland, until he was 41 years old and a lieutenant colonel.

Two years later, he received a master's degree from George Washington University. He went to helicopter school as a colonel at the age of 48. Most of the students were young enough to be his sons.

Fought in North Africa

John William Vessey, Jr. was born in Minneapolis on June 29, 1922, and enlisted in the National Guard in 1939. He was called to active service in February 1941, before the United States entered World War II, and later fought with the 34th Infantry Division in North Africa and Italy.

In his more recent career, General Vessey has been mostly a troop commander. He was commander of an infantry division's artillery; chief of staff of an armored division; commanding general of the Fourth Infantry Division at Fort Carson, CO, and commanding general of the Eighth Army and United States Forces in South Korea.

He has also been an operations officer here in Washington and was Deputy Chief of Staff for Operations in 1975 and 1976 when one of his principal subordinates was then-Lieutenant General Meyer. General Vessey has been Vice Chief of Staff since 1979.

General Vessey has earned seven major combat decorations, including the Distinguished Service Cross, the Army's second highest, and the Purple Heart for a wound in Vietnam.

The general is married to the former Avis C. Funk of Minneapolis. They have three children, John William, III, who is 32; Sarah Ann, 28; and David, 25, a Chief Warrant Officer in the Army.

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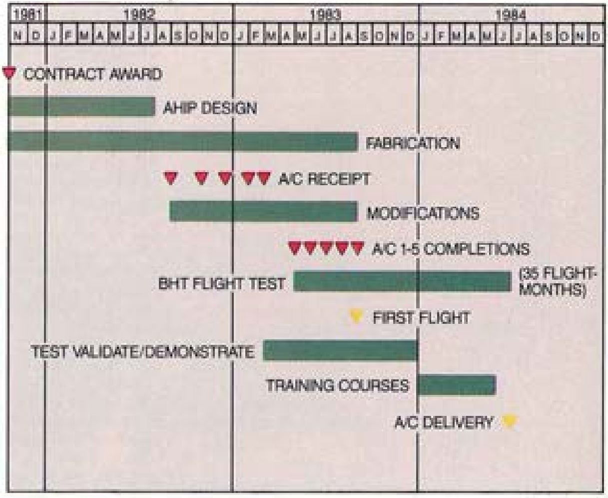

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PLAN TO ATTEND!

A 1982 Advance Registration Form appears on the next page. Send it in; an attractive Silver Anniversary souvenir will be given to each Advance Registrant.

Advance Registration Form for AAAA's 1982 National Convention — April 22-25

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I plan to attend the functions of the 1982 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 advance registration closes Wednesday, April 14; and that I may receive a full refund by phone call to AAAA made on or before that date, or by written notification to AAAA that's postmarked not later than April 14, 1982.

SPECIFIC FUNCTION HELD AT THE 1982 AAAA NATIONAL CONVENTION	MIL/DAC MEMBER FEE	CIVILIAN MEMBER FEE	MIL/DAC CHAPTER DELEGATE	CIVILIAN CHAPTER DELEGATE	FEE FOR ALL SPOUSES	NON-MEMBER FEE*	ITEM LINE TOTAL
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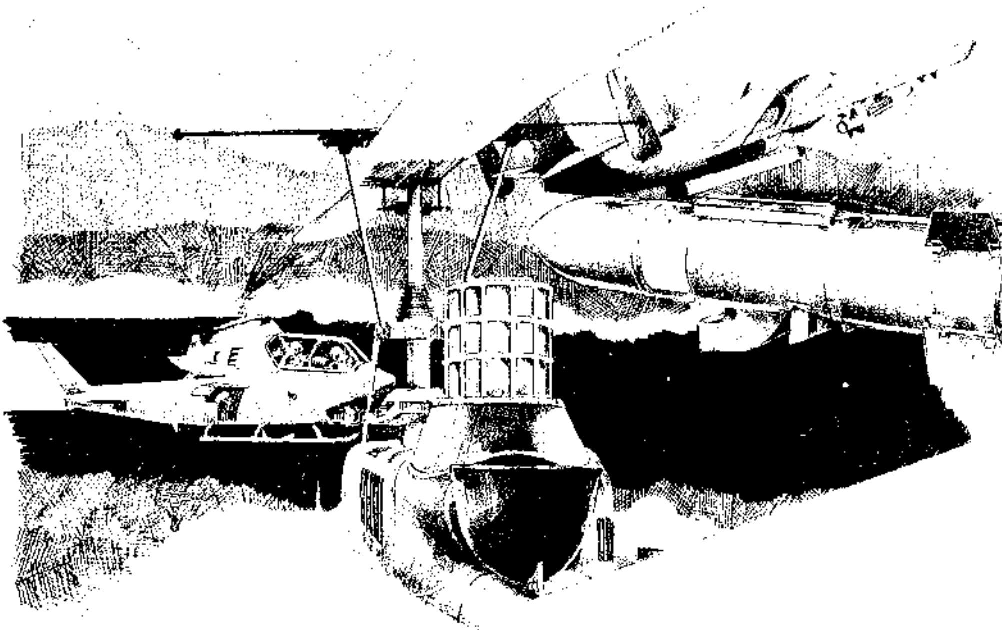

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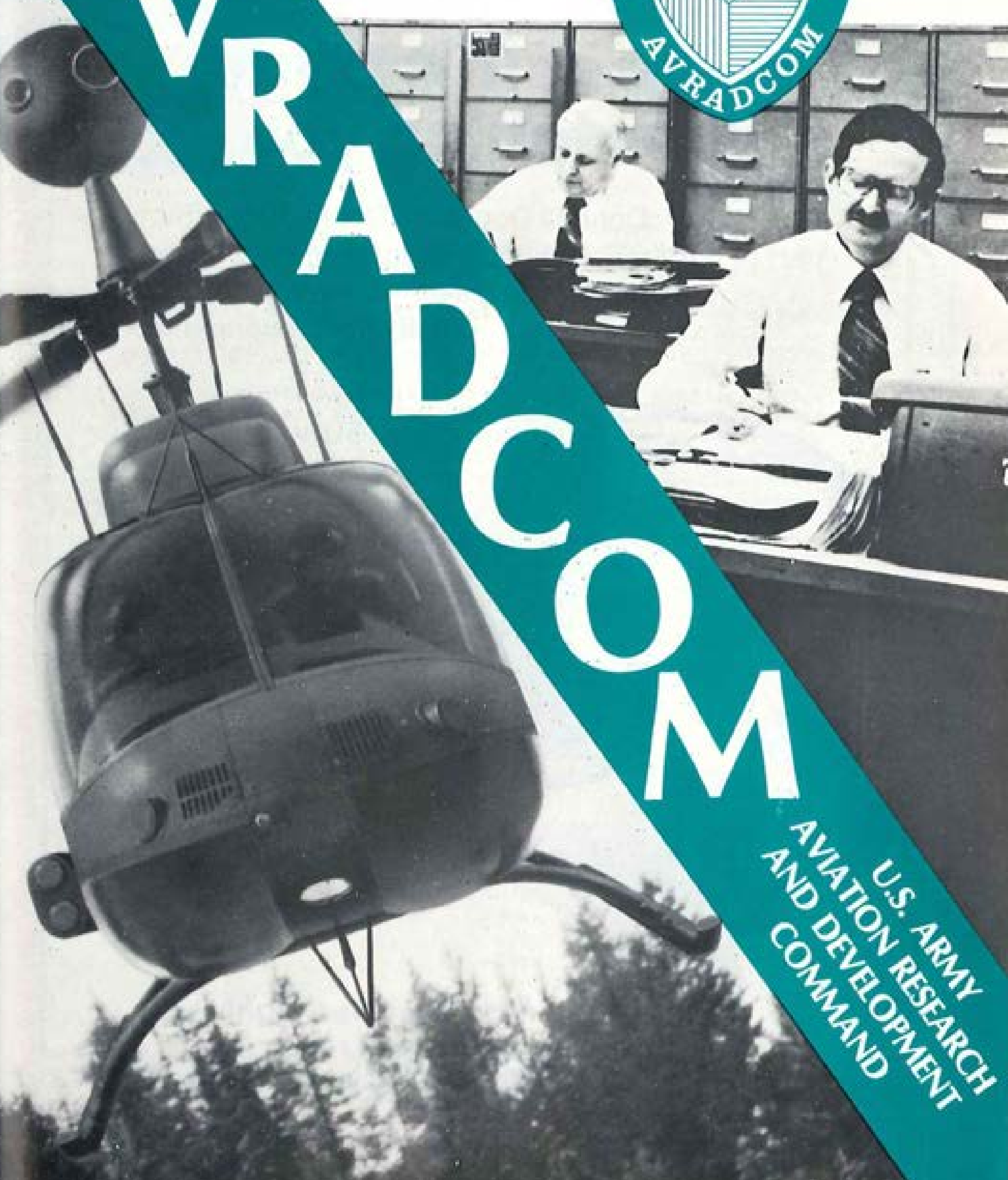

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COMMAND

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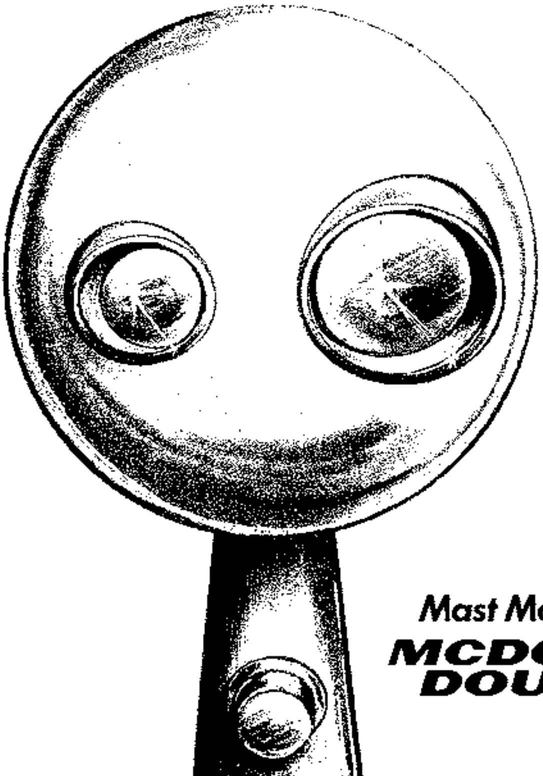

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I am delighted to introduce this second special issue dedicated to Aviation Research and Development Command (AVRADCOM). In our first special AVRADCOM edition we concentrated on acquainting you with AVRADCOM's organization and missions. This issue will focus on specific R&D projects from which you will see benefits through the 1990's.

These are truly exciting times for Army Aviation and AVRADCOM. We are fielding the UH-60 BLACK HAWK, modernizing the CH-47 Chinook, nearing production on the AH-64 Apache, beginning development of the Army Helicopter Improvement Program, putting the modernized AH-1S Cobras in the field, and developing the Aquila remotely piloted vehicle.

The challenges associated with accomplishing this massive Army Aviation modernization effort are enormous. I'm sure the readers of this publication realize that the total Army's modernization requirements encompass far more than aviation and that there simply isn't enough money to do everything we need to do. Nevertheless, with AVRADCOM leading the way for Army Aviation, I have every confidence the story of how improved aviation assets affect the Army's total force capability will be told and told well.

One final note. Congratulations to AAAA on your silver anniversary and best wishes for a productive annual meeting from 23-25 April.

DONALD R. KEITH
General, United States Army
Commanding

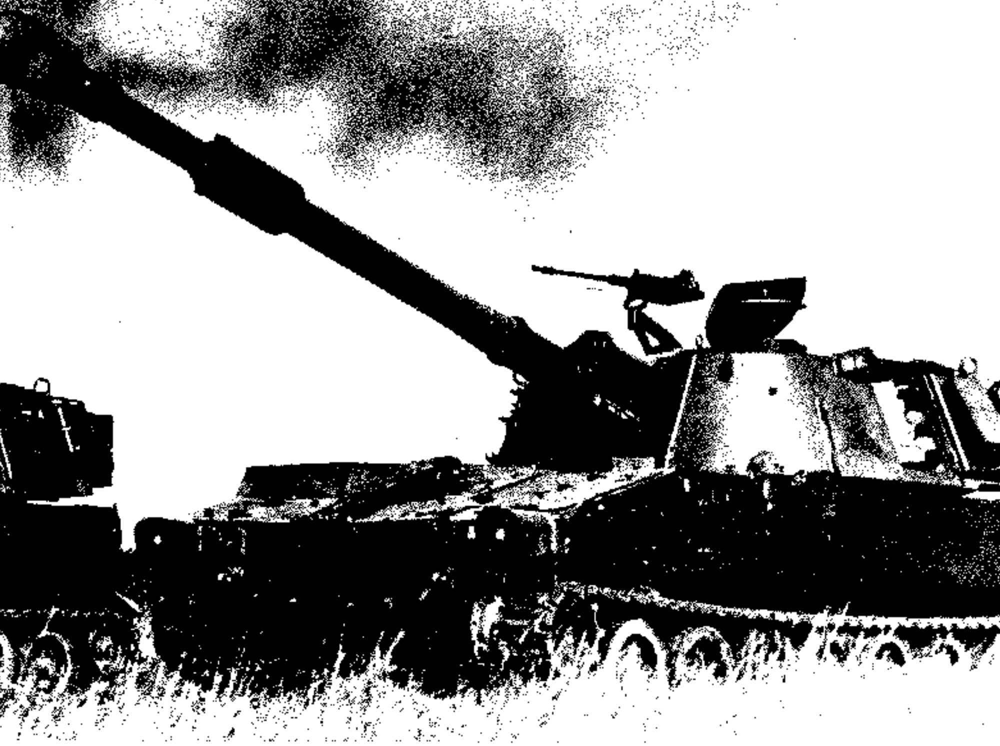
"First round,

...with the breakthrough in target acquisition, the Aquila artillery RPV.

Thanks to the miracles of miniaturized solid state electronics, a small RPV—Aquila—will be able to fly over a battlefield and give you an eagle-eyed view of targets and threats—a real-time television picture of the terrain below. Aquila will pinpoint targets with such precise accuracy that you can fire for effect on the first round. And for the utmost in accuracy, it will designate the target for laser-guided munitions.

Aquila will bring a new level of effectiveness to artillery weapons. The system is being developed by Lockheed under the direction of AVRADCOM.

fire for effect..."



But what about enemy air defense?

Aquila is a speck of a target. It's only 6 feet long and 13 feet wide. Weighs only 220 pounds, including its electronic payloads. Its small size paid off in tests at Ft. Bliss, Texas. In a number of flights, an Aquila demonstration program RPV survived many bursts from several types of weapons. The RPV not only survived, it wasn't hit once. As for infrared, it doesn't generate enough heat for homing.

What's the timetable?

This breakthrough in target acquisition can be operational in the mid-1980s. The Aquila demonstration program already has shown that the artillery RPV can operate in the real world. Soldiers flew 150 demonstration flights out of a total series of 218.

Better eyes in the skies.

When the other side has more men, more tanks, more guns, you'd better get steel on deep targets faster, more accurately than ever before. And that's precisely what the Aquila target acquisition system was designed to help you do.

Lockheed Aquila

by BG Ellis D. Parker

R&D: Fulfilling requirements

LIKE it or not, we are locked in a vicious cycle. The threat drives our technology which leads to innovation and eventually the requirement for new system capabilities. The threat reacts, and we start the cycle all over again.

Fielding a new system involves a host of thinkers and workers. Researchers, developers, users, producers, trainers, industry, and logisticians are but a few who contribute. Without the total integration of effort into a mold of partnership and teamwork, new technology necessary to keep pace with the threat would never be developed.

The objective of research and development is to provide the user with the most technologically advanced weapons systems possible within given budgeting constraints. Army Aviation force modernization is the ultimate goal.

Force modernization efforts are twofold — purchasing of new sophisticated weapons and modification or upgrading of existing weaponry. A brief examination of attack, scout, assault, and cargo helicopter categories coupled with a quick review of aircraft survivability categories highlights current R&D achievements.

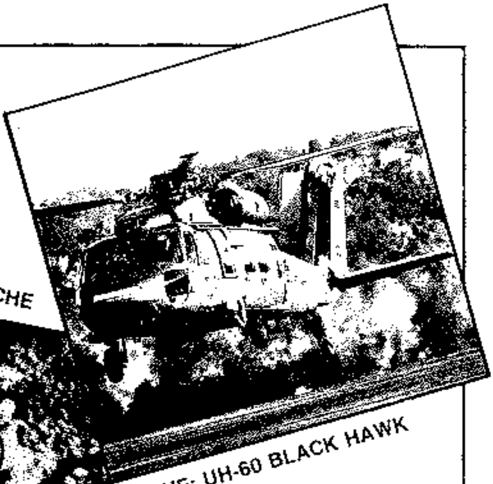
ABOUT THE AUTHOR
Brigadier General Ellis D. "Don" Parker serves as the Deputy Director of Requirements and Army Aviation Officer in the Office of the Deputy Chief of Staff for Operations and Plans, Dept. of the Army.

The attack category

In the attack category, the fully modernized AH-1S is a very capable anti-armor system. But by itself, it cannot fill the Army Aviation antiarmor role for the near and mid-timeframes. Thus the need exists for the AH-64 **APACHE.**

The **APACHE** is a twin-engine, tandem seated helicopter designed from the beginning as a stable, manned aerial weapon system. It will provide responsive direct aerial fires as an integral element of ground combat units. It will be fully capable of performing its mission at night and in adverse weather conditions.

Presently the scout/observation fleet is composed entirely of the OH-6 and OH-58. Both these aircraft have limitations in performing their mission around the clock in a high-threat environment.



ABOVE: UH-60 BLACK HAWK

BELOW: THE AH-64 APACHE

Therefore, we have established two new programs to improve our scout/observation capability.

First, the OH-58 fleet is undergoing modifications to convert 585 OH-58A's to the OH-58C configuration. This will provide a scout helicopter that can perform adequately with the AH-1S **COBRA.**

Additional OH-58 airframes will be modified into a more capable, near term scout helicopter. The **Army Helicopter Improvement Program (AHIP)** will provide an improved high-density altitude and hot day performance scout helicopter. A mast-mounted sight will incorporate a laser designator and FLIR capability, improve survivability, and make it capable of operating with and supporting the AH-64 attack helicopter.

Assault/utility helicopter improvements are equally important to the mission of Army Aviation. The UH-1 modernization program, starting in the late 80's, will include new composite rotor blades, modern avionics, improved drive-train components, and other safety, maintenance and survivability features.

The assault category

The **BLACK HAWK** has become a reality through the team efforts of many people. It represents one of the most successful efforts in the history of R&D. The **BLACK HAWK** is a substantial improvement in performance and capability over the UH-1. It is our first true squad-carrying helicopter, and its battlefield survivability is unequaled by any other production helicopter in the world.

In the cargo area the modernized CH-47D helicopter has been improved to provide a cost-effective means to sustain a medium lift capability beyond the year 2,000. This modernization is achieved through a complete remanufacturing effort to incorporate increased capability with greater survivability, and better reliability, availability, and maintainability through improved technology components and subsystems.

The result is a cargo fleet with increased effectiveness and readinesss through reduced maintenance man-hours per flight hour. The first modernized CH-47D will be delivered to the Army in May 1982.

An aggressive ASE program

The Army has an aggressive **Aircraft Survivability Equipment (ASE)** program to support Army Aviation. The procurement and installation of this equipment will assist Army Aviation in accomplishing its mission in spite of the Soviet air defense threat. ASE is probably the most cost-effective combat multiplier that we can apply to our aircraft; therefore, it is a very high priority effort which is intensively managed.

While these many systems are reaching the troops, continuing Army advanced R&D programs will affect modernization significantly beyond the 1980's. A brief summary of the most promising of these efforts demonstrates the effects of R&D on the future of Army Aviation.

ACAP — A promising program

The first promising program is the **Advanced Composite Airframe Program (ACAP).** The ACAP will demonstrate methods for employing advanced composites in the primary airframe structure of military helicopters.

It is anticipated that the ACAP will provide an approximate 17% reduction in production costs and 22% reduction in weight. By 1984, this should enable the Army to pay less per pound for aircraft, carry more ordnance of fuel, and enhance survivability.

The second effort is the **Advanced Digital/Optical Control System (ADOCS).** Objectives include developing, demonstrating, verifying, and applying improved flight control technology to provide greater helicopter mission capability and survivability while significantly decreasing pilot work load. Supporting development will include an evaluation of digital/fiber optic components and flight test/demonstration of a complete control system in FY 84.

These programs and others such as the **Advanced Technology Demonstrator Engine (ATDE),** the **Integrated Technology Rotor (ITR),** and the fuel efficient **Modern Technology Engine (MTE)** are major advanced development efforts which fully demonstrate the R&D community's contributions to the Army's follow-on modernization and next generation helicopter programs.

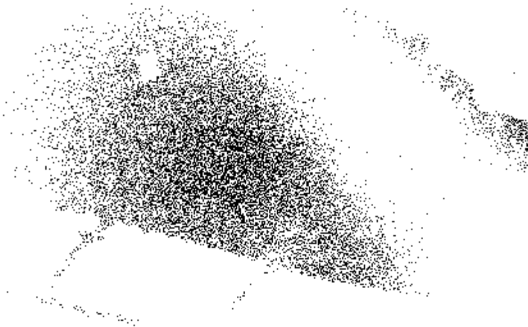
Problems and challenges

Notwithstanding the fact that R&D has generated substantial progress in modernization and will continue to produce exciting advanced development efforts, we can rest assured that personnel involved in R&D will not rest upon the past accomplishments.

Improvements are needed in our ability to fight in a modern-chemical-biological warfare environment, and to fight in the face of ever-improving enemy air defense systems. In addition, there are still the problems of an aging fleet; a shortage of modern materiel Army-wide — not just aviation; and the trauma of playing "catch up" with peacetime budgets.

Although their challenges are formidable, AVRADCOM and the Army's R&D community of players will meet the challenge in order to enhance the effectiveness of Army Aviation as part of the total Combined Arms Team. IIIII

THE ENEMY WON'T WAIT FOR THE ICING TO CLEAR



So don't let it ground your defenses either.

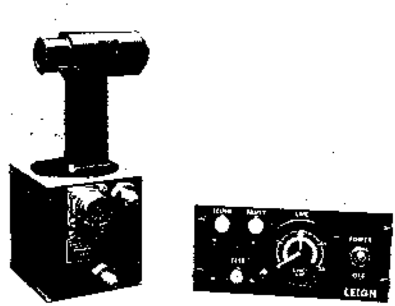
Leigh has designed an Ice Detection System specifically for helicopters that makes flying on the margin considerably safer. So that you can surprise *him*.

The system gives fast and accurate warning of icing conditions. Aircrew quickly know the severity of the icing being encountered — a cockpit display gives a precise readout of the liquid water content in the ambient air.

Weight will not keep you down either. Microprocessor electronics ensure a lightweight unit of less than two pounds.

There's more. Mated with Leigh's Integrating Rate capability, our system will calculate the amount of ice building up over a period of time. Output signals can be used to trigger cycling of the de-icing equipment, reducing the possibility of uneven shedding of ice from the blades.

If you'd like to know more about keeping your defenses up, call Tom Spruston at (613) 820-9720, or write to Leigh Instruments Ltd., Engineering and Aerospace Division, 2680 Queensview Drive, Ottawa, Canada K2B 8J9. Telex 053-4129.



LEIGH

by MG Story C. Stevens

A view of the future

THE widely publicized growth in threat weapons systems as well as increased concern about the capability to deploy and operate U.S. Forces in various geographical locations pose both a challenge and an opportunity for Army Aviation and USAAVRADCOM.

This challenge is aggravated by the aging of our light helicopter fleet and continuing resource constraints. As I reported to you in the 1980 AVRADCOM issue of **Army Aviation Magazine,** R&D continues to provide needed solutions to tomorrow's threat.

I am proud to report that cooperation has never been better between the user and development communities to enhance Army Aviation's ability to meet and defeat this formidable threat.

The TRADOC community has developed an Air/Land Battle Concept which drives the twelve **Mission Area Analyses (MAA)** being conducted by TRADOC Centers. The **Aviation Mission Area Analysis (AMAA)** is scheduled for completion by the USAAVNC in early 1982 and will identify Army Aviation deficiencies for correction.

When tactical, organizational, and/or training solutions to these deficiencies are possible, they will be pursued. When tactical, organizational and/or training solutions are either not available or insufficient, materiel solutions will be sought.

AVRADCOM has supported the AMAA by identifying technological opportunities for Army Aviation of the 1980's and '90's and by identifying candidate materiel solutions to deficiencies. It is worth emphasizing that the accuracy of both the threat and technology forecasts are crucial to the validity of any MAA.

Concurrent with the user community's Air/Land Battle Concept and AMAA efforts, the development community has been aggressively developing a hierar-

ABOUT THE AUTHOR
Major General Story C. Stevens is the Commander of the United States Army Aviation Research and Development Command, a subordinate organization of USADARCOM, located in St. Louis, Missouri.

chy of **Department of the Army (DA)**, HQ DARCOM, and Army Aviation long range **research, development, and acquisition (RDA)** plans.

The DA Long Range RDA Plan pertains to the 15 years of planning the **Program Objectives Memorandum (POM)** and its **Extended Planning Annex (EPA).** This drives the DARCOM Long Range RDA Plan which identifies research and technology and acquisition programs to satisfy MAA deficiencies, and explains how the technology products support future developments to solve deficiencies.

The Army Aviation RDT&E Plan, published annually by AVRADCOM provides: an executive summary of Army Aviation's 20-year RDT&E Plan, the concept-based acquisition strategy addendum upon which our R&D is based; a threat addendum; and a capability analysis addendum which identifies to the user the capability enhancement potential of planned future systems and product improvements.

DA RDA Strategy Group

The DA RDA Strategy Group formed by the Weapon Systems Aviation Division of ODCSRDA has been instrumental in enhancing user/developer coordination and cooperation achieved this past year.

This group of senior military and civilian representatives from ODCSRDA, HQ DARCOM, AVRADCOM, ODCSOPS, HQ TRADOC, and the USAAVNC Directorate of Combat Developments was organized in 1980. Notable achievements of this group to date include:

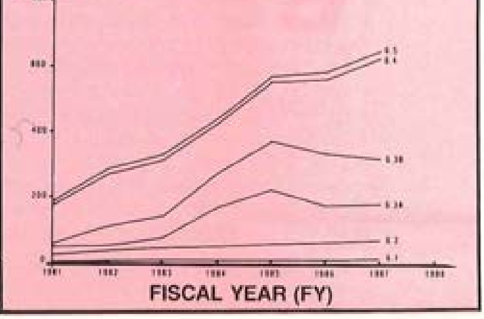
- A hierarcy of DA, DARCOM, and AVRADCOM Long Range RDA plans responsive to the AMAA and the 1980 Assistant Secretary of the Army (RDA) Vertical Lift Technology Review Report findings of **Figure 1**.
- Articulation of Army Aviation RDA programs resulting in program funding growth to meet user needs as shown in **Figure 2**.
- **Preplanned Product Improvement (P^3I)** Programs for the UH-60A, AH-64A, and CH-47D beginning in FY 83, 84, and 85 respectively.
- Planned future generation of light helicopters, the LHX. The LHX will consist of scout/attack & utility observation versions using common dynamic com-

FIGURE 1

VERTICAL LIFT TECHNOLOGY SUBGROUP REPORT

- INCREASE 6.1, 6.2 AND HI PAYOFF 6.3A FUNDING GREATER THAN OR EQUAL TO 10 PERCENT PER YEAR
- ADVANCED TECHNOLOGY COULD REDUCE HELICOPTER GROSS WEIGHT BY 30 PERCENT AND FUEL REQUIRED BY 40 PERCENT
- HI SPEED AND EXTENDED RANGE INCREASINGLY IMPORTANT FOR SELF-DEPLOYABILITY
- URGENT NEED FOR HELICOPTER SYSTEM PROTECTION AGAINST CB/LASER
- AERO TECHNOLOGY INVESTMENT NEEDED TO AVOID REPEATING DEVELOPMENT PROBLEMS
- PROCUREMENT SPENDING INADEQUATE TO MAINTAIN INVENTORY
- IN CONSTANT 1972 DOLLARS, ARMY AVIATION TECH BASE FUNDING DECLINED IN LAST 8 YEARS
- AFTER AAH R&D, 6.4 WILL ONLY ADDRESS RPV'S AND COMPONENT IMPROVEMENT

FIGURE 2



HIGH PAYOFF APPROACHES

	AVIATION P^3I	LHX	SEMA-X
DESIGN FOR OPERATION ON INTEGRATED BATTLEFIELD	ACCOMODATED	DESIGN MANDATE	DESIGN MANDATE
REDUCE SIZE/POWER CONSUMPTION	IMPROVE	PROGRAM PREMISE	PROGRAM PREMISE
STANDARDIZE	AVIONICS, ASE	FAMILY OF VEHICLES	COMMON SENSOR/ PROGRAM PREMISE
SIMPLIFY	COCKPIT	DESIGN EMPHASIS	SYSTEM CONSIDERATION
PRE-PLANNED PRODUCT IMPROVEMENT	IS P^3I	PLANNED FOR P^3I	PLANNED FOR P^3I
CHOOSE "STATE OF THE ART" OVER "FRINGE OF THE ART"	PROGRAM MANDATE	IN DESIGN APPROACH W/P^3I	IN DESIGN APPROACH W/P^3I

FIGURE 3

ponents. The LHX is intended to be the light, affordable complement to the AH-64 APACHE and the UH-60A BLACK HAWK. It will replace the aging AH-1, UH-1, and OH-58 fleet in the 1990's.

- A planned special electronic mission aircraft, the SEMA-X to provide a standard, military airborne platform for our SEMA missions of the 1990's.

The threat, lessons learned, current and projected resource constraints, and technology forecasts indicate that there are certain high pay-off approaches to developing materiel for the Army Aviation element of the Combined Arms Team of the future. **Figure 3** above covers several approaches that are discussed below:

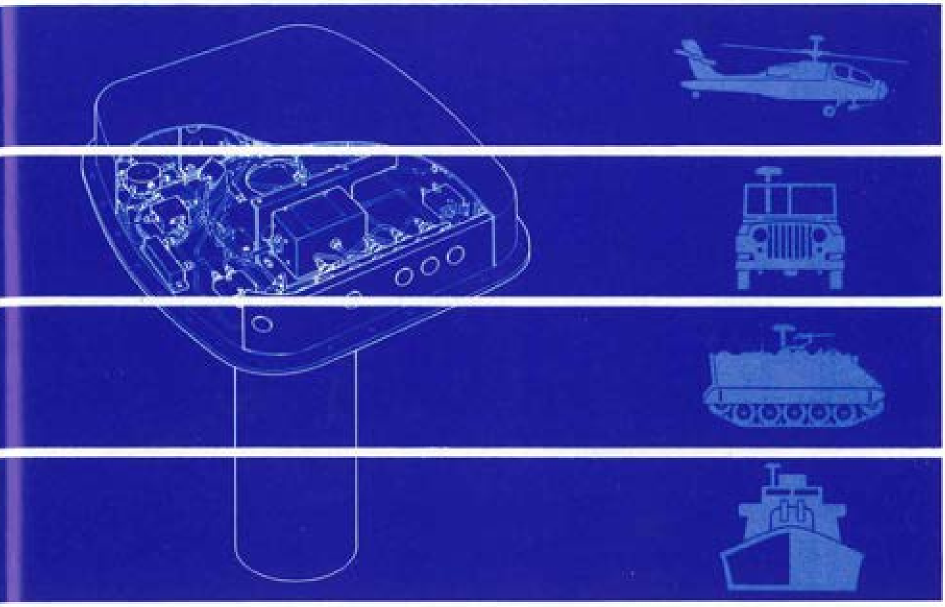
- **Design for operation on the integrated battlefield** — Aviation Life Support Equipment is being developed to permit operation on the future battlefield where **nuclear, biological, chemical (NBC)** and laser threats are present. This equipment includes the **Aircrew Life Support System - Integrated Battlefield (ALSSIB)**, the integrated aircrew helmet, new aviator protective mask, nuclear flash goggles, laser eye protection device, and the onboard oxygen generating system. Aircrew and ground crew protection, cooling, decontamination, and rest must be provided.

An **Aircraft Decontamination Deicing and Cleaning System (ADDCS)** is being developed and research continues on new decontaminates. **Unattended Aerial Vehicles (UAVs)** are being investigated to perform NBC reconaissance to provide a form of remote detection.

- **Reduce size and power consumption** — The **Advanced Composite Airframe Program (ACAP)**, initiated in FY 81, is expected to demonstrate weight and cost reductions of 22% and 17% respectively. Lightweight, fuel efficient engines, such as the 800 shp **Advanced Technology Demonstrator Engine (ATDE)** and the 5,000 shp Modern Technology Demonstrator Engine (MTDE), will add to the expected savings generated by ACAP. The MTDE is targeted for the CH-47D P^3I program and will decrease mission fuel required by 19%, increase payload range by 36%, increase payload capability by 47%, and increase productivity by 74%. The ATDE is expected to provide a 20% reduction in fuel consumption and to be a candidate engine for the LHX.

- **Reduce the manpower requirements** — Ongoing LHX Concept Formulation efforts are evaluating the feasibility of a single crewmember cockpit, a feature which potentially could reduce size, fuel consumption, and manpower requirements. Although several valid technical and operational feasibility issues need resolution and will be investigated during the LHX Concept Formulation effort, the single crewmember cockpit concept could significantly increase our battlefield capability by permitting a larger fleet of LHX aircraft for the same number of aviators in comparison to a dual

A NEW LOOK AT THE ELECTRONIC BATTLEFIELD



Successfully field demonstrated to the U.S. Army, Loral's new **Radar Frequency Interferometer** (RFI) quickly and quietly detects, identifies and locates hostile tactical radars with deadly accuracy.

Tactical applications of the Loral RFI range from precision cueing of optical/electro-optical systems and weapon set-on to real-time surveillance.

Non-radiating and unaffected by atmospheric obscuration, the extremely small, lightweight mast-mountable RFI is readily adaptable to both helicopters and a wide variety of ground vehicles.

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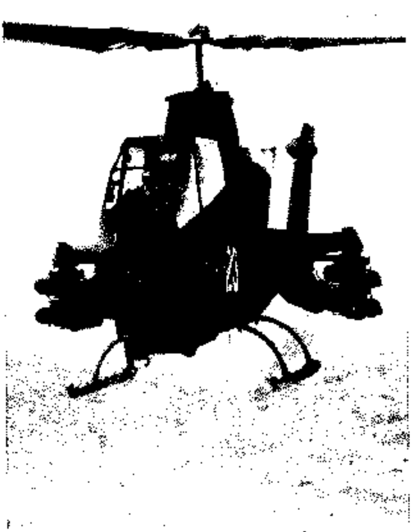
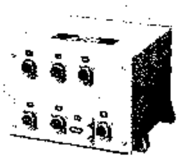
Laser Warning Receivers



AN/AVR-2 DT/OT II Installation.

Sensor Unit



Interface Unit

See our exhibit at the AAAA National Convention, 22–25 April, Chase Park Plaza Hotel, St. Louis, Missouri

Aircraft survivability in the modern battlefield depends on the deployment of sensors responsive to new threats.

Perkin-Elmer is continuing to apply its technology to counter the threat that laser-guided weapons pose to military vehicles.

The latest application of our technology is the AN/AVR-2 Laser Detector Set which is designed to warn Army aircraft of laser illumination from hostile weapon guidance systems. The Sensor Units possess the logic for laser detection and identification in the presence of natural background. An Interface Unit then sends a signal to the AN/APR-39 Radar Warning Receiver, for appropriate flight crew response.

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- Adaptability to meet new optical threats
- Integrated logistic support
- Compatibility with digital data bus
- Systems modeling and design analysis
- ECM/OCM interface

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PERKIN-ELMER

Responsive Technology

crewmember aircraft. **Unattended Aerial Vehicles (UAVs)** have many potential missions in addition to the fire support role of the **Aquila,** thereby freeing aircrews for those missions not suitable for UAVs. UAV future applications include: NBC reconnaissance, decoy/harassment, electronic support measures, radio relay, electronic CM, mine detection, psychological operations, and meteorological data collection.

• **Standardize**—This is the premise for the LHX and SEMA-X programs. Presently there are 10 different Army airborne **Intelligence/Electronic Warfare (IEW)** platforms, most of which are modified civilian fixed-wing aircraft. The SEMA-X is intended to replace the OV-1, RV-1, RU-21, and RC-12 aircraft in the 1990's. SEMA-X's primary role will be to gather battlefield intelligence for use in directing activities along the **Forward Line of Troops (FLOT)** and will also perform a reconnaissance/early warning role. The UH-60A, AH-64A, and CH-47D P³I programs will enhance ASE and avionics standardization.

Lightening an aviator's load

• **Simplicity** — Aviation electronics technology is providing many opportunities for simplifying materiel and the aviator's workload.

The **Army Digital Avionics System (ADAS)** will reduce electrical switches by 56%, circuit breakers by 80%, control panels by 50%, instruments and indicators by 76%, status annunciation by 85% while increasing redundancy and system reliability.

Simplicity is also being pursued in other component technology programs, such as the Army/NASA **Integrated Technology Rotor/Flight Research Rotor (ITR/FRR)** Program where advanced design concepts and materials are expected to yield a 60% areduction in rotor system part count, 50% reduction in maintenance manhours/flight hour, 100% increase in MTBR, and reduce basic rotor weight by 15%.

• **Preplanned Product Improvement (P³I)** — In his memorandum of 30 April 1981, **Deputy Secretary of Defense Carlucci** defined P³I as an evolutionary approach which minimizes technological risk, and inserts advanced technology through planned upgrades of those deployed subsystems which offer the greatest benefits. He recommended that most new and existing systems should be partitioned for performance growth through the application of sequential upgrades to key subsystems. The Army Aviation long range RDA plans comply by including P³I for the UH-60, AH-64, CH-47, LHX, and SEMA-X.

• **Choose the "State-of-the-Art over the "Fringe-of-the-Art"** — The P³I concept is that state-of-the-art improvements will be grouped in a block improvement of a system allowing system evolution. If a P³I or new system program is to be of acceptable risk and yet seize technological opportunities we must be certain that a technological advancement has been demonstrated to be state-of-the-art.

The demonstrator programs

This is the essence of our technology demonstration (6.3A) program. Current or planned demonstrator programs include: **Helicopter Adverse Weather Fire Control/Acquisition Radar (HAWFCAR); Advanced Low Observable Aircraft (ALOA); 5,000 shp MTDE; 800 shp ATDE; Air Self Defense System (ASDS); Fiber Optic Guided Missile (FOGM); Helicopter Adverse Weather Target Servicing System (HAWTSS); Helicopter Automatic**

Targeting System (HATS); Integrated Technology Rotor/Flight Research Rotor Program (ITR/FRR); Advanced Digital/Optical Control System (ADOCS); Advanced Composite Airframe Program (ACAP); Light Helicopter Advanced Technology Demonstration (LHATD); and **Rotorcraft System Integration Simulation (RSIS).**

The Manufacturing Methods and Technology (MM&T) program also assists in the maturing of technology by demonstrating promising improvements in manufacturing programs and tooling, such as low cost composite main rotor blades, an all composite transition section for the UH-60, and industrial robotics.

USER'S INFLUENCE ON R&D AS A FUNCTION OF TECHNOLOGICAL MATURITY

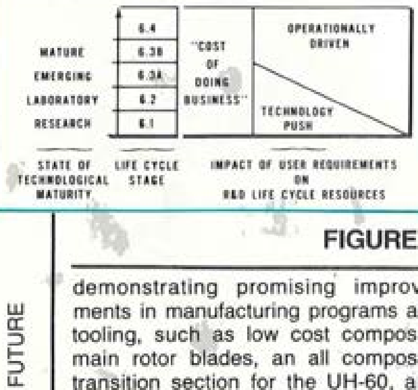


FIGURE 4

● **Reduce costs** — Many of the aforementioned programs will reduce acquisition and life cycle costs. In the interest of reducing the cost of training, AVRADCOM is investigating the reduction of the specific cost of firing a HELLFIRE missile. Equipping the relatively low cost 2.75" rocket with a "strap down" laser semi-active seeker will, in effect, provide a low cost HELLFIRE emulator. The 2.75" emulator is estimated to cost only approximately 8% of the actual HELLFIRE round.

The obvious side benefit of providing point target guidance to the 2.75" rocket, equipped with the new MK66 motor, gives a substantial capability against light armored or wheeled vehicles which would otherwise require the expenditure of a HELLFIRE missile for long ranges.

As illustrated in **Figure 4**, the operationally driven portion of our R&D resources is predominant and the user community's influence over the R&D program and planning this year has been unprecedented.

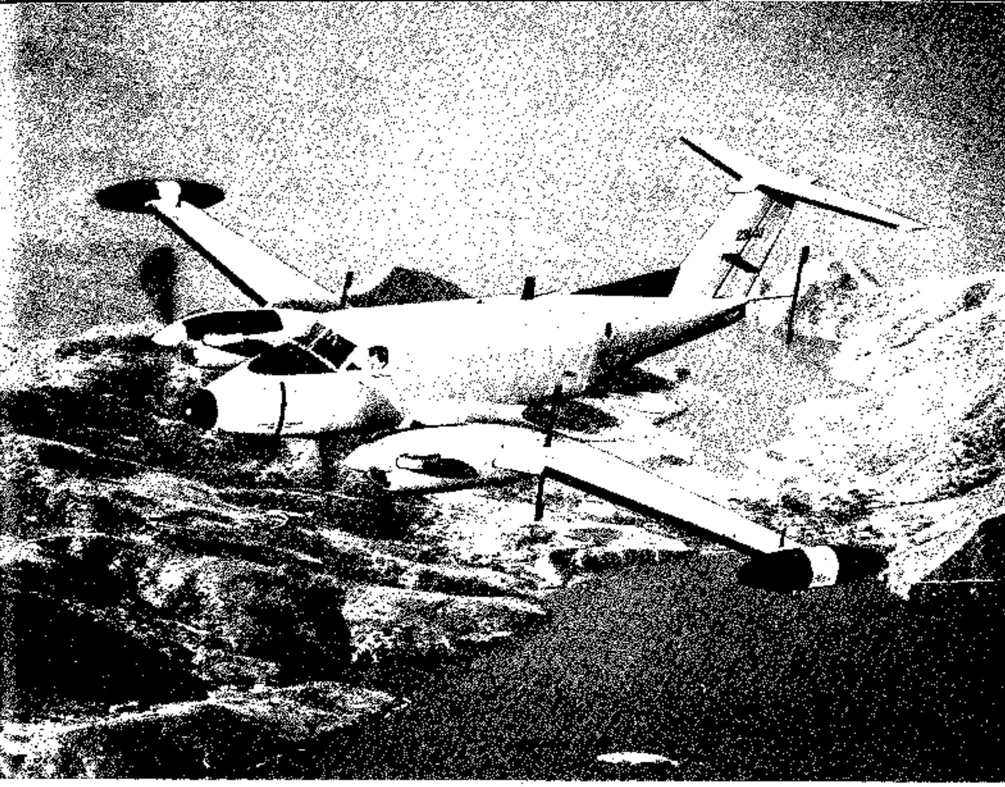
Technology push is vital

However, we must not neglect the two other important portions of our R&D program, i.e., the relatively inflexible portion which comprises the cost of doing business and the technology push portion.

The technology push portion of the program is vital to the generation and development of promising new technological opportunities.

The vitality of this portion of our program is evidenced by the presentation of the Army Award of Excellence for 1980 by the Assistant Secretary of the Army (RDA) to our U.S. Army Research and Technology Laboratories. This award was based on such factors as program accomplishments, efficient management of laboratory personnel, management initiatives and accomplishments, fiscal obligations performance and significant improvements achieved.

Aviation technology is one of the keys to success on the future battlefield. We should seize upon the technological strengths of this country not only to counter the threat but to provide a Combined Arms Team to carry the offense and win on the future battlefield, whenever and wherever it may be. IIIII



This top-ranking military jetprop is volunteering for more special missions.

Beechcraft's rugged C-12 jetprop has earned its military stripes as a hardworking military transport. Its turboprop economy has been saving money for the Army, Air Force and Navy and Marines all over the world. In addition, the C-12 has gained an enviable reputation for reliability.

Now it's ready for more special assignments.

With available installations for aerial surveillance, tactical field support, ECM, photography, Infra-Red, Side Looking Radar (SLAR), remote sensing, and many others, this versatile aircraft offers a broad range of mission capabilities.

And because many of these special equipment packages can be quickly removed or converted, one C-12 airframe can be used to fill the roles of several special missions aircraft.

In addition, the comprehensive Beech logistics support program now assumes total responsibility for all on-site maintenance, crew training, parts inventory, and worldwide technical service. As a result, the C-12 continues to deliver operational readiness rates well in excess of 90%.

If your command could use a special mission support system with this kind of multi-role capability, write Beech Aircraft Corporation, Aerospace Programs, Wichita, Kansas 67201.

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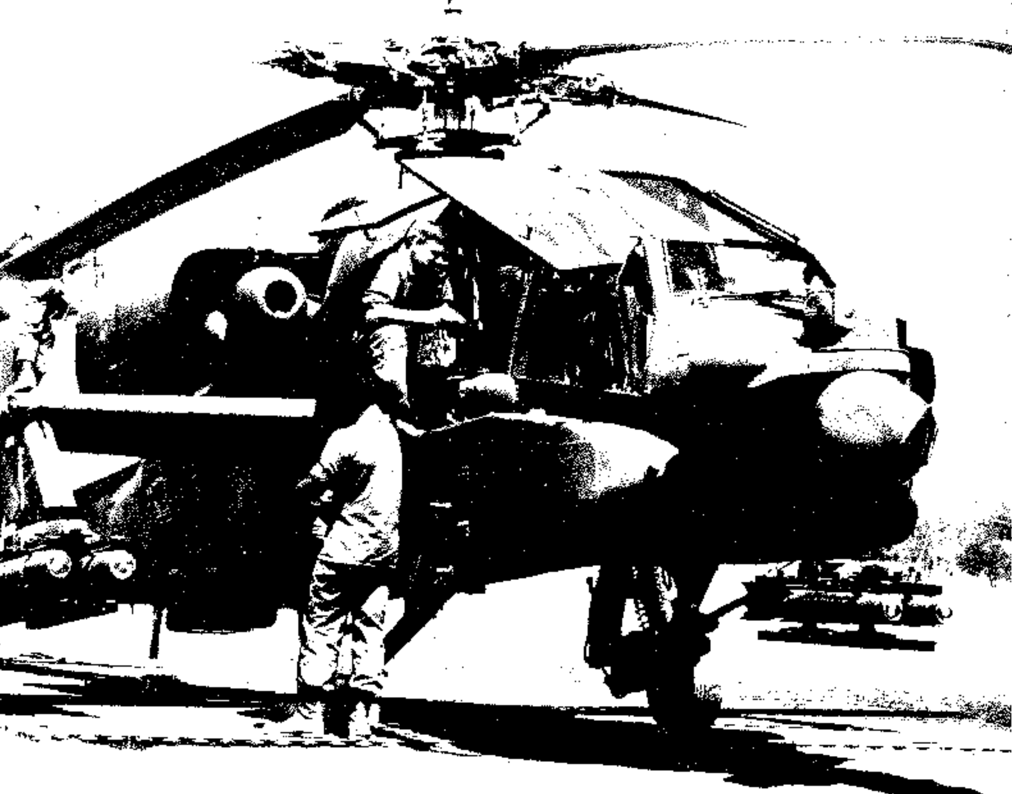
APACHE . . .
Field Tested Tough



The U.S. Army/Hughes AH-64A "APACHE's" on-time, on-schedule completion of the Army's Operational Test II milestone proved its troop compatibility with hands-on operation by Army personnel.

During this final demanding three-month long test, in hot (temperatures up to 114°), dusty conditions, the AH-64A demonstrated outstanding mission reliability. With all maintenance performed by Army personnel, maintenance-man-hours per flight-hour and other operational characteristics significantly bettered the stringent requirements for the Army's new anti-armor system.

In OT II Army pilots logged over 400 flight hours in day/night operations of AH-64A's, bringing development flight test time to over 3,200 hours. The APACHE. . .fully tested. . .transitioning to production.

Hughes Helicopters, Inc.
Ahead of TIME Technology

Transitioning to Production

by Richard B. Lewis, III

The ultimate helicopter

THROUGHOUT this issue are discussions on a wide variety of advanced technology demonstration projects which are all focused toward application in the next generation of Army aircraft. We will benefit from fuel efficient engines, composite airframes, digital avionics, and other technologies in the **Light Helicopter Family (LHX)** and in the new **Special Electronic Mission Aircraft (SEMA-X).**

Emerging capabilities such as millimeter wave radar — **Helicopter Adverse Weather Fire Control System (HAWFCARS)**, and the **Helicopter Automatic Targeting System (HATS)**, will be incorporated as block improvements to the **Advanced Attack Helicopter (AAH)** and the **Army Helicopter Improvement Program (AHIP).**

AVRADCOM will ensure that the very best technology is provided to the Army in the earliest affordable timeframe. The two key precepts of this commitment are "as soon as practical" and "as affordable as possible."

There are many other technology opportunities which are already emerging, which could give us even greater capability if the Army wanted, needed, or could afford this technology. As we incorporate these technologies, we will go beyond the next generation helicopter.

ABOUT THE AUTHOR
A frequent contributor to this magazine and a six-year member of the AAAA, Richard B. Lewis, III, serves as Technical Director at the U.S. Army's Aviation Research and Development Command.

Quantum improvements ahead

All of the ingredients of the future helicopters will find their way, at least in part, into the next generation of Army aircraft. Our major commitment to digital systems integration is already visible in the AHIP and in the Coast Guard's **Short Range Rescue and Recovery (SRR)** aircraft.

Through use of AVRADCOM's **Systems Testbed for Avionics Research (STAR)** aircraft, we will ensure that advanced avionics components and systems are thoroughly debugged before a commitment is made to production and fielding.

In the measurable future, quantum improvements in navigation will be achieved through integration of lightweight Doppler Navigation Systems, the NAVSTAR Global Positioning System, the **Position Location Reporting System/Joint Tactical Information Distribution System (PLRS/JTIDS)** hybrid, digitally stored maps, and other positioning radar systems operating either in the millimeter wave region or at 10.6 micron wavelengths.

Improved secure communications will be enhanced through multi-band radios, SINGCARS-type anti-jam and intercept resistant technology, and digital voice processing. Introduction of micron scale electronics — an output of the **Very High Speed Integrated Circuit (VHSIC)** program — will enhance the capability and reliability of our electronic components while simultaneously reducing size, weight, and cost.

Aircraft survivability equipment will be expanded to include higher frequency emitter detection, greater position fixing accuracy (as demonstrated by RF interferometers) and adaptive jamming capability.

Target acquisition/transfer

Onboard fire control systems will be linked in real time through target handoff equipment to battalion, division and corps **Intelligence Surveillance Target Acquisition (ISTA)** and **Command and Control (C_2)** networks. Shielding and coatings will protect aircraft systems from electromagnetic energy weapons, and wide use will be made of fiberoptic data links for high information survivability. The man-machine interface will be enhanced through utilization of "by exception" controls and displays, and many onboard systems will be accessed and controlled through the crewmember's voice.

Extensive use of composite materials in secondary structures is apparent on the **BLACK HAWK** and **APACHE**, and rotor blades on all Army helicopters will be made of composite materials by the next decade. Several French helicopters and the Army's AHIP use composite main rotor hubs. Our advanced composite aircraft program is providing the wherewithal to maximize use of composite materials in the future.

In addition to the obvious advantages of field repairability, low manufacturing cost, and inherent survivability, the use of composite materials in primary structures affords design flexibility needed for exotic shaping and incorporation of radar absorbing materials (for **stealth helicopter** properties). Beyond graphite and epoxy, however, there is a wide variety of stronger and more exotic materials, including metal matrix composites which could find their way into transmissions, landing gears, and other highly stressed components should the need arise.

Advanced manufacturing technology will automate the production of aircraft components making them more affordable. Independence from scarce strategic materials can be achieved through conversion to sand and coal — primary ingredients of high-strength filaments and the resins that bond them together. Already, advanced resins are being employed to protect the leading edge of the CH-47C/D fiberglass rotor blade from rain, sand, and spark discharge effects with stunning results.

Laser protective transparencies and advanced coatings will increase aircrew and component survivability in the "Buck Rogers" battlefield of the future. Crashworthiness and ballistically tolerant structural concepts will perpetuate the outstanding survivability already demonstrated in the **BLACK HAWK.**

As fuel consumption becomes an increasing issue for Army Aviation — and manifests itself in such instances as restricted training, fuel allocation to key units, and the substitution of lower graded or syn-fuels, we will be hard pressed to continue current operations. One major shortcoming in the aviation R&D program is the lack of funding for an aggressive broadly based engine development program wherein we can ensure that the engines of the 2000's will be available.

Our 800 horsepower **Advanced Technology Demonstrator Engines (ATDE)** have already demonstrated the fuel consumption and specific weight goals set for the program, but substantial additional funding is needed to complete full military qualification and make these engines available for LHX, AHIP, or other future aircraft.

In like manner, we have the knowledge to proceed with the fuel efficient engine in the size range needed to power the CH-47, one with the potential of saving millions of gallons of fuel a year.

At issue here is the up-front investment required to achieve these results, given the scarce financial resources available to the Army today. So, in the '90's, we're going to have to make do with product improvements of the T-700 and perhaps a fielded version of the ADTE and not much else.

However, not all is lost because major improvements are being made in the inlet protection, infrared exhaust suppression, electronic fuel control, improved bearings and seals, and advanced drive system concepts.

A promising design

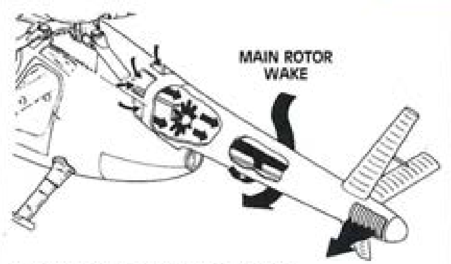
One very promising new transmission design is NASA's hybrid transmission which employs both gears and rolling contact surfaces to transmit torque with much reduced transmission noise. The concept is less complex than current transmissions and is expected to lead to reduction in costs. The use of ceramics for bearings and other selected engine components will increase with attendant life improvements.

Depending upon the economics of world oil production, it is probable that syn-fuel based engine fuel stocks will be employed with some changes required on the part of engine designers to accommodate different starting characteristics and different types of impurities that are not governed by the fuel specifications.

We're already confident in our ability to operate the newer generations of engines on such fuels, but many have to alter our operating procedures with the older fielded engines.

If higher speed becomes a mandate in order to effectively compete with our adversaries' aircraft, then renewed emphasis will be placed on convertible fan-shaft engine technology to give us the best of both worlds. At the same time, options for advanced anti-torque control concepts may demand us to reexamine our transmission design approach and selection of engines.

The no-tail rotor technology (see **Figure 1** below) currently being demonstrated for the Army and DARPA by a Hughes Helicopters contract may lead the way to other innovative tail rotorless configurations in the future.



CIRCULATION CONTROL TAIL BOOM
IN MANEUVERING FLIGHT WHEN MAIN ROTOR VELOCITIES DROP, THE DIRECT JET THRUSTER (RIGHT) WILL PRODUCE THE FORCES NEEDED FOR CONTROLABILITY.

FIGURE 1—NOTAR CONCEPT

Better materials for engines and transmissions are a certainty. We've already adopted new families of high hardness steel for improved gear life, and we're examining a variety of advanced manufacturing technologies to ensure the high temperature capacity of our turbines, and at the same time, retain the strength needed for a viable lifecycle fatigue endurance.

The increasing use of ceramic coatings for temperature barrier protection and control of engine clearances will provide significant increases in the overall efficiency of our engines.

A look at the aeromechanics

No forecast of future helicopter technology would be complete without an examination of the aeromechanics attributes of the vehicle. We have already enjoyed the benefits of tip-shaping, advanced airfoils, and higher rates of twist on the main rotor sections of our Advanced Attack Helicopter, AH-1S, and **BLACK HAWK** aircraft.

Full-scale testing has already validated the concept of a completely bearingless main rotor with attendant reduction in maintenance and component cost. Tests are underway presently to examine, in full-scale, the response of higher harmonic control inputs to the rotor system. Model tests have shown that appropriate multi-cyclic pulsing of the rotor can significantly attenuate undesirable vibration characteristics.

Rotor noise reduction

Other concepts being examined include aeroelastic conformability which would permit the rotor to respond to control inputs or gusts in such a manner as to always seek an optimum loading distribution, thus maximizing performance throughout the flight envelope. We are increasingly able to design rotors from the ground up, that is, using wind tunnel test data on advanced airfoil sections and sophisticated numerical analyses to tailor a rotor blade design to a specific set of mission conditions.

This process has already been provided for information to industry as they submit their proposals on the UH-1H composite main rotor blade product improvement program. As a result of a cooperative test program with ONERA, France's equivalent of NASA, we have gained new insight into the mechanisms which generate rotor noise, and a breakthrough in understanding rotor noise appears to be on the horizon.

Higher speed capabilities

As we look at higher speed capability, we have been extremely impressed with the performance of both the Sikorsky **Advancing Blade Concept (ABC)** aircraft and the Bell XV-15 **Tilt Rotor Research Aircraft (TRRA).** As missions are defined which require a combination of low speed, agility, and high speed cruise capability, we may be able to bring these aircraft into engineering development and exploit the very fine potential which is already demonstrated.

A key tool in the development process of any new sophisticated aircraft system is analytical simulation; our capability to do this has been materially enhanced in a cooperative program with NASA involving the **Vertical Motion Simulator (VNS).** The Army has modified the motion base and has added an improved cab and upgraded the visual image facilities. The overall facility computation power and operations support are shared with NASA. We are systematically investigating the machine interface parameters which will allow us to optimize the use of valuable aircrew assets in an increasingly sophisticated battlefield arena.

To round out the development of future aviation technology, as least brief mention of future weapons systems is required. Because of the classification of this article, it's not possible to go into some of the details inherent in the many opportunities which exist. However, it is appropriate to point out that quantum improvements are emerging with respect to our ability to fly and fight in adverse weather and at night.

Next generation **Forward Looking Infrared (FLIR)** technology will employ staring focal plane arrays with increased sensitivity and improved resolution. Millimeter wave radars will be employed for a variety of functions, including target acquisition, terrain mapping, and navigation updating. Laser radars may be employed for extremely precise localization of wire hazards or distant target arrays.

Greater lethality foreseen

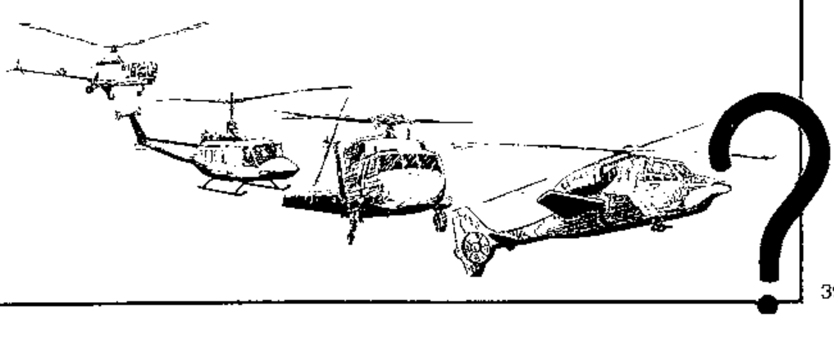
In the fire control system itself, increasing use of distributed processing will be employed to exploit the abundance of sensors on our future aircraft. In turn, integrity of the fire control system will be assured through application of an optical multiplex data bus structure, improved bore-sighting, and automatic handoff from the on-board fire control to the weapons. Greater lethality will be achieved through increased fire control accuracy and better fusing and warhead design.

Increasing use of indirect fire will be facilitated through command and control links and automatic target handoff systems. Fiber-optic links may be employed to provide an anti-jam, non-line-of-sight capability for future crew-guided missiles. Hypervelocity rockets and missiles will be employed to shorten the time lines of engagement. Progress will be made in the direction of fire and forget weapons systems.

So. . **what's beyond the next generation helicopter?** . . Many things that we cannot afford in the near term, a number of technologies which are still too immature to presage successful engineering development completion. A much improved working level dialogue, established between the development and user communities, will ensure that as technologies reach an appropriate stage of maturity, they will be considered for application on current and future systems.

21st century technology

As a result, it is highly probable that as we provide major block improvements to the **BLACK HAWK** and the **APACHE** Advanced Attack Helicopter, they will advance past the next generation of helicopter and become the representatives of 21st century technology which will restore this Nation's ability to meet a sophisticated and numerically strong enemy on equal footing. ◻◻◻



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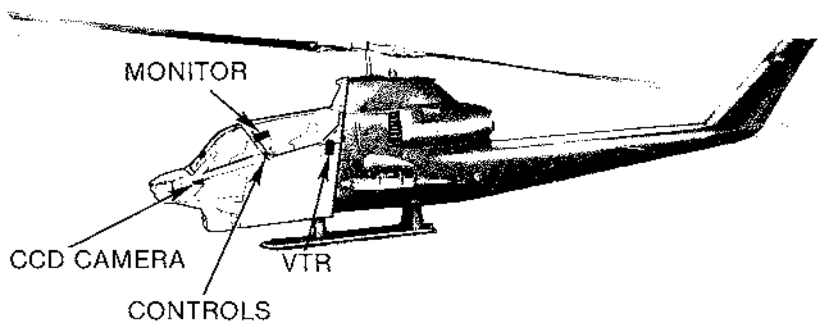

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by LTC Grady W. Wilson

The Army's flying ice maker

THE termination of U.S. involvement in Vietnam and the resultant shift in emphasis to the European theater led the Army to the realization that the existing helicopter fleet was not equipped to handle the entire spectrum of the European winter.

None of the existing fleet possessed a system capable of detecting or operating in the often present European icing conditions. Prior to this time, the operation of helicopters in icing conditions was either forbidden or considered "not conducive to longevity."

Unfortunately, Soviet operations in the Siberian winter necessitated an icing capability in their helicopters. Thus, it became imperative that the U.S. Army develop an all-weather capability in its helicopter fleet.

This realization led to the development of one of the most unique pieces of test equipment in the Free World: the **Helicopter Icing Spray System (HISS)**, the Army's flying ice maker. This system is assigned to and operated by AVRADCOM's **U.S. Army Aviation Engineering Flight Activity (USAAEFA)** located at Edwards AFB, California.

ABOUT THE AUTHOR

An experimental test pilot, Lieutenant Colonel Grady W. Wilson is assigned to the Director of Flight Test at the US Army Aviation Engineering Flight Activity (AEFA), Edwards Air Force Base, California.

The "plumbing" explained

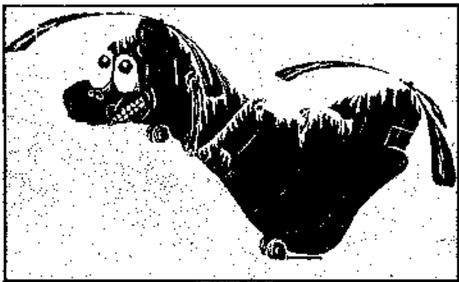
The HISS is mounted in a highly modified CH-47C **CHINOOK** and consists of an 1,800-gallon water tank, a 60-foot wide spray boom assembly suspended beneath the aircraft from a cross tube through the cargo compartment, and the associated water and bleed air plumbing necessary to transfer the water to the spray nozzles located on the boom.

The boom assembly consists of two concentric tubes which allow the water-flowing through the inner tube to be surrounded by hot bleed air to prevent freezing. The bleed air under pressure then exits through the nozzles and produces atomization of the water.

The water capacity of the tank is restricted to 1,400 gallons due to weight and balance considerations of the CH-47C.

The success or the failure of any simulation is measured by how closely the product approaches the natural condition. In the case of the HISS, its value is measured by how closely it can approximate the natural icing cloud.

To evaluate this, it was first necessary to characterize a "natural cloud."



The HISS emblem (above) tells it all.

All clouds can be generally described in terms of their droplet sizes, the droplet distribution (the number of drops of each size), and the **liquid water content (LWC)** in grams per cubic meter (gm/m^3).

The icing cloud most encountered by the helicopter is of the stratus type, and usually contains a **median volumetric droplet (MVD)**size of 9 to 18 microns with LWC's ranging up to 0.6 gm/m^3.

The cumulus cloud can be expected to contain slightly larger droplets with LWC's ranging to 1.6 gm/m^3. By way of comparison the current HISS configuration produces an MVD of 20 to 50 microns depending on the flow rate and is capable of LWC's from 0.25 to 1.0 gm/m^3. The 0.25 gm/m^3 cloud can be produced for 90 minutes while the 1.0 gm/m^3 cloud can only be produced for 45 minutes.

The test results obtained with the HISS have proven that its current configuration produces an acceptable simulation of the natural icing environment. This has led to the use of the HISS as a primary icing certification vehicle by the U.S. Army. It allows the test aircraft to be subjected to a much broader range of water contents than could be countered in natural icing.

It also allows the temperature to be varied through the variation in altitude. The normal test matrix for moderate icing will include liquid water content to 1 gm/m^3 at —5°C and decreasing linearly to 0.25 gm/m^3 at —20°C. Testing is not conducted at colder temperatures due to the rare occurrence of ice at these temperatures under natural conditions.

The current USAAEFA test procedure requires a formation of 3 to 4 aircraft determined by the test airspeed. The normal flight consists of the HISS, the test aircraft, the Firebird chase (JUH-1H helicopter equipped with a fire suppression system) and a high-speed photographic chase (normally a U-21). If the test airspeed is compatible with the Firebird chase, it doubles as a photographic chase thus eliminating the need for the high-speed chase.

A 1,500—12,000 foot sweep

The normal procedure calls for the high-speed chase to enter the test area approximately 10 minutes prior to the remainder of the flight and conduct a temperature sweep from 1500 feet AGL to 12,000 feet MSL. This information is then relayed to the remainder of the flight allowing them to initiate a climb to the test altitude for the temperature desired. Upon entering the test area the HISS reduces airspeed to 40 KIAS, lowers the spray boom and initiates the desired flow rate. The HISS then accelerates to the test airspeed (90 to 120 KTAS) and the test aircraft enters the cloud from below.

The test aircraft maintains horizontal spacing (stand-off distance) at 150 feet by using a lighting system mounted on the aft portion of the CH-47. The lights are triggered by a radar altimeter whose antennas are mounted in the upper portion of the cargo door, and illuminates a red light if the distance is less than 150 feet and an amber light if the distance is greater than 160 feet.

After the test aircraft is in position, the chase moves into formation on his right side allowing both visual and photographic coverage of the ice accretion on the test aircraft. The flight then proceeds in this manner until the test aircraft experiences some undesirable characteristic or the water or fuel load dictates a return to base.

Testing started in 1973

The initial testing with the HISS was conducted in 1973 at Fairbanks, Alaska. Since then the system has been employed in Alaska, Moses Lake, Washington, and, for the past four years, at St. Paul, Minnesota. Practically every aircraft in the Army inventory has been tested behind the HISS to include the UH-1H, AH-1Q, AH-1G, CH-47D, YUH-60, YUH-61, UH-60, and OV-1.

Developmental anti-ice/de-ice systems for helicopters ice protection have also been flight tested. The past two years has seen the first usage of the system by a commercial firm. During basic terms of this agreement stated that in return for continued FAA funding support, the HISS would be made available to commercial users.

The future for the HISS holds a continuing improvement program on the cloud size and droplet distribution of the cloud. This past winter saw the installation of a separate APU to provide an increased bleed air capability for the boom. Long range plans call for an improved system incorporating a larger water capacity and larger spray boom to be deployed with the improved capabilities of the CH-47D.

Near term plans call for the modification of the aircraft to a fiberglass rotor blade configuration during the spring of 1982, and the possible installation of a second APU to further increase the bleed air supply.

HISS shown during BLACK HAWK certification tests

the winter of 80-81, **Bell Helicopter Textron (BHT)** conducted approximately 20 hours of icing tests on the Bell 412 behind the HISS.

This past winter (81-82) both BHT and Sikorsky Aircraft had entrants in the icing test program; Bell with the 412ST and Sikorsky with the S-76. This cooperative effort was made possible through an interagency agreement between AVRADCOM and the FAA. The

The HISS has been instrumental in the certification of the **BLACK HAWK** for the moderate icing envelope, and this past winter saw the newest member of the Army helicopter family, the YAH-64A, receive its initial icing trials.

Whatever the future of Army Aviation may be, you can be certain that the HISS will play a major role in the achievement of all-weather capability in the Army fleet. IIIII by Dr. Lewis L. Feaster

For the 2000's just ahead: LHX!

THE U.S. Army's inventory of light helicopters is comprised of several thousand scout, attack, and utility aircraft. These aircraft were acquired in the '60's and early '70's and will soon reach a normal 20-year service life.

It's a matter of some concern that this aging fleet could become an operationally deficient and economically unsupportable force. This condition is expected to be somewhat relieved through implementation of the **Army Helicopter Improvement Program (AHIP)** and introduction of the AH-64 and the UH-60 helicopters during the '80's. However, the AHIP is an interim solution to the Army's requirement for a scout helicopter.

The problem is further aggravated by evolving tactical concepts which envision operation over wider ranges in highly dynamic battlefield settings. These scenarios place an increased emphasis on such factors as mobility, sustainability, and control measures. Rapid deployability to various trouble spots around the world is also a major factor; and the ability to conduct operations at night, under adverse weather conditions and in the presence of battlefield obscurants, such as smoke, haze, and dust, is considered essential.

Looking ahead to an LHX advanced development program, Dr. Lewis L. Feaster serves as the Director of Advanced Systems (DRDAV-N) at the U.S. Army Aviation Research & Development Command.

Some areas of concern

Survivability on the battlefield is expected to become increasingly difficult due to the use of improved conventional weapon systems and potential for the introduction of non-conventional weapons. For the helicopter, this means surface-to-air guns with higher rates of fire, better fire control, and more lethality; surface-to-air missiles with advanced guidance and higher flight velocities; and threat aircraft — both rotary and fixed wing.

Two major areas on which the Soviets are placing a great deal of emphasis are air defense and electronic warfare capabilities. They apparently recognize these two areas provide a high payoff for increasing their overall combat effectiveness and are rapidly expanding their capabilities in both areas.

Other areas of concern are represented by their attention to developing rotary wing air-to-air tactics, employment of chemical agents, and development of tactical lasers as well as more exotic systems.

Projecting the U.S. Army helicopter fleet into the 1990's time frame and comparing its capability to that of the forecast threat produces the following list of perceived needs:

- High target servicing rate.
- Adverse environment operation.
- **Nuclear, Biological, and Chemical (NBC)** and **Electromagnetic Particle (EMP)** tolerance.
- Rapid deployment capability.
- Improved speed, range, endur-
- Improved speed, range, endurance, and dependability.
- Precise navigation and target location.

To meet these needs and enhance the future force structure, AVRADCOM has been conducting concept formulation studies for a new aircraft system known as the **Family of Light Helicopters (LHX).**

These studies are designed to provide information that will assist the Command in structuring its technology base program and in supporting an LHX advanced development program beginning in mid-1983. Prototyping would start in 1986-1987 with the first delivery to units in the field being scheduled in the mid-1990s.

Cost as a prime consideration

A primary consideration for the LHX is an affordable aircraft design that can be produced in large numbers. An armed scout version is planned for initial development with attack and utility derivatives to be evolved around a common set of dynamic components (engines, transmissions, rotors, etc.).

It's envisioned that both the scout and attack variants would use the same airframe and that a different airframe would be required for the utility model. Along with low cost, a small air vehicle in the 6,000-8,000 pound gross weight category is desired. Other general characteristics to be incorporated in the LHX are the "ilities" — reliability, maintainability, and survivability.

For the LHX, however, these common descriptors carry a new dimension of meaning.

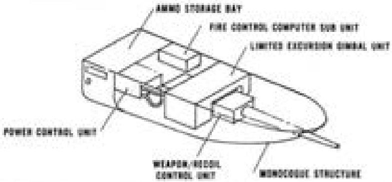
Survivability is to become more a matter of not being hit or destroying the enemy first, rather than the mere ability to withstand a certain number of hits. Through the use of composites and advanced design techniques, the LHX will be able to continue operation in a damaged mode; and, while the mission equipment package, flight control system, radios, etc., may be degraded, the basic mission can still be performed.

Weapon technology surveyed

To determine candidate weapon systems for engineering development in the 1986 time frame, AVRADCOM recently completed a preliminary survey of weapon technology. In assembling the report, concept options for gun-type weapons were submitted by the **U.S. Army Armament Research and Development Command (ARRADCOM);** missile, rocket, and other advanced system concepts were provided by the U.S. Army **Missile Command (MICOM);** and recommendations were received from various industry sources.

Several departures from current weapon design convention were considered by ARRADCOM: first, assuming a high agility LHX, a limited flexible mount was used instead of the conventional turret; second, an interchangeable armament module was proposed to allow several armament options; and third, new technological developments in ammunition and gun

FIGURE 1



ADVANCED ARMAMENT MODULE

componentry were exploited. An example of one of the designs is shown in **Figure 1** (above).

The missile system options provided by MICOM represent an extremely wide array of characteristics and performance features with substantial differences in seeker type, range, and armor penetration. Other variables represented by the candidates include flight trajectory, time of flight, method of destruction, and probability of hit/kill.

With this survey as a starting point, a one year investigation will be initiated in early 1982 to refine the results and identify optimum weapon suites for the LHX family.

Crew workload reduction is of paramount importance and will be accomplished through a planned series of investigations which have already begun in the concept formulation stage and will continue into engineering development.

A preliminary avionics architecture study has already shown the potential for dramatic weight savings of up to one-third that can be achieved with current design approaches, and for workload reduction to a level which may permit single pilot combat operation.

One-man cockpit under study

Based on these very promising results, the team of Boeing Vertol/Honeywell has been awarded a contract to further explore the one-man cockpit concept. If the concept proves feasible, tremendous savings in weight, manpower, and training costs will result; if not, the work will be directly related to

A Performance-Oriented, Piloted Flight Motion Simulator

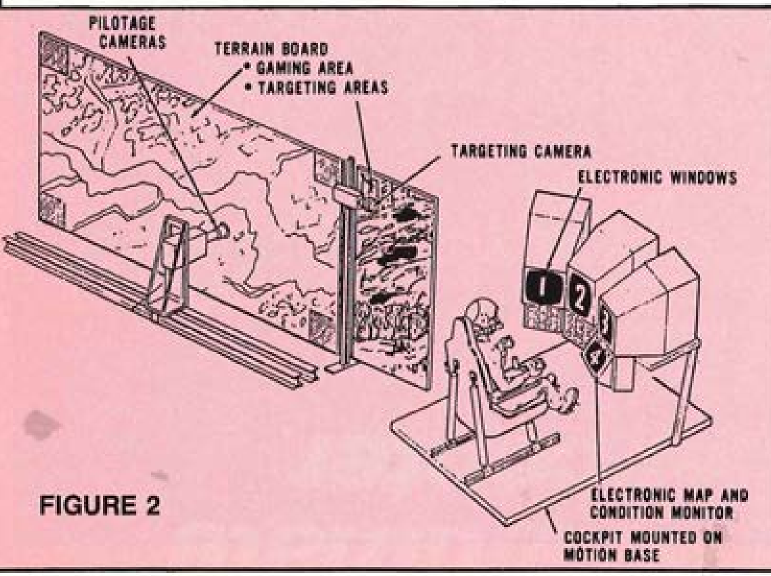


FIGURE 2

workload reduction for a two-man crew.

In developing a conceptual control and display layout, a performance oriented, piloted flight motion simulator (**Figure 2** on the opposite page) will be used to determine the degree of automation required, the type and location of displays, and the pilot's performance in acquiring targets, avoiding threats, and coping with emergencies.

The flight simulator will have the same visual display that would result if staring pilot vision sensors were used with a wide-field-of-view display. This arrangement can be thought of as providing "electronic windows".

A systematic buildup of control and display configurations will be applied to the simulator beginning with a relatively conventional helicopter arrangement that includes a helmet mounted display and introduces voice monitoring of aircraft system condition.

ADOCS followed by EMMADS

The next step will provide an **Advanced Digital Optical Control System (ADOCS)** followed by display upgrades that include flat panel flight and targeting displays, an electronic map for navigation, and an **Electronic Master Monitor Advisory Display System (EMMADS).**

Further control system refinements will incorporate terrain avoidance, voice command, and automated flight and navigation modes. A considerable degree of inventiveness is being used in the designs which range from an all heads-up display system to the one shown at the right in **Figure 3** which embodies the electronic window configuration developed for the simulator.

In this concept, the pilot's seat is raised to see out of limited transparencies or lowered for flight using the wide-angle display. While the multi-screen pilotage display may look like a creation from the movie, "Star Wars", further consideration of such factors as the laser threat, NBC protection, vulnerability reduction, and low detectability may make this a viable option.

The one-man cockpit study is being performed for the LHX-Scout since it is expected to be the first version fielded; and further, it appears that a baseline armed scout configuration can be easily modified for light attack and light utility/observation models.

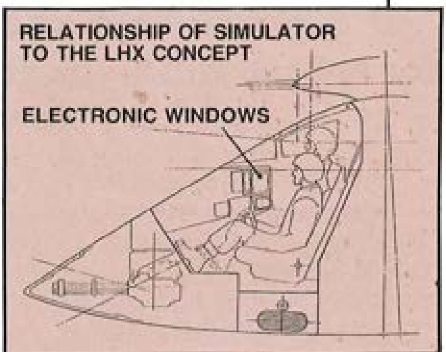
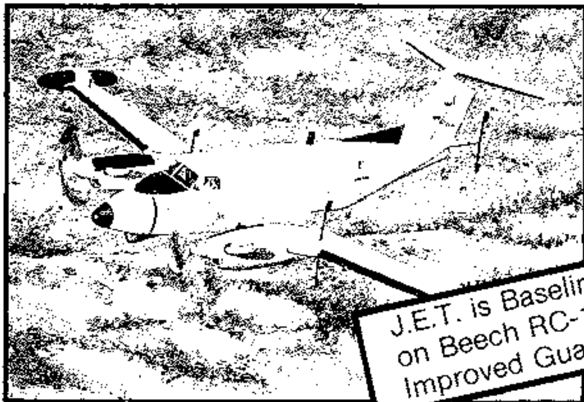


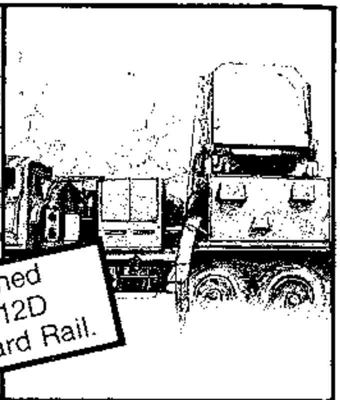
FIGURE 3

The final report on the above effort will be published in October-November 1982 and is timed to provide input for a follow-on advanced development effort which will include a flight demonstrator.

A new plateau of capability

As mentioned earlier, these and other studies will provide the foundation for an advanced development program leading to prototype construction and evaluation. Working closely with the user and industry communities, AVRADCOM is striving to provide a new plateau of capability for the Army Aviation fleet of the future — LHX: small, fast, and deadly! IIIII





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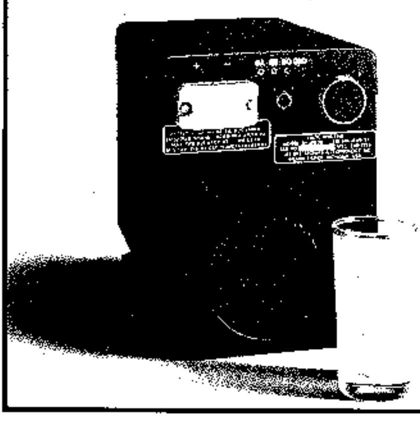

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Fresh Ideas in Avionics

by L. Thomas Mazza
and Danny E. Good

ACAP airframes to fly in 1984

TO accelerate the fielding of a helicopter which costs less and has greater capabilities than its existing helicopters, the Army has embarked on an ambitious Research and Development Program which will have helicopters flying with airframes constructed of fibrous composites.

AVRADCOM's Applied Technology Laboratory has undertaken the **Advanced Composite Airframe Program (ACAP)** to develop the design data, and fabrication and test experience necessary to reduce the technical risk associated with the introduction of fibrous composite airframe construction into aircraft production.

The data and experience developed and the benefits demonstrated should lead to an early commitment to the production of fibrous composite airframes on the part of the helicopter manufacturers and an earlier acceptance by the Army and other operators than would otherwise be possible.

ABOUT THE AUTHORS
This article has been co-authored by L. Thomas Mazza and Danny E. Good, two Project Engineers assigned to the Applied Technology Laboratory, USAAVRADCOM, located at Fort Eustis, Virginia.

Benefits clearly shown

Over the past 10-15 years, the Government and industry alike have expended considerable effort in support of programs to develop composite materials and design concepts for application to rotary-wing aircraft structures. The potential benefits of composites have been clearly demonstrated in a variety of advanced development programs during the 1970's.

During one such program, an all-composite tail section for the AH-1G helicopter was designed, fabricated, and successfully flight tested. The Army's UH-60A and AH-64 aircraft both use fibrous composite construction in secondary, non-flight critical, and airframe components today; however, there has not been sufficient developmental experience to commit to the production of all-composite airframe.

The unknowns which have inhibited the helicopter manufacturers and the military community from fully commit-

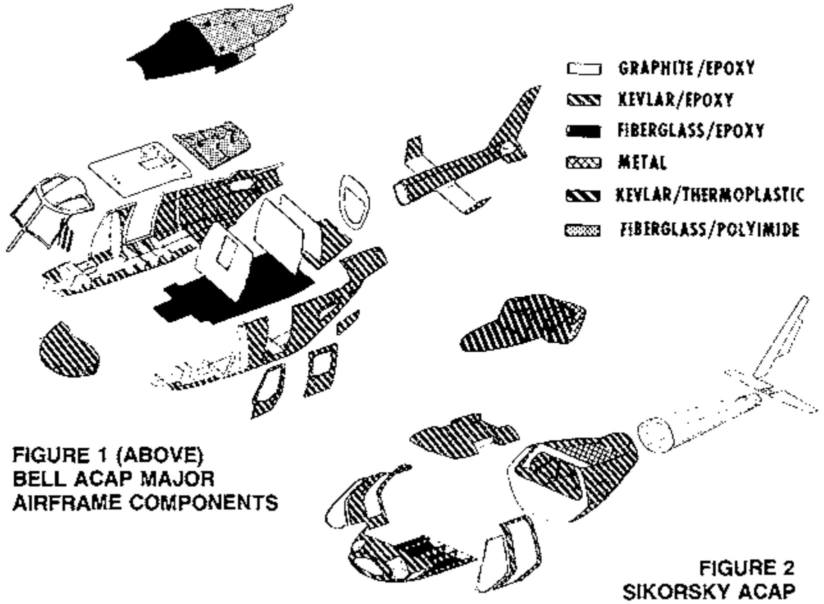

FIGURE 1 (ABOVE) BELL ACAP MAJOR AIRFRAME COMPONENTS

FIGURE 2 SIKORSKY ACAP MAJOR AIRFRAME COMPONENTS

ting to the production of airframe components fabricated from fibrous composites can only be eliminated through a development program such as the ACAP. The most reliable means of identifying and resolving problems associated with the fabrication of a complete airframe using composites is to design, fabricate, and test a full-size airframe.

The assembly of a flight vehicle and flight testing is necessary to ensure that all the interface issues associated with systems integration and flight worthiness have been identified and resolved. A full-size airframe is needed in order to provide valid detection, vulnerability, and crashworthiness verification test data.

The ACAP provides the opportunity for a convincing demonstration of the practicality of applying fibrous composites to the complex airframe structures while dealing with the militarization needs: maintainability, vulnerability and crashworthiness.

The ACAP will demonstrate the technological advancements achievable through the application of fibrous composite materials and advanced design concepts to the primary and secondary airframe structure.

The program goals are to demonstrate compliance with the crashworthiness requirements of MIL-STD-1290 and improvements in reliability, maintainability, vulnerability, safety, and survivability while achieving a 17% reduction in airframe production costs and a 22% reduction in airframe weight when compared to a baseline metal airframe.

The ACAP was initiated in 1979 with multiple contracts awarded to five companies for the ACAP preliminary design. In the **Preliminary Design Phase,** each contractor developed a metal baseline design and three separate composite airframe design configurations, emphasizing cost and weight reduction, increased ballistic tolerance, and reduced radar detection.

Trade-off analyses were conducted by each contractor and a final structurally efficient, low-cost, low-weight, ballistically-tolerant design configuration, which incorporated some radar signature reduction features, was selected.

In the follow-on competitive procurement, contracts were awarded to Bell Helicopter Textron and Sikorsky Aircraft to develop the Phase I effort in detail designs and design support testing of their selected ACAP helicopter design configurations.

In addition to the airframe, a landing gear will also be developed since the entire crash energy management system (airframe, landing gear, and seats) must be considered in order to effectively design and demonstrate crashworthiness characteristics.

Commercial compatability

The dynamic systems, subsystems, and operational components are those of an existing commercial helicopter with only minor modifications being required for compatibility with the ACAP helicopter design. The Bell ACAP helicopter, using components from the Model 222, has a design gross weight of 7,525 pounds. The Sikorsky ACAP helicopter, using components from the S-76, has a design gross weight of 8,470 pounds.

To provide an overall airframe design that is structurally and environmentally sound, while at the same time lightweight, low in cost, and producible, many trade-offs are required in order to select the most effective material and structural design configuration for the various airframe components. A breakout of the major structural components and the selected materials are shown in **Figures 1** and **2.**

In general, the designs use graphite for the high strength and stiffness applications, such as longerons, frames, and beams. Kevlar is the predominant skin material for both primary and secondary structures, while fiberglass is used in areas subject to high wear.

Different composite matrix systems,such as epoxies, polyimides, and thermoplastics, provide the flexibility to select a fiber/matrix combination which best meets the application. Large cocured and bonded airframe sections and assemblies substantially reduce the number of parts and mechanical fasteners which, in turn, reduce labor-hour requirements and thus reflect a lower cost.

Extensive design support testing of critical joints, cutouts, and attachments will be conducted to substantiate the selected structural design configurations. One-fifth scale model wind tunnel tests were conducted to verify the drag and static stability characteristics of the airframe. The ACAP helicopter is being designed to MIL-STD-1290 crashworthiness requirements, which are more stringent than the requirements placed on either the UH-60A or YAH-64.

Extensive design support test

A partial airframe section with one main landing gear attached will be drop tested to substantiate the crashworthy characteristics of the landing gear and the airframe interface structure. In addition, tests will be conducted to determine tolerance to potential military threats. This extensive design support test effort will provide the information necessary to validate and refine the detail design prior to full-scale fabrication.

A number of manufacturing approaches have been identified which are directed toward reduced labor-hour requirements and a reduced number of components, parts, and fasteners. The selection of fabrication and assembly techniques plays an important role in the detailed design and tool design effort, as they are the primary producibility and cost drivers.

Manufacturing techniques, such as automated filament winding, tape and broad goods layup, pultrusions, thermoforming, and numerically controlled cutting and trimming, will be used. Detail tool designs will be completed and manufacturing plans will be formalized prior to the Government's In-Process Review of the ACAP program in September, 1982.

Phase II outlined

The Phase II efforts will consist of the fabrication of three full-scale airframes, extensive laboratory testing, and ground and flight demonstration of the ACAP flight vehicles. Inasmuch as the primary goals of the ACAP are weight and cost reductions, as compared to conventional metal aircraft structures, the fabrication of three complete airframe assemblies provides the opportunity to track the weight and cost of the airframes.

Actual weights, man-hours and material costs will be accumulated and compared to the airframe cost and weight predictions as well as to available cost and weight data for conventional metal airframes.

Prior to flight demonstration of the ACAP helicopters, the integrity of the full-scale airframe will be verified through static and shake tests, ballistic tests, drop tests, and electromagnetic compatibility tests. Fifteen hours of ground testing will also be conducted to ensure functional and operational compatability of the aircraft systems and subsystems with the ACAP airframe.

In mid-1984, the ACAP aircraft will be ready for a 50-hour productive flight test program which includes progressive envelope expansion in an orderly and progressive assessment of airspeed, altitude, load factor, flying qualities, and performance characteristics.

Beyond the ACAP engineering flight test itself, additional militarization testing is planned. The ACAP flight vehicle could be used as a flying test bed for a variety of avionic and electrical systems investigations. Since composite airframes pose some unique problems with regard to the operation of existing and future avionic systems the flight vehicle is the perfect place to conduct more extensive investigations into avionics compatability, electromagnetic effects, and grounding and shielding characteristics.

Ballistic tolerance, laser tolerance, and crashworthiness are other survivability characteristics of the ACAP which will be assessed further to prove the overall effectiveness of composites for the airframe of the future.

At the completion of the ACAP flight test, composite technology will have been demonstrated such that the technical risk associated with the introduction of a composite airframe into production will be at a level acceptable to both the manufacturer and the military community.

Due in late '80's

The aviator can then expect to see the composite technology developed in the ACAP emerge in the late '80's as product improvements for the UH-60 and AH-64 and in the early '90's in new production aircraft. With the fielding of composite airframe technology, the Army Aviator can expect to have a combat aircraft that is safer and more damage tolerant, and at the same time will carry more payload or provide increased range, or both. IIIII

U.S. ARMY

AVRADCOM

MISSION

RESEARCH AND DEVELOPMENT

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

MATERIEL ACQUISITION

- ACCOMPLISH FIRST PROCUREMENTS
- DEMONSTRATE EQUIPMENT SUITABILITY

SUPPORT MATERIEL READINESS

- TECHNICAL IMPROVEMENTS FOR FIELDED SYSTEMS
- REDUCE COST OF OWNERSHIP

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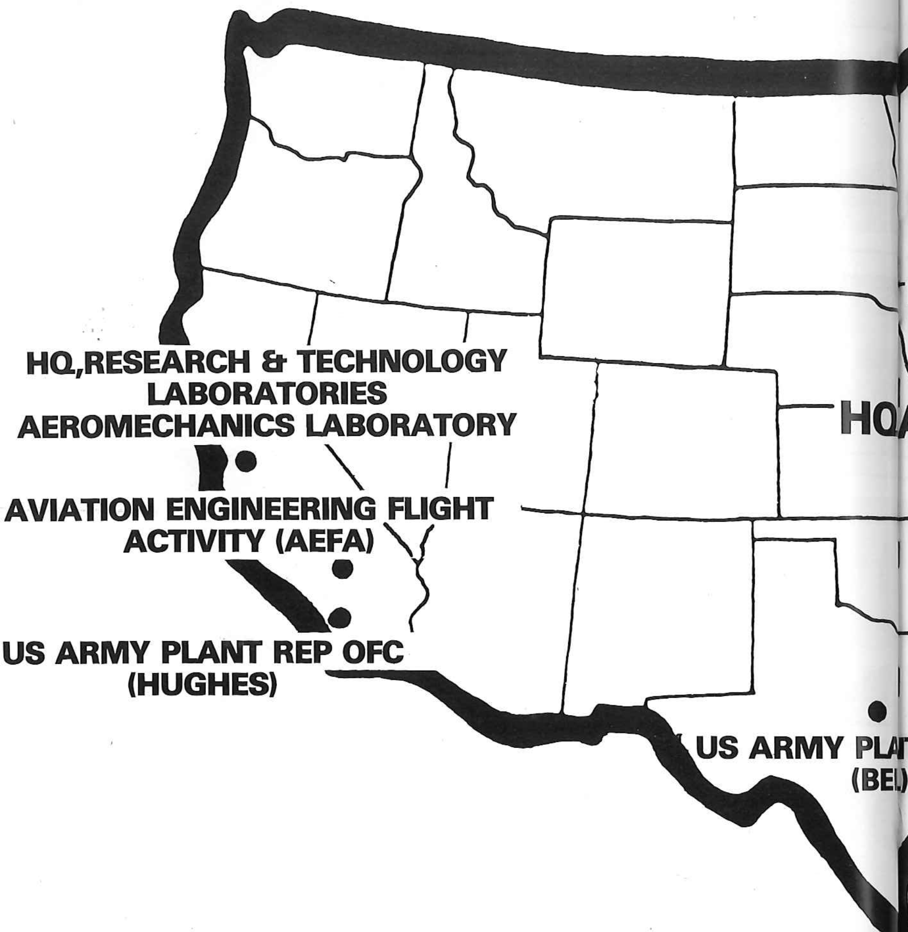

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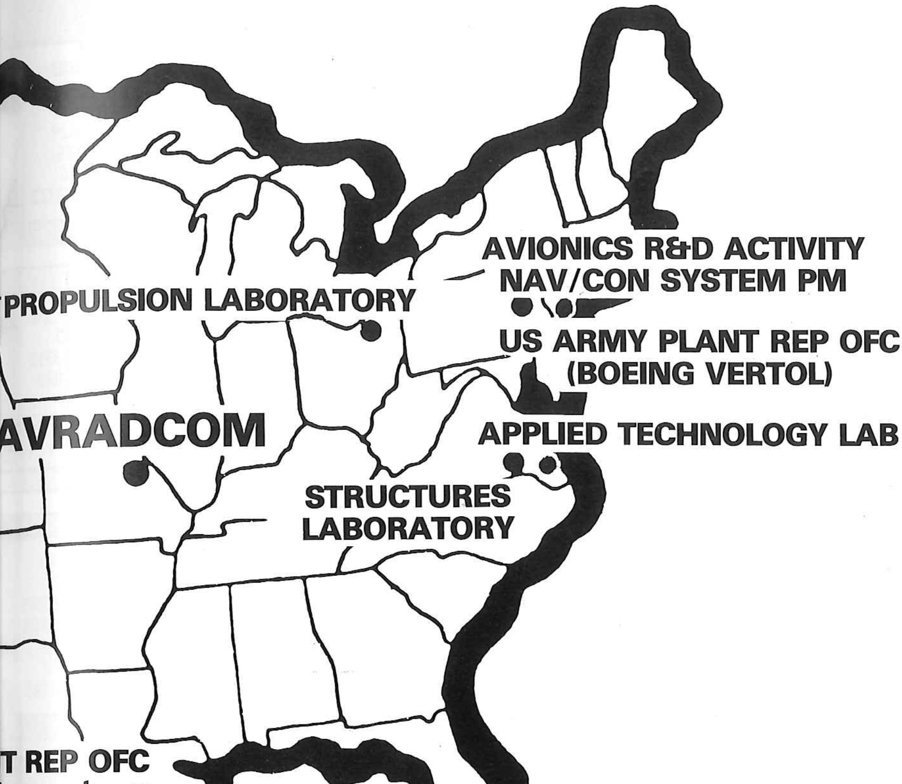


A 40-year evolution

AVRADCOM: The history and development

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 USAF assumed the responsibility for research and development, procurement, and logistical support of the Army's aircraft.

Aug., 1952—All Army Aviation logistical functions were transerred 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—TMC assumed 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 assumed 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.

April, 1963—TMC became 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 Ft. Worth, TX. Two additional plant cognizance activities were 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)** —

complex (Research and Technology Laboratories) were organized and assigned to **AVSCOM.** They were located 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..

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 became the U.S. Army **Materiel Development and Readiness Command (DARCOM).**

A CHRONOLOGICAL REPORT COVERING THE JUNE 1942 TO JULY 1982 ORGANIZATIONAL STRUCTURE IN AVRADCOM

later redesignated as the U.S. Army **Aviation Materiel Laboratories (AVLABS)** in March 1965, and now called the **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 (USAATA),** now the US Army **Aviation Engineering Flight Activity (AEFA)** at Edwards Air Force Base, CA, was assigned giving **AVCCOM** responsibility for aircraft flight standards and qualification.

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

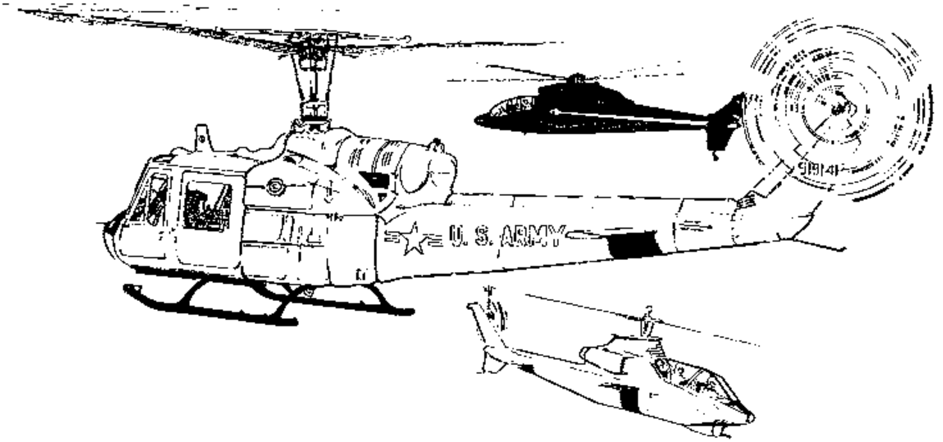
Jan., 1970—The U.S. Army Air Mobility Research and Development

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, 1982—AVRADCOM will celebrate its fifth anniversary.



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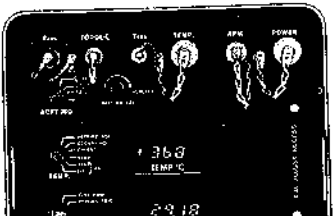

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by Raymond F. Clark

The STAR of AVRADCOM . . .

THE **Systems Testbed for Avionics Research (STAR)** is a UH-60 which has been uniquely configured as a research and development test aircraft. This vehicle is the focal point of all Advanced Avionics Systems programs within AVRADA.

Why a STAR?

With the increased emphasis on developing digitally integrated avionics systems and integrated controls and displays in Army helicopters, the need arose for a test aircraft where these concepts could be demonstrated and verified.

Traditionally, individual autonomous avionics systems were developed. These systems, including their own dedicated controls and displays, were then flight tested independently in whatever aircraft was available at the moment. With the integrated system approach, once an individual sensor, for example, is developed, its operation in the total system environment, which includes multiplex data buses, multifunction controls and displays and other sensors, must be verified.

Ideally, this is accomplished in two steps, the first being in the laboratory and the second in flight. AVRADA's Digital Hot Bench in the **Tactical Avionics System Simulator (TASS)** provides the capability for an integrated laboratory test. The goal of the STAR is to provide a facility to accomplish the flight test phase in addition to providing

ABOUT THE AUTHOR
Deeply involved in STAR, Raymond F. Clark is a Project Engineer assigned to the U.S. Army's Aviation Research and Development Command.

Army pilots and engineers an opportunity to gain valuable experience with an integrated aircraft system.

Developing the STAR

A "state-of-the-art" Army aircraft was desired which had a large payload and cabin area to enable a number of test systems and instrumentation to be installed on racks with easy access. An adequate supply of electrical power, both three phase, 400 hertz and 28 vdc, was also required.

The BLACK HAWK proved to be an ideal aircraft because it met all of the above requirements. To achieve the desired total system environment, a multiplex digital data bus (MIL-STD-1553), integrated controls and displays, equipment racks and test instrumentation had to be added. In order to lower the technical risk and meet near term test objectives a two phase approach was decided upon.

The first phase provided a basic digitally-integrated system structure built around the **Integrated Avionics Control System (IACS)** as well as general purpose equipment racks and test instrumentation. This phase of the modification was completed in May, 1981.

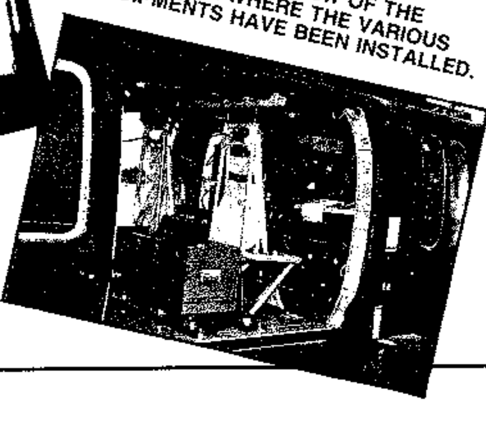
The second phase will result in a completely integrated avionics system and cockpit with the installation of the **Army Digital Avionics System (ADAS).** (see **Army Aviation,** December 31, 1980, page 27). This is planned for completion in late 1983 (see **Figure 3** on Page 66).

Two views

Figure 1 shows the STAR's nose avionics bay in its present configuration. The navigation radios, crypto equipment, and doppler signal data converter were removed and the **Command Instrument System (CIS)** processor relocated. This made an area available in the nose for forward looking sensors to be tested (i.e., multifunction coherent CO_2 laser radar). A forward looking TV camera provides a simu-

FIGURE 1—THE STAR'S NOSE AVIONICS BAY IN ITS PRESENT CONFIGURATION.

FIGURE 2—A VIEW OF THE CABIN AREA WHERE THE VARIOUS EQUIPMENTS HAVE BEEN INSTALLED.



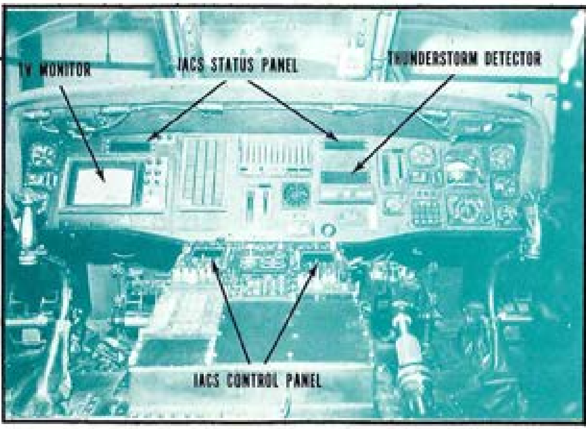


FIGURE 3 (LEFT) THE ACRADCOM STAR

lated FLIR image as background for flight symbology tests.

Figure 2 shows the cabin area where the communication and navigation radios were relocated and the general purpose digital computer, test instrumentation, equipment racks, and test equipment controls were installed. There is sufficient space available on these equipment racks to install the ADAS system.

The **Cockpit Instrument Panel (CIP)** and lower console are shown in **Figure 3**. The pilot's right side is relatively unchanged with the exception of the addition of the Ryan Stormscope (thunderstorm detector) control and display units, and IACS status panel (all mounted just right of CIP center). Extensive changes were made to the co-pilot's side.

The airspeed, barometric altitude, and stabilator indicators were all relocated along the far left and the copilot's **Control Display Unit (CDU)** moved to the center of the CIP to provide adequate space for the installation of a TV monitor and IACS status panel. Symbology presented on the monitor replaces that lost from eliminated flight instruments. The lower console is relatively open as a result of replacing the radio control heads with the IACS control panels.

Since this photograph was taken, the doppler was replaced by the improved AN/ASN-137 with its control/display being integrated into the IACS. A keyboard was added to the lower right for pilot access to the general purpose computer. The entire ICS system was replaced with the C6533(XE-2) which has individual volume controls for each receiver channel.

In-house effort selected

This first phase of the installation was accomplished in-house. Originally it was planned to accomplish this installation on contract. It was decided, however, to do this effort in-house after reviewing what appeared to be excessive contractor cost estimates.

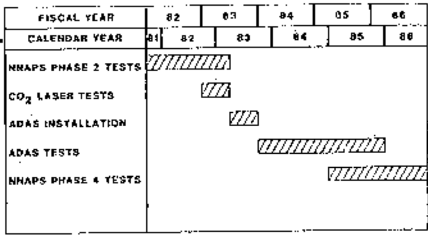
The job was accomplished by the Government for ⅓ of the originally estimated price. This included design, fabrication, and documentation.

An additional benefit was that the design could be modified as the job progressed to exactly meet the Government's requirements, and Government technicians and engineers had complete knowledge of the system from the start without having to interpret contractor furnished drawings.

Tests

Initial flight tests were conducted to verify correct operation of all modified systems and instrumentation. Following

FIGURE 4



STAR TEST PROGRAM SCHEDULE

the completion of this effort, flight tests were conducted to collect terrain signature data over NOE/Contour courses in the mountains near Carlisle, PA.

This data, along with still more to be gathered, will be used to develop and test algorithims for automatic Terrain Correlation Navigation updating of the Doppler Navigation System. Tests in the near future will include the **Night Navigation and Pilotage System (NNAPS),** digital map symbology, and pilotage symbology.

The NNAPS program consists of several interrelated efforts oriented toward development of an avionics system to enable an aircrew to operate effectively in the NOE environment, day or night.

The NNAPS uses digital information from the Defense Mapping Agency augmented by current battlefield situation and flight mission data collected at the unit level to generate a topographic map display with inflight annotation capability. The pilotage symbology is an extension of AVRADA's symbol development work for augmentation of the AAH pilot's night vision system.

During late FY82, it is planned to test the multifunction coherent CO_2 laser, Phase I POD. Its capabilities include wire detection, terrain following, and velocity measurement. The objective of the tests is to evaluate the flight performance of the multifunction CO_2 laser radar in a compact flightworthy configuration. This system will be installed with the NNAPS to enhance pilotage performance.

The Future

The installation of the ADAS system will apply digital system architecture to the entire aircraft system. Fully integrated control and display capabilities will be provided to both flight crew members through two CRT displays and one keyboard terminal unit on each side of the cockpit.

These will handle flight, navigation, engine, advisory/caution, and secondary systems information. The majority of point-to-point wiring and dedicated circuit breakers will be eliminated through use of multiplex remote terminal units, solid state power controllers and the MIL-STD-1553 data bus.

Second stage goes in-house

The high quality of the first installation, the magnitude of the cost savings, the invaluable experience gained by the engineers, and the other benefits accrued resulted in a decision to conduct the more complex second stage installation in-house.

This stage will involve completely modifying the entire instrument panel, and overhead and lower console, and eliminating the major portion of the aircraft's electrical wiring.

The resulting modular system will have the flexibility to add additional systems for test and to incorporate any changes required as a result of testing by software modification. Bench testing of the NNAPS electronics equipment will be conducted in-house as Phase 3 of the program before embarking on Phase 4 testing scheduled in the STAR.

The STAR will provide Army Aviators with an opportunity to fly an integrated digital aircraft and provide valuable feedback to AVRADA engineers. Through its bus-oriented architecture the vehicle will also provide a flexible system integration and verification tool for Army Aviation through the '80's. ||||

by William G. Bousman

Rotors for the '80's and beyond

WHERE will the next generation of rotors come from and what will they look like? To a large extent, we believe, these questions will be answered by the **Integrated Technology Rotor/Flight Research Rotor (ITR/FRR)** Project.

This project is a joint undertaking of AVRADCOM's Aeromechanics and Applied Technology Laboratories and the NASA-Ames Research Center. Two **Integrated Technology Rotors (ITRs)** will be built and flight tested. One of the ITRs will provide a basis for the **Flight Research Rotor (FRR)** that will be used as a research tool on the Army/NASA **Rotor Systems Research Aircraft (RSRA)**.

A continuing need

The Army has a continuing need for rotors that provide more lift, can fly faster with better efficiency, and yet cost less to build and operate. There has been a great deal of work done in the last few years at the basic research (6.1) and exploratory development (6.2) levels to improve rotors over a broad range of technologies. Although this work has revealed many areas with large potential payoffs in terms of improved characteristics, there is also substantial risk associated with these new technologies.

ABOUT THE AUTHOR
A research scientist, William G. Bousman is serves with AVRADCOM's Aeromechanics Laboratory located at the NASA-Ames Research Center.

Until confidence is developed in these areas, we are reluctant to include them in new helicopter development or Product Improvement Programs. Here is where the integration of these technologies and demonstration at full scale becomes important.

As sketched in **Figure 1,** we take the recent advances from the technology base and integrate them at the advanced development (6.3) level (hence, the name Integrated Technology Rotor). Through flight test we demonstrate that the risk is reduced and the technologies are sufficiently mature for engineering development.

A similar situation exists for advanced rotors for civil application. In approaching this problem, NASA had planned the development of a full scale Flight Research Rotor for the RSRA that would provide significant parameter variability and detailed blade instrumentation. With this research capability, they would examine rotor improvements that would provide new capabilities in the 1990's.

The very similar objectives of the Army and NASA have provided an excellent opportunity to pool our resources and jointly accomplish far more than we can separately. Our plans are to design and build two ITRs, and then use one of these as a basis for the FRR with its associated parameter variation and advanced instrumentation.

What will the ITR look like?

Figure 2 provides a conceptual representation of what we expect. To improve maintenance and reliability the rotor will most likely use a composite, bearingless hub. Without the flap, lead-lag, or pitch bearings the hub will be structurally simple and provide a small profile. This will significantly reduce the rotor drag and thereby improve performance.

Advanced airfoils, tip shapes, composite construction, and the new methods of aeroelastic tailoring of the blade properties will give us better lift in hover, improved efficiency in forward flight, and reduced vibration.

The ITRs are designed to demonstrate that the new technologies are sufficiently mature, such that we can go on to design and build prototype rotors for Army missions. The backbone of the program is the technical goals we have set. These include not only performance improvements, such as increased hover and cruise efficiency, and increased speed, but also reductions in vibration, noise, maintenance, weight, and acquisition cost.

The tradeoffs

In designing the rotor to meet these technical goals the designer will have to balance improvements in rotor performance with the effects upon **Mean-Time-Between-Removals (MTBR),** reductions in noise with the effects on rotor weight, and improvements in hover efficiency with the effects upon acquisition cost.

We are seeking improvements across a broad spectrum of technologies, rather than in one or two areas. Consequently, the ultimate success of the program is

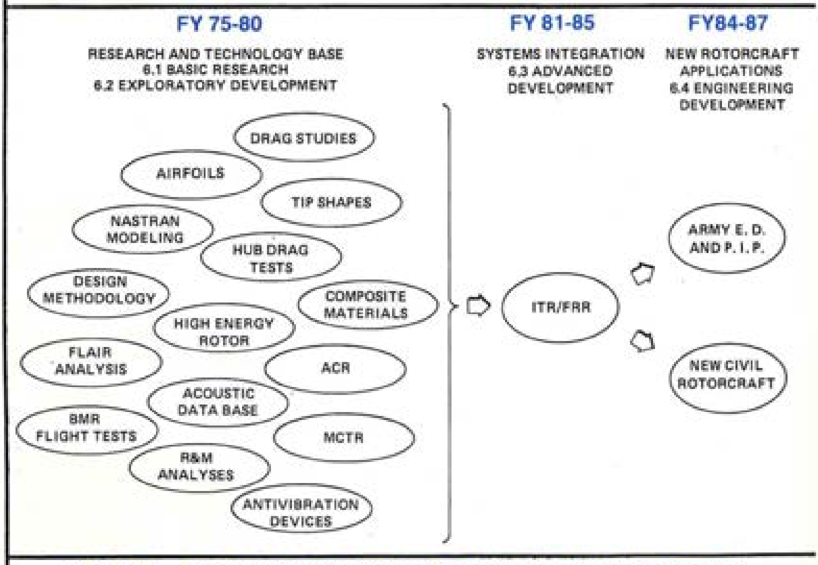


FIGURE 1 — TECHNOLOGY BASE AND ADVANCED DEVELOPMENT

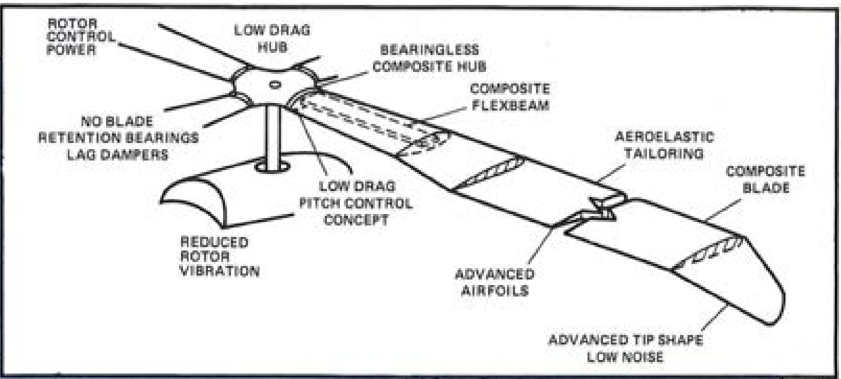


FIGURE 2—A CONCEPTUAL REPRESENTATION OF THE ITR

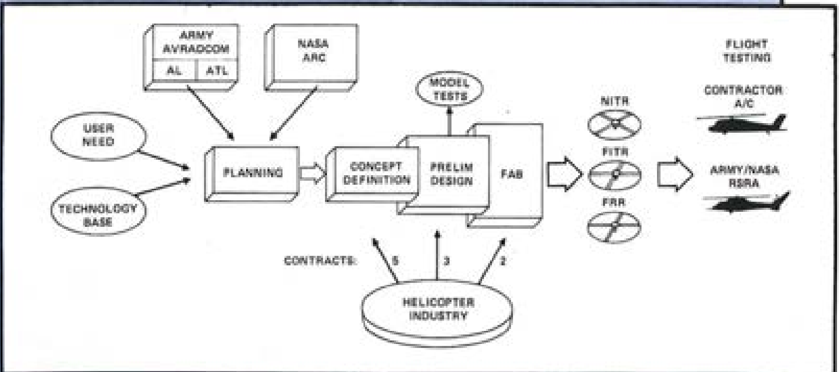


FIGURE 3—AN OUTLINE OF THE ITR/FRR PROJECT

not whether the rotor will fly faster or carry a little bit more, but how it stacks up against all of our technical goals.

What are our plans and where are we today?

Figure 3 shows an outline of the ITR/FRR Project. From the initial planning phase we proceed to five contracted studies of **Concept Definition,** which will examine candidate hub concepts. **Preliminary Design** will follow with three contractors and, finally, **Detail Design and Fabrication** where we will issue two contracts — one for an ITR alone, and one for an ITR and its related FRR. First flight of the ITR is planned in 1985.

Presently we are well into **Concept Definition** with studies by Bell Helicopter Textron, Boeing Vertol, Hughes Helicopters, Kaman, and Sikorsky Aircraft. As this issue goes to press, we expect to be issuing the **Request for Quotation (RFQ)** for **Preliminary Design.**

Efforts from **Preliminary Design** through flight test will require considerable energy and skill from the companies building the ITRs and FRR, and many problems remain to be solved along the way. But from our position today, we believe the technology base is in excellent shape to support the project, and we look forward to a broad range of advances in the rotor design technologies in the next half decade. IIIII

by MAJ John Sheehan

Target acquisition on a dirty battlefield!

THE future battlefield is often described as dirty. The definition of a "dirty" battlefield is just like an aviator's opinion, you know, "everybody has one."

The one thing which is easily agreed upon, however, is the fact that target acquisition systems are degraded by smoke, fog, rain, dust and aerosols. In view of the projected threat, we must continue to maintain the same standoff ranges at night and during adverse weather conditions currently provided by our day systems to effectively utilize the range of our weapons.

There have been a number of studies concerning the adverse battlefield environment, but perhaps the entire problem was best summarized by **General Frederick J. Kroesen**, Commander in Chief, USAREUR, when he said:

"Perhaps the first USAREUR priority for consideration by the Aviation Research and Development community is the recognition of the need to see. Anyone who has spent more than a few weeks in North Central Europe can attest to the vicissitudes of weather that will impact on any war fought in the region.

"The cycle of day and night during the long nights of winter provides 14 hours of darkness. Smoke and dust, which any war can generate on a grand scale, and fog and rain so common in all of Northern Europe, will also reduce visibility. All of these factors will impede the use of airpower in the European battle until we have new technology in the field which allows us to see through them."

ABOUT THE AUTHOR
A Senior Army Aviator, Major John Sheehan serves as a Project Engineer with AVRADCOM's Applied Technology Laboratory at Fort Eustis, Virginia.

An ATL project

The **Helicopter Adverse Weather Fire Control/Acquisition Radar (HAWFCAR) (Figure 1)** is being developed by AVRADCOM's Applied Technology Laboratory to demonstrate the much needed all-weather target acquisition capability for our scout and attack helicopters.

To accomplish this, both Martin

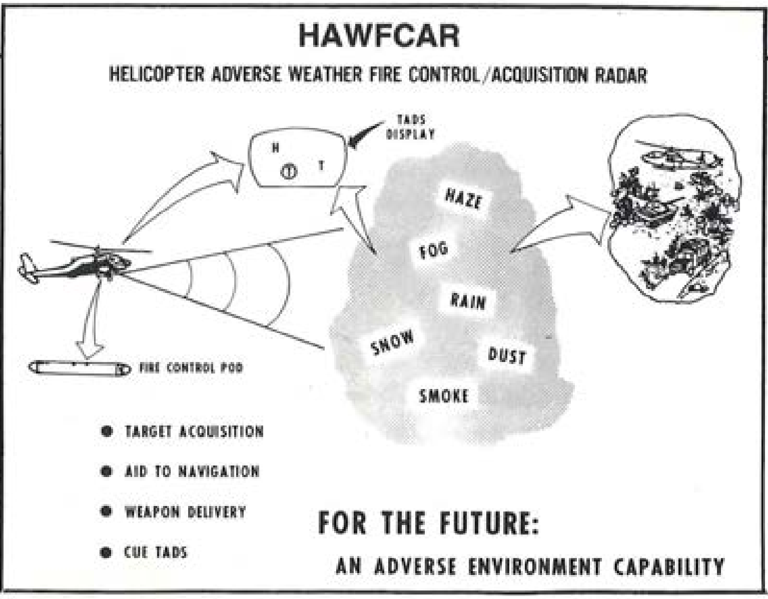


FIGURE 1—FOR THE FUTURE, AN ADVERSE ENVIRONMENT CAPABILITY

Marietta Aerospace and Westinghouse Electric Company are developing these pod enclosed radar systems for evaluation. Hughes Helicopter will integrate both HAWFCAR systems into the AH-64 **APACHE.**

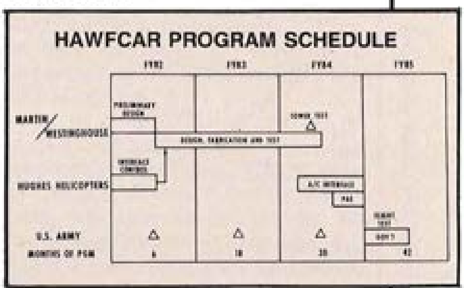
After a short system flight test and system check-out, a **preliminary airworthiness evalutation (PAE)** will be conducted, which will permit Army pilots to fly this configuration of the AH-64. The actual test of the HAWFCAR system will be conducted by an all Army crew. The **Helicopter Adverse Weather Fire Control/Acquisition Radar** program schedule is shown in **Figure 2.**

To facilitate the test program, both HAWFCAR pods will be installed on the same aircraft and tested during the same time period. The test configuration is depicted in **Figure 3.**

At a later date, if the decision is made to field a HAWFCAR system on attack and/or scout helicopters, the radars may not be pod mounted; however, it should be clear that a pod-mounted system provides the unit commander a certain degree of flexibility.

The **Helicopter Adverse Weather Fire Control/Acquisition Radar** will detect, acquire, and track stationary and moving ground as well as airborne targets. These targets will be classified as fixed or rotary wing and wheel or track vehicles. The targeting information will be displayed on the current **Target Acquisition Designation**

FIGURE 2



HAWFCAR TEST CONFIGURATION

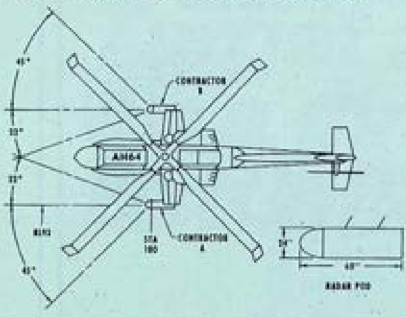


FIGURE 3

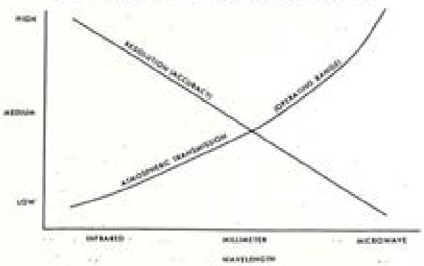
System (TADS) and can automatically cue TADS to the target if desired.

The HAWFCAR systems will provide a track-while-scan capability, thereby being able to handle multiple targets. These multiple targets will be prioritized according to threat data, weapon range, velocity and value. HAWFCAR will perform all of these functions at distances compatible with the engagement range of the present AH-64 weapons suit.

HAWFCAR will perform detection, acquisition and track in either an air-to-ground mode, an air-to-air mode, or a total combined volume search mode, which will cover both air-to-air and air-to-ground. In addition, the system will be capable of performing in a terrain-avoidance mode for contour or NOE flight. Update of the on-board Doppler system will be possible through the navigation update mode of the radar system.

FIGURE 4

FUNDAMENTAL SENSOR TRADE OFFS IN REALISTIC BATTLEFIELD ENVIRONMENTS



Battle is major determinant

The battlefield scenario will, in fact, determine which mode of operation the operator will select. The movement to contact, or enroute phase of the mission, would allow rapid movement in the contour flight regime utilizing the terrain-avoidance mode of operation while occasionally switching to the "navigation update" mode for precise update of the navigation system.

During the slower NOE portion of the enroute segment, the system could be placed in standby mode, if not actually needed. If, however, during this segment an aircraft were designated to provide overwatch, it could operate in the air-to-air or total volume search mode and provide substantial early warning of threat aircraft.

Once joining the main battle elements or covering force, the attack and scout helicopter equipped with **Helicopter Adverse Weather Fire Control/Acquisition System** would deny the enemy any advantage gained by the use of smoke. In fact, smoke would provide HAWFCAR a significant advantage. The scout and attack helicopters would be able to see through that early morning fog which covers the European roads and through the dust and the smoke associated with the battlefield itself, while utilizing these same obscurants to conceal themselves from visual detection.

The absolute first preference for target acquisition is the passive electro-optical systems; however, the requirement to continue to fight or to carry the fight to the enemy during adverse conditions is imperative. The fundamental tradeoff between sensors is shown in **Figure 4**.

It can be easily seen that although the infrared passive sensors offer the highest resolution, they, in fact, provide limited atmospheric transmission and, hence, limited operating range in adverse weather or on the dirty battlefield. HAWFCAR is envisioned as a "use it when you need it" system capable of providing a near all-weather targeting capability.

Reducing the "intercepts"

There exists some valid concern about the use of an active radar system and its relationship to survivability of the aircraft. This concern has not been ignored. The **Helicopter Adverse Weather Fire Control/Acquisition System** is extremely fast, and the reduction of time lines, and thus exposure, increases the survivability.

Particular attention has been paid to areas of **electronic counter countermeasures (ECCM)** and probability of intercept. There are a number of things inherent to the system designs and many additional steps are being taken to further reduce the probability of intercept.

While engaged in the battle, the HAWFCAR will provide a rapid scan and will continue to track multiple targets. The simultaneous classification of both moving and stationary targets in a cluttered environment will be possible. The priority of each target will then be provided for target servicing or hand-off as appropriate.

This demonstration program is designed to identify the capabilities and limitations of HAWFCAR and to identify both program and hardware risks associated with cost and scheduling. More importantly, it's designed to provide the user the option of target acquisition on the "dirty" battlefield.

It is not by accident that the AH-64 **APACHE** is being used as the test bed. HAWFCAR is a future system. Its ultimate use will be on the advanced attack helicopter or an advanced scout helicopter. In this regard, additional thrusts of the program include a "man in the loop simulation" to identify the man/machine interface requirements.

A closed-loop fire control gun projectile tracking demonstration to automatically adjust the 30mm chain gun on target by tracking the rounds in flight will demonstrate fire control capabilities for future weapons systems.

A team approach

The development of the **Helicopter Adverse Weather Fire Control/Acquisition System** represents a team approach from the entire DARCOM community and early user involvement has helped to scope the requirements accurately. The future hardware demonstration is only a starting point. It has been proven time and again that the best piece of equipment, when used improperly, can quickly become a liability rather than an asset.

In this regard, we need to begin now to develop the appropriate tactics for use of an all-weather system. We need not think of the advantages afforded the enemy during adverse weather and on the "dirty" battlefield, but rather need to concentrate on his disadvantages and our advantages.

Just as great strides in technology coupled with tactics and doctrine have dispelled the rumor that "night air does not produce lift," the HAWFCAR technology will allow us to convince the enemy that "he can run but not hide" on even the dirtiest battlefield of the future. IIII

ALSE — The new challenge

by MAJ Allen J. Jarvis

ARMY Aviaton has emerged from being a forgotten step-child of the '50's to a modern lethal tool of the combined arms team.

Over the past 20 years, Army aircraft have progressively improved in performance, fire-power, and communications. Yet as we look back, **Aviation Life Support Equipment (ALSE)** has not kept pace with the changing threats and virtually has been unchanged since the early '60's.

Although we have made great strides in improving crash safety with crashworthy fuel cells and lightweight crashworthy armored seats, we have done very little to optimize the aviator's mission effectiveness or enhance the flight environment.

Equally important has been the lack of adequate postcrash survival equipment which would allow our downed aircrews to successfully evade an enemy under any environmental condition.

AVRADCOM has recognized these shortcomings and initiated a program in 1979 to establish central management of the development of ALSE under one Project Office. It is envisioned that by pulling together all the diverse efforts in ALSE development under a single headquarters, we will provide unity of direction, purpose, and most importantly we will insure maximum utilization of limited dollar resources.

ABOUT THE AUTHOR
A rated Army Aviator, Major Allen J. Jarvis serves as the ALSE Development Project Officer in the Directorate for Systems Engineering and Development at the US Army Aviation R & D Command.

Addressing today's threats

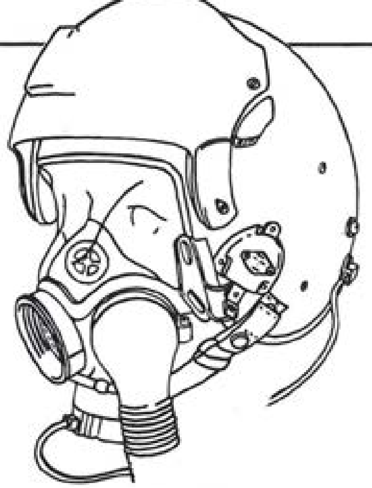
Our first priority is to initiate a FY 83 development effort which will eliminate the known deficiencies in current aircrew clothing and life support equipment. We'll need to address threats to the aviator that 20 years ago sounded like the scenario of a Buck Rogers novel, and to this end a total systems approach to this development will be taken.

Laser, fire, nuclear, chemical, biological, ballistic, crash, and environmental threats will be incorporated into one clothing system. This system will also enhance the various target acquisition, weapons sighting, and night vision devices worn by Army Aviators. This new ALSE clothing is called the **Aircrew Life**

Support System, Integrated Battlefield (ALSSIB) Program.

The program with the next highest priority is the development of an integrated helmet.(**Figure 1**) This new lightweight helmet will provide improved crash impact protection, noise attenuation, and communications. It will have built-in provisions for protection against lasers and nuclear flash, as well as a new aviator chemical-biological protective mask.

It will also be compatible with oxygen masks and night vision goggles, and fit the first percentile female through the ninety-ninth percentile male. This program is well underway and the advanced development contract will be signed in the third quarter of FY 82.



ARTIST'S CONCEPTION OF AIRCREW INTEGRATED HELMET SYSTEM SHOWING LOW PROFILE, QUICK DONNING GAS MASK, DUAL (STOWED) VISORS WITH LASER PROTECTION AND CB COMPATIBLE OXYGEN MASK MOUNTING SYSTEM.

Improved crash survivability

Another joint effort with the Navy is aimed at improving crash survivability in the cramped cockpits of the AH-1S and AH-64.

The **Inflatable Body and Head Restraint System (IBAHRS)** is an automatic crash activated restraint which inflates a bladder between the shoulder harness and body, removes any slack, and forces the occupant back in the seat, thus preventing him from impacting cockpit structures.

Although the primary application is for attack and scout helicopters, it has the potential for being the standard Army/Navy helicopter crew restraint system.

Drastically needed but forgotten for many years is the means to locate and recover downed aircrews. The Army presently does not possess the capability to conduct a search and rescue mission effectively in a combat environment.

A program to develop a **Personnel Locator System (PLS)** will soon be initiated, one that will enable selected aircrews to locate downed crew members covertly and to rescue them rapidly in adverse weather without enemy contact. This system will be coupled with the AN/PRC-112 scheduled to replace the unreliable AN/PRC-90.

A new survival kit coming

A new modular survival kit to assist downed aviators will also be fielded. It will be tailored to each specific aircraft and will be able to be configured to the specific environment in which the aircrews are operating. These modular kits will replace the obsolete one-person survival kit with two- and five-person models.

The new kits are expected to enhance crew survivability in a hostile environment and, coupled with the PLS, will provide a greater chance for effecting speedy rescues anywhere in the world.

A water survival capability, currently nonexistent, is under development in the form of a flotation kit for helicopter aircrews and passengers. This new lightweight flotation kit will be back-mounted and configured for both tropic and arctic use (**Figure 2** below).

Finally, we have two systems in the conceptual stage which, if successful, will provide aviators and ground crews with added protection in a chemical warfare environment. They are the **Helicopter Self-Decontamination System (HSDS)** and the **Airborne Remote Chemical Detection System (ARCDS).**

In partnership with the Chemical Systems Laboratory, Aberdeen Proving Ground, MD, AVRADCOM will initiate a program to explore the possibility of harnessing the hot engine exhaust of helicopters and directing this heat at areas of chemical contamination. Through heat and velocity of the air passing over the contaminated surface, evaporation of the agent should occur.

This program may provide a quick means of decontamining small areas, such as weapons systems and avionics bays. Our ground crews could then repair these systems without water and the heavy butyl rubber gloves and other cumbersome CB clothing.

The **Remote Chemical Detection System** is a contamination avoidance system which utilizes lasers to scan the battlefield and sense chemical agents. Once an agent cloud has been detected the pilot can alter his flight course to prevent contamination and relay this information to field commanders who can then take protective measures prior to agent contact.

FIGURE 2—The new back-mounted, lightweight flotation kit that will provide increased water survivability in both arctic and tropical climates.

Tomorrow's threat here today

This article has taken a quick look at just a few of the current and future development efforts designed to enhance the aviator's survival on the future battlefield. There are many more programs planned and on-going.

What is important to note is that the problems we thought of as future threats are here today. This has been recognized and AVRADCOM is expediting the development of ALSE to counter these known and projected threats. Financial resources are limited. Therefore, a systematic approach to eliminate these deficiencies is underway.

There is no short term, easy solution to fielding ALSE equipment. AVRADCOM recognizes these challenges in the '80's and will field a new generation of Life Support Equipment to carry us into the year 2,000 and beyond. IIIII

by Samuel R. Hurt

Beyond the '90's - SEMA-X

IT is almost inevitable that initially we will be outnumbered in the theater of war. But, whether the mission is to crush an enemy attack or to launch an offensive operation, it is the job of the corps and division commanders to bring about a winning concentration of force at the point of actual combat . . . To concentrate at the right place, everytime, corps and division commanders must be prime intelligence operators."

This quote from FM 100-5 clearly indicates that intelligence products support the prime objective of winning the battle. A major intelligence production source is the Army's fleet of **Special Electronic Mission Aircraft (SEMA).** The planned replacement for these aircraft is called SEMA-X, the "X" implying either "unknown" or "experimental").

Before looking at SEMA-X in great detail, it is useful to look at current SEMA systems and missions. **Figure 1** (see page 78) groups the missions into three sets; standoff, short range, and penetration, all referring to the position of the sensor platform relative to the **Forward Line of Troops (FLOT).**

It turns out that all the standoff missions are flown by fixed wing aircraft, the short range by rotary wing, and the penetration missions are not flown at all.

The SEMA **communication intelligence (COMINT)** system is the **GUARDRAIL Five,** using a U-21 aircraft. The **GUARDRAIL** intercepts signals in the communications frequency ranges for purposes of gathering all sorts of intelligence data, including eavesdropping, direction finding, and the like. An improved version of **GUARDRAIL** will be installed in the RC-12D in the near future.

The SEMA **electronic intelligence (ELINT)** system is the **QUICKLOOK II,** carried by the RV-1D. From a casual viewpoint the only difference between

ABOUT THE AUTHOR
SEMA-X is the future and dealing in this particular phase of Army Aviation's futures is Samuel R. Hurt, a Project Engineer assigned to the U.S. Army Aviation Research and Development Command.

QUICKLOOK and **GUARDRAIL** is the signal frequency. However, the ELINT intercepts radar traffic as opposed to voice traffic. The similarities are striking and will be addressed later in this article.

A sister ship to the RV-1D is the OV-1D **MOHAWK.** In fact, the RV-1 is a derivative of the OV-1. The **MOHAWK** carries several **image intelligence (IMINT)** systems: Photo, **Infrared (IR)** and **Side Looking Airborne Radar (SLAR).**

The collection of SEMA (**Figure 2** on opposite page) shows the SLAR Antenna Pod on the OV-1D. The SLAR and IR packages cannot both be carried on a given mission, but either can be carried with the cameras. The photo and IR missions are receiving less emphasis than they did a few years ago, partly due to the requirement to penetrate in order to use the down-looking systems.

All the above assets belong to the Corps commander. There are some Division assets also, present and planned, but because of the emphasis currently being placed on Corps intelligence needs, this discussion is limited to Corps.

With the limited resources that exist at Corps, it is impossible to properly support the variety of configurations, some types having as few as six aircraft per Corps. This situation mandates that SEMA needs be met outside the logistic system, which is properly geared to the high volume user.

FIGURE 1

CURRENT SEMA MISSIONS

- **STANDOFF**
  - **SIGNAL INTELLIGENCE**
    COMINT — GUARDRAIL
    ELINT — QUICK LOOK
  - **IMINT**
    SLAR, PHOTO
- **SHORT RANGE**
  - **ELECTRONIC WARFARE COMMUNICATIONS, QUICK FIX, RADAR JAMMING**
- **PENETRATION**
  - **RECONNAISSANCE**
    IR, PHOTO

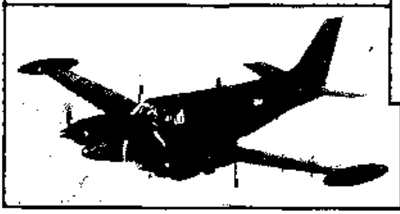
The MOHAWK and SEMA-X

The **MOHAWK** is the Army's only fixed wing airplane which was designed for combat. The design is now more than 20 years old and will be 30-35 years of age before being replaced by SEMA-X. The commercial derivatives which carry the COMINT sensors have also served admirably in peacetime, but they were not designed for combat in any environment and are woefully inadequate for the threat environment of the 90's and beyond. These and other problems are addressed in the **Mission Element Need Statement (MENS)** for SEMA-X.

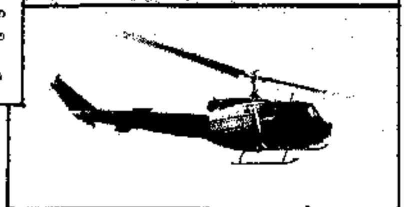
Everyone wants to know, "**What is SEMA-X?**"

It's fair to state at this time that SEMA-X is a problem which needs to be solved — a series of deficiencies which require correction and of unknowns that need to be defined. The official problem statement for SEMA-X program is the MENS. During the Concept Exploration phase of the SEMA-X Program, the problems articulated in the MENS will be examined and the number of possible solutions pared down to a manageable set.

But in the interim, any promising solution must be considered. Balloons, satellites, airplanes, helicopters, motorcycles, RPVs, and doing nothing are all contenders at program initiation. Of all potential solutions, those of-



SEMA



TOP LEFT — GRUMMAN RV-1D QUICK LOOK
BOTTOM LEFT — BEECH U-21 GUARDRAIL

TOP RIGHT — GRUMMAN OV-1D
BOTTOM RIGHT — BELL EH-1 QUICK FIX

fering least promise are eliminated, a process that continues until only one or two candidates are recommended for the Demonstration and Validation Phase, which is being initiated at Milestone 1.

Basically a platform program

A single alternative will be selected for **Full Scale Engineering Development (FSED)** and Production. SEMA-X is predominantly a platform program. Inherent, however, is the very complex integration that must marry the rather elegant sensors and processing to make a total system. The sensors are being developed under separate programs by those organizations possessing the specialized expertise.

One can think of the total system as the total airborne system, but a key element of current airborne intelligence systems is the ground components. With the advent of capabilities such as the **All Source Analysis System (ASAS)**, we can begin to respond to questions such as, **"What are we ever going to do with all this data?"**

SEMA-X is expected to be a key player in this arena. Current plans call for the Division Special Electronic Mission packages to be integrated into **BLACK HAWK** aircraft, and for Corps systems into SEMA-X.

Will SEMA-X target for Corps Support Weapons Systems (CSWS)?

Why not move everything back to Corps and relay to the Divisions what they need?

What about the Aquila or other RPV programs?

Can SEMA-X live in the threat environment of the '90's?

Can anything live in the threat environment of the '90's?

These are but a few of the questions that demand answers — Our job at AVRADCOM is to launch the SEMA-X **Concept Exploration Phase** in a way that will assure our obtaining the highest quality answers to this myriad of legitimate perplexities.

We're under contract now to initiate the first phase of the elimination or screening process. All combinations of platforms, sensors, and operating concepts will be examined to determine which are most likely to accomplish the

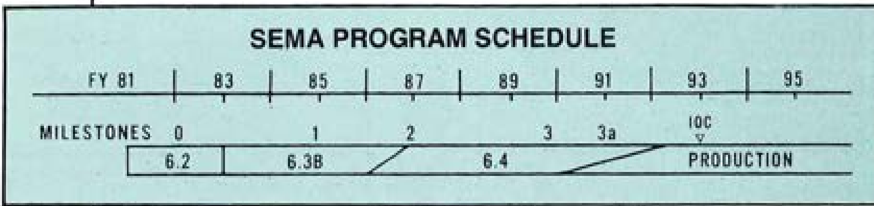


FIGURE 3

mission. The trivial solutions are first eliminated so that only a few require detailed analysis.

However, each of the apparently trivial solutions will be scrutinized in sufficient detail to assure that it is truly out of the zone of consideration.

A second effort of similar logic may be required to reduce the number of alternatives to a reasonable number to be subjected to a **Cost and Operational Effectiveness Analysis (COEA)**.

Affordability is main issue

Parallel efforts will concentrate on the issues to be addressed during the **Concept Exploration Phase.** A preliminary list of issues has been drafted for inclusion in such an analysis. Of course, the **numero uno** issue is, and will continue to be, affordability, which will be a primary consideration as candidates are evaluated for effectiveness against the threat.

The threat has been validated; the need has been affirmed by Hq TRADOC; and the funds requested in the 83-87 POM, approval of which will constitute program go-ahead. The schedule for this program is seen in **Figure 3** (shown above). Several issues associated with the Corps airfield will be addressed. Survivability is an obvious question, but what about affordability of the airfield which may be dedicated solely to SEMA?

The proper balance between Stealth and ASE has tremendous implications in terms of cost, survivability, and mission effectiveness.

Which threats can be defeated by aircraft maneuvering, if any?

Should SEMA-X incorporate a single mission package which performs all SIGINT, IMINT, and Jamming missions, or should each package consist of a module which can be swapped out in the tactical environment?

Which antennas should be podded and which integral to the platform?

The answers to these questions typify the homework that must be done here at AVRADCOM to assure that when SEMA-X finally reaches the user it will indeed permit him to "see" the battlefield in order to multiply the effectiveness of the killer forces under his command.

No other alternative

In spite of all these uncertainties, there is one thing no one questions: The present SEMA platforms **cannot** provide the Army with airborne intelligence in the '90's due to threat and supportability problems. Our challenge is to provide an affordable new capability to the Corps commander in the '90's. ▮▮▮▮▮

Hardware on the way!

IN an effort to keep you up to date on what is happening in the Aviation arena for near term fielding, individual AAAA magazine issues are dedicated to our Project Managed systems throughout the year. This article is therefore designed to provide a brief review and the latest information on those systems since the last edition.

CH-47 Mod Program
by Colonel Dewitt T. Irby CH-47D Program Manager

The CH-47 Modernization Program is entering the second year of production. Work is progressing very well on the initial production contract for nine aircraft with the first delivery to the United States Army now planned for early May, 1982. Our Materiel Fielding Team will be on-site for the first aircraft (production aircraft number 5) delivered to Company B, 159th Aviation Battalion, 101st Airborne Division, Ft. Campbell. **Initial Operational Capability (IOC)** will be February, 1984.

The CH-47D will be the first U.S. Army aircraft system to be fielded with **Skill Performance Aids (SPAS)** technical manuals for the airframe, engine, and **Auxiliary Power Unit (APU)**. The new manuals will be easier to read, and will contain step-by-step instructions on how to maintain and troubleshoot the helicopter.

Verification of the draft SPAS manuals is underway at Ft. Eustis. Pilot transition training commences in August, 1982 to establish the TRADOC resident training base.

Developmental objectives in the areas of reliability, availability, maintainability, and durability were significantly exceeded during DT/OT II. The CH-47D has demonstrated a reduction in scheduled **maintenance manhours per flight hour (MMH/FH)** of almost 55%, compared to CH-47C baseline data, and a reduction in unscheduled MMH/FH by 25% at the **Aviation Unit Maintenance (AVUM)** level.

The third prototype YCH-47D recently completed 82 hours of rigorous flight testing at Yuma Proving Grounds under conditions of extreme heat, sand, and dust with no significant problems. Between June and October, 1981, the YCH-47D performed static and operational flying demonstration tours at various military installations. External cargo carrying capabilities were demonstrated with loads weighing up to 25,500 pounds.

As the Army's primary combat service support airlift in the theater and Corps area, the CH-47D will be capable of sustained operations under day, night, marginal visibility, and adverse meteorological conditions, to include light icing.

The CH-47D — in production, ahead of schedule, and below cost! Twenty years of **Chinook** experience pay off by providing the U.S. Army with an additional 20-year aircraft life utilizing state-of-the-art technology in a safer, more productive, and reliable medium lift helicopter.

The ASE Program

by Colonel Edward C. Robinson
ASE Project Manager

The **Aircraft Survivability Equipment (ASE)** Project Manager's Office has endeavored, since its inception, to increase the combat effectiveness of Army Aviation in the field by providing the simplest means of countering the threat.

This has been accomplished by considering the use of tactics first, followed by reductions in the complete signature of the aircraft (i.e. aural, optical, radar, infrared), the use of warning systems, the employment of active jamming systems, and, finally, vulnerability reduction by hardening critical aircraft components.

Systems are designed with extra space, weight, and power to allow modular updates where possible to counter the changing threat providing the capability for preplanned product improvement. Such a concept is best shown by the example of the AN/ALQ-136 Radar Jammer.

This radar jammer will be the basic means by which we will jam radar-directed threat weapons, but it must be modified to meet the challenge of new radar threats. The modification is accomplished by the addition of modules within the already existing black box configuration. Therefore, the size of the black box and the interfaces will not change nor will the already familiar controls or displays in the cockpit.

System updates are the means we use to meet the changing threat on those systems that are already fielded and those that are in production, such as the AN/APR-39(V)1 Radar Warning Receiver, AN/ALQ-144(V)1/3 IR Jammer, AN/ALQ-136(V)1 Radar Jammer, AN/ALQ-156(V)1 Missile Detector, IR Suppressor, and the M-130 Chaff/Flare Dispenser.

These systems have given the individual aviator the means to survive on today's modern battlefield. However, we are not standing on our past performance.

New systems are a "must"

Realizing that we are dealing with a dynamic situation relative to the sophistication and expansion of the technology exploited by the threat, we cannot maintain the current levels of combat effectiveness solely by upgrading existing equipment.

As a result, we are now developing systems such as the AN/AVR-2 Laser Warning Receiver, the AN/ALQ-169

Optical Warning Location Detection (OWL/D) and the AN/ALQ-162 Radar Jammer.

The OWL/D will inform the aviator that his aircraft is being acquired by an optically directed threat. The AN/ALQ-162 Radar Jammer is a **Continuous Wave (CW)** jammer to meet CW threat weapons systems.

In the concepts area, on-going investigations are being conducted to reduce the workload placed upon the aviator in handling, interpreting, and reacting to information provided by ASE.

Possible solutions include the use of a single control/display head and integration of ASE equipment into the MIL-STD-1553 Multiplex data bus. This concept will reduce the weight in the wiring bundles required to operate onboard ASE and provide a single control/display which can effectively present need-to-know information throughout the entire mission.

All of these efforts combine to make up an aggressive program designed to insure the continued combat effectiveness of Army Aviation in the face of an increasing threat on the battlefield of the future.

The AHIP Program

by Colonel Ivar W. Rundgren ASH Project Manager

The January 1982 issue of **Army Aviation** was dedicated to the **Army Helicopter Improvement Program (AHIP)**, AVRADCOM's newest major development program that was awarded to Bell Helicopter Textron in 1981.

AHIP, managed by the Advanced Scout Helicopter Project Manager, will meet the g' ınd commander's requirements for a dedicated, day/night, highly survivable aerial scout. The scout will conduct reconnaissance, surveillance, security, and target acquisition/designa-

AHIP — A Major Program

tion under mid-intensitites and obscured weather conditions of warfare.

Modification of the OH-58A helicopter will include integration of the Mast Mounted Sight with day/night adverse weather target acquisition and designation capabilities, communication/navigation, and airvehicle performance improvements to provide the capability for world-wide environmental and nap-of-the-earth operations.

The summer of 1984 will see prototypes delivered for Government testing with the AHIP being an integral part of the Army's combined arms team by 1986.

The RPV Program

by Colonel Robert D. Evans RPV Project Manager

To win, we must attack deep to delay and disrupt the enemies' follow-on forces as a prelude to taking decisive offensive action. Fundamental to the success of this doctrine is an ability to see deep to locate and destroy high value targets, and quickly assess the ensuing damage.

Today's stand-off systems are severely limited by terrain, weather, and battlefield obscurants. Additionally, the awesome Soviet air defense umbrella makes penetration of the forward line of own troops by manned aircraft a suicide mission.

Realistically, then, today's Army has

an inadequate capability to see deep. The Army's answer to this deficiency is the Army Reconnaissance, Target Acquisition and Designation **Remotely Piloted Vehicle (RPV)** System, designated the **Aquila.**

The RPV is a tactical system as mobile as the Division's Artillery and able to penetrate the Soviet air defense umbrella successfully. An RPV Platoon of four sections will be assigned to each division. Each RPV section consists of five air vehicles, a ground control station, a catapult launcher, a net recovery system and associated support equipment.

The entire system is mounted on seven trucks and three trailers. The air vehicle is small (7 ft. long; 13 ft. wing span; 220 lbs. design gross weight) and carries a payload that can see, locate, and designate targets with a TV/Laser system, and can adjust artillery fire.

The laser is compatible with all Army and Air Force precision-guided munitions. After initial fielding of the daylight system, a night and limited adverse weather capability will be provided with the addition of a **Forward Looking Infrared (FLIR)** payload. Command, control, and navigation of the air vehicle are under control of the Mission Commander in the ground control station.

High growth potential

Although the system employs techniques at the frontier of technology, it has been specifically designed for ease of operation and high reliability in the field. Built-in test equipment quickly isolates faults to the replaceable unit level. At the section level, one finds that 90% of the faults require no more than 30 minutes for correction.

The ground control station incorporates a complete training simulation that enables personnel to maintain section and individual skills at a peak level of readiness. Flexibility is provided by the capability to hand-off air vehicles between ground control stations, by a real-time ability to change routes and targets, and by a fully inertial on-board navigation system that provides for extended periods of independent flight without contact with the ground.

Because the system design provides for interchangeable mission payloads, it has a fantastic growth potential through preplanned product improvements. Potential applications include radio relay, electronic warfare, ordnance delivery, and chemical-biological detection.

Additional product improvements include extended range and a capability for a ground control station to control several air vehicles simultaneously.

IOC scheduled in 1987

The RPV has been in full scale development since August, 1979. With design complete and initial hardware and software fabricated, flight test will commence in 1982. Due to funding changes, outyear schedules have not been finalized.

However, current planning is for DT/OT II to be conducted in 1984-85 leading to an **Initial Operating Capability (IOC)** in 1987. Alternatives for an interim capability are also being explored while the RPV is progressing through the development cycle.

With the fielding of the RPV, the Army will for the first time have an acquisition capability that is equal to the range of its weapons. You will be kept apprised on the progress of the above described programs in future special issues of this magazine. We hope you are as excited about the prospects for the '80s as are all of us in AVRADCOM. The Research and Development community will continue to strive to meet the needs of the field by providing greater capability with increased reliability. **IIIII**

by Edward T. Johnson
and David B. Cale

How to minimize engine operating cost

Develop fuel efficient engines!

THE operators and designers of most combat vehicles have always been concerned about fuel consumption, but sensitivity to this aspect of performance is greatest in aircraft design, especially in recent years with the energy crunch.

Figure 1 on p. 86 depicts the aircraft engines available over the power range of interest to the Army. The majority of these engines was initially developed in the '50's and '60's with subsequent horsepower increases over the years as additional power requirements were defined.

The advanced technology band shown is what the Army is currently projecting it can achieve with improvements in components and engines through development of new engines. The two engines of current interest are the 800 **Horsepower (HP) Advanced Technology Demonstrator Engine (ATDE)** and the **Modern Technology Demonstrator Engine (MTDE).** The 800 hp ATDE, when installed in a utility type helicopter, can save the Army approximately 14 million gallons of fuel (based on 1979 flying rates) a year.

The MTDE, when installed in a medium transport-type helicopter, can save the Army approximately 8 million gallons of fuel a year. In addition to the fuel savings, these engines would provide the potential for increasing the operational capability of the aircraft through increased payload and range. Details of the two programs follow.

ABOUT THE AUTHORS
The article's co-authors, Edward T. Johnson and David B. Cale, are Project Engineers at USA AVRADCOM's award-winning Applied Technology Laboratory located at Fort Eustis, Virginia.

Certain goals achieved

Effort on the 800 SHP ATDE program was initiated in 1977 with the award of contracts to Avco Lycoming and Detroit Diesel Allison for the 800 shp ATDE. In addition to a reduction of 20% in specific fuel consumption compared to current engines, the following technical goals have been demonstrated: a reduction in vulnerable area; an increase in specific power; and a reduced acquisition cost.

The full authority digital electronic fuel controls proved their worth during the test program in protecting the hot section hardware when test problems occurred. The Lycoming engine (**Fig. 2**) and the Detroit Diesel Allison engine (**Fig. 3**) are shown on the next page.

The ATDE effort provides: an advanced propulsion technology at an affordable cost; a technology from which future engineering developments may evolve at minimum risk, time and development cost; and a base for significant reduction in acquisition cost.

Analysis shows that retrofit of the

ATDE into the existing UH-1/AH-1 fleet would save approximately 14 million gallons of fuel per year based on 1979 flying hours. Incorporating the engine into a new aircraft design taking full advantage of its performance to reduce the aircraft empty weight would result in an annual savings of over 10 million gallons of fuel for a 1,000 aircraft fleet operating 35 hours per month per aircraft.

In addition, the use of the smaller aircraft would result in a reduction of over $10 million in fleet acquisition cost. Both ATDE programs are continuing with additional effort being directed toward resolving component performance and durability issues revealed during the experimental engine testing.

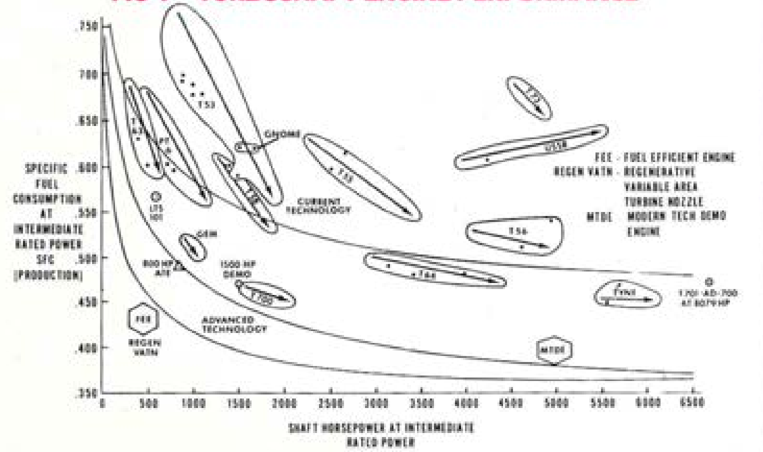
In addition, each demonstrator engine will be run to evaluate the operation of the engine on shale-derived fuel. A continuing development effort is scheduled to begin in 1983 to fabricate additional engines and continue development testing to improve durability and complete a prototype **Preliminary Flight Rating Test (PFRT).**

The 5,000 hp class MTDE is scheduled to be initiated in FY 83. The primary objective of the program is to demonstrate an advanced level of performance in this horsepower category of an engine designed to meet the Army design requirements and combat environment. To help achieve this objective, emphasis will be placed on reliability, maintainability, and survivability as well as the reduction in the amount of fuel consumed.

Low cost emphasis

Reduced fuel consumption in gas turbine engines is obtained from an integrated design incorporating higher pressure ratio compressors, improved combustor efficiency and temperature distribution, higher temperature turbines, improved turbine cooling techniques, and improved material properties. The incorporation of newer technology will allow the use of fewer parts which

FIG 1—TURBOSHAFT ENGINE PERFORMANCE



helps to keep the acquisition cost at an affordable level, a design-to-unit cost target will be maintained to emphasize low cost.

Specific goals for the MTDE program are to demonstrate:

a fuel consumption of 20% to 25% less than current engines in the 5,000 horsepower class;

an improved specific weight (hp per pound of engine weight); and

an engine capable of providing lower acquisition and operation and support cost.

Fig. 2 — The Avco Lycoming Engine

"What will the MTDE do for Army Aviation?"

An analytical assessment of replacing the T55-L-712 in the CH-47 with the MTDE has been made. These analyses show that the payload of the CH-47 can be increased by 47% of the 4,000 ft, 95° F operating condition while saving 22% in the fuel required. This means that a significant amount of supplies can be moved in a shorter period of time while reaping the benefits of reduced mission fuel consumption.

In addition to the CH-47, a quick review of replacing the T701 engine in the HLH has been conducted. This estimate showed an increase in aircraft productivity (ton miles per gallon or pound of fuel consumed) of 24%. Thus, MTDE could mean more fuel available on the front line for other aircraft or for additional flying hours for the CH-47 aircraft.

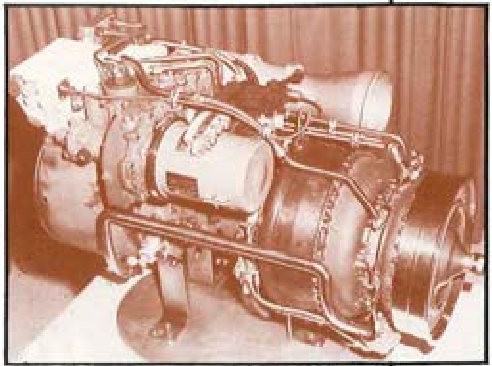


Fig. 3 — Detroit Diesel Allison Engine

The engineering leaders of the major international helicopter manufacturers endorsed the R&D essential to reduce fuel consumption for turboshaft engines. This was done at the 1980 **American Helicopter Society Forum.**

Significant cost savings

The 800 shaft horsepower ATDE and the 5,000 horsepower MTDE offer significant logistic and cost savings in terms of fuel economy. These savings are a combination of improved engine cycle performance and greater productivity of the aircraft.

"How to Minimize Engine Operating Cost?" . . . Develop fuel efficient engines! The payoff only comes about after the work is successfully accomplished. **IIIII**

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Dataproducts

by John Acurio

Drive-Train Systems for future helicopters

For a good number of years, many of the key developments in Army Aviation have been paced by propulsion systems. Looking ahead to the 1990s, we will continue to exercise perceived requirements for a broad range of engine and drive-train systems, and strengthening the technology base will remain our general objective.

The fallouts will have a significant impact on new propulsion systems while providing components for product improvements. The propulsion advances now under development place a high level of emphasis on fuel consumption, weight, durability, and cost.

Each of these considerations is factored into programs with the overall concern that new concepts (technology demonstrators or systems programs) properly account for the potential impact on the developer and user.

ABOUT THE AUTHOR
John Acurio serves as the Director of the USA AVRADCOM's Propulsion Laboratory, Research & Technology Laboratories, NASA/Lewis Research Center located in Cleveland, Ohio.

Drive-train/transmission area

One of the areas that continues to capture attention is the drive-train and power transmission system, which, of course, tends to be very much vehicle oriented. Therefore, it simply is not in the same category as engine developments, which tend to be adopted for more than one vehicle. Yet, the interplay with the helicopter industry is of paramount importance to ensure that the new technology is transferred effectively.

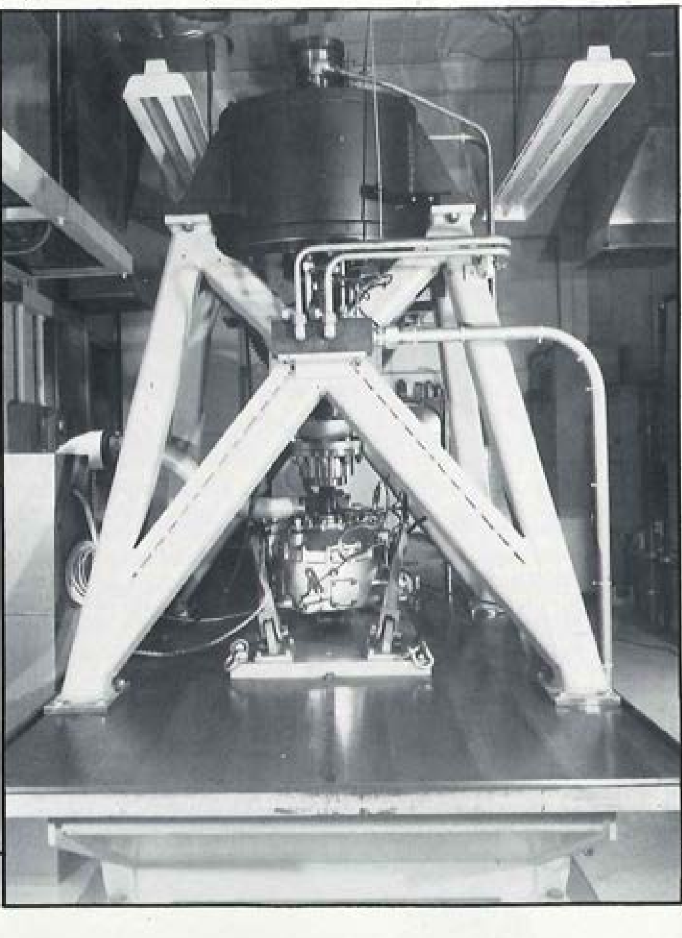
This, then, is the primary concern providing the technology for power transmission systems that will be used in new vehicles and minimizing the risks in development, regardless of the contractor selected to develop the vehicle or weapon system. Toward that end, the

FIGURE 1 — Hybrid Traction Gear

FIGURE 2 — 500 HP Single-Input Transmission (Below)

6.1 Research and the 6.2 Exploratory Development programs are centered about exploiting the gains in new transmission concepts that may become 6.3a Advanced Development programs.

Looking first at the 6.1 and 6.2, examples of fall-outs from the programs are high hot-hardness gear steels, new tooth forms, and traction technology; high-speed ball, roller and tapered roller bearings; high-speed shaft and face seals; shaft dynamics, balancing and damping criteria; highspeed clutches and couplings, lubricants and filtration criteria;



contact lives, including fretting and wear; and housing of new materials.

The work covers the development of basic theories, laboratory experiments, life and endurance tests, and end applications. It's a continuing effort to provide components with capability for higher load with predictable life as a means of reducing weight and the parts count.

Although we will continue to refine the analytical tools, such as three-dimensional stress analysis for gear contacts, heat transfer and cooling of lubricated contacts, and temperature limitations of new high-strength, high-temperature bearing materials, the results give rise to the need to combine the technologies into an **Advanced Development** (systems technology) **Program.**

Its objective will be to demonstrate the application of laboratory advances in an operating unit, specifically designed to flightworthy standards. Specific program goals include a 20% to 50% increase in mean time between removal, improved maintainability, 20% reduced weights, lower costs, and significantly reduced noise.

Two approaches are being considered: First, a conventional geared system with updated component technology and, second, an advanced concept that would combine some gears with traction rollers in a hybrid arrangement. **(Figure 1).**

In mid-1981 a NASA-AVRADCOM-Industry conference on Advanced Power Transfer Technology was held at Lewis Research Center to advise industry on these activities.

To support current and future transmission development the Army utilizes a number of excellent test facilities. One is a 500 hp, single-input transmission (**Figure 2**), and the other is a 3,000 hp dual-input unit (**Figure 3**).

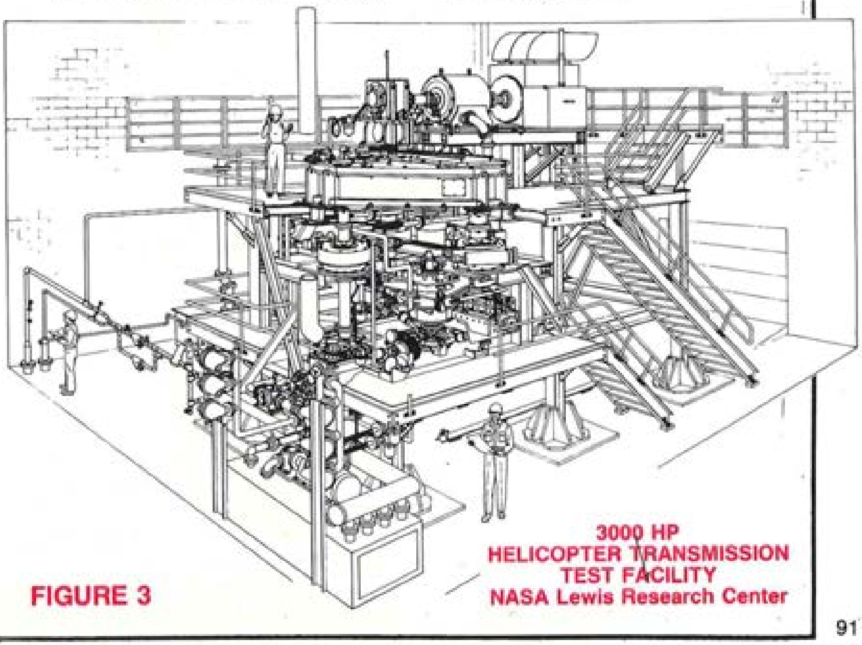
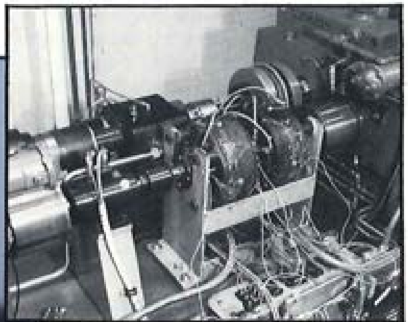


FIGURE 3

3000 HP HELICOPTER TRANSMISSION TEST FACILITY NASA Lewis Research Center



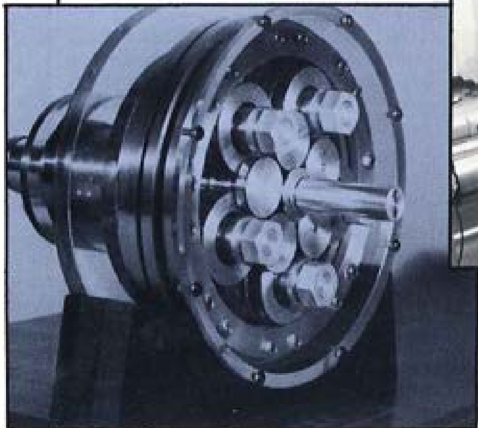


FIGURE 4 (Above) and FIGURE 5 (Left) depict traction-drive stands where experimental high-reduction transmissions are evaluated.

Both are used for detailed measurements of operating parameters, such as temperatures, loads, deflections, noise, and vibration. These test beds also are suited to test theories and evaluate component substitutions. A third valuable research asset is the traction-drive stand where experimental, high-reduction transmissions are evaluated.

Aircraft configuration sought

These traction systems (**Figures 4** and **5**) represent a rebirth of an old idea, i.e., using rollers instead of gears to transmit power through a speed-reduction unit. Several such units have been built and tested, and the process of arriving at a configuration suitable for aircraft use is underway.

Whether future transmissions will continue to use conventional components is not yet clear; however, the prospects of changing to a quieter and more compact system using rollers are exciting and bear continued attention.

As such, emphasis is being placed on all potential technologies that can be applied to traction parameters, including contact pressures, surface fatigue mechanisms, lubricant and traction fluids, slip, and roller tolerances.

At the same time, the need for using gears in the low-speed, high-torque output end of the transmission probably will lead toward a hybrid system; however, the overall gains still can be dramatic.

The payoffs are considerable

Despite this promising development, the requirement to pursue the customary components will remain with us well into the future.

Therefore, we will also explore using available technology to integrate an engine and transmission as an aircraft unit. That will add more participants to the process, but the payoffs could be considerable in weight and overall compatability.

by MAJ Charles C. Crowley

AVIATE: A new approach for testing

IN the past, automobiles were simple and easy to fix, and most individuals did their own repairs. But then as pollution devices, electronic fuel controls, and a host of other contrivances were installed on our cars, most "shade tree" work simply couldn't be performed because of a lack of skills and the required equipment.

The same evolution is facing today's Army with respect to aviation. As complex, sophisticated systems are developed, so must the support equipment be developed to maintain them or readiness will be seriously degraded.

Although operator's tasks are often simplified by complex equipment, the burden placed on the repairers is often insurmountable. Historically, maintainers have been provided with a myriad of test equipment, most of it unique to one specific function. This has resulted in a proliferation of test equipment in the Army.

Many of today's aviation systems have passed the state of being able to be diagnosed and contain black boxes or **Line Replaceable Units (LRU's)** using **Printed Circuit Board (PCB's)** and microprocessors that in themselves require a complex piece of test equipment.

ABOUT THE AUTHOR

Major Charles C. Crowley is Research and Development Coordinator in the USA AVRADCOM's Directorate for Systems Engineering and Development.

Single, common, automatic

Faced with this problem, current development efforts are underway to develop a single, common, automatic test station that can be used by all aviation systems.

Using a common station has certain advantages. First, as stated earlier, equipment has surpassed the testing capability of single, manual test sets, and secondly, its use at all levels of maintenance will reduce costs and training requirements.

The system that has been developed will be known as **Aviation Intermediate Automatic Test Equipment (AVIATE)** (**Figure 1**).

The AVIATE, expanded version of the non-aviation automatic test equipment commonly called EQUATE, consists of computer controlled diagnostic equipment that is capable of being further expanded to meet new require-

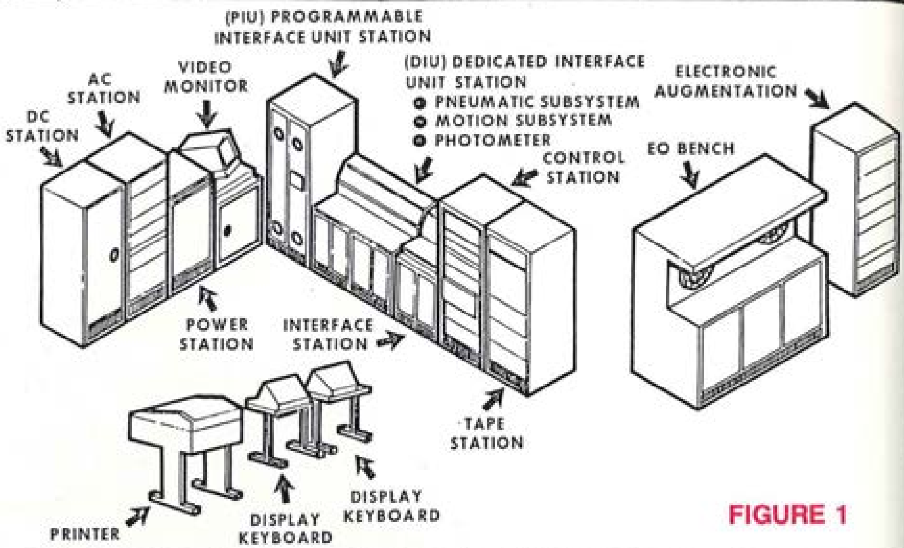


FIGURE 1

AVIATION INTERMEDIATE AUTOMATIC TEST EQUIPMENT (AVIATE)

ments. It's capable of being either statically employed in a building or truck mounted for mobility when providing the necessary support at AVIM's.

In addition to the hardware itself, each item to be tested or diagnosed must have a computer program written to perform the required testing.

To tie-in each component to the AVIATE, a unique cable, known as an **Interface Device (ID),** must be designed for this purpose. The ID, along with the computer program, make up a **Test Program Set (TPS).**

A typical scenario

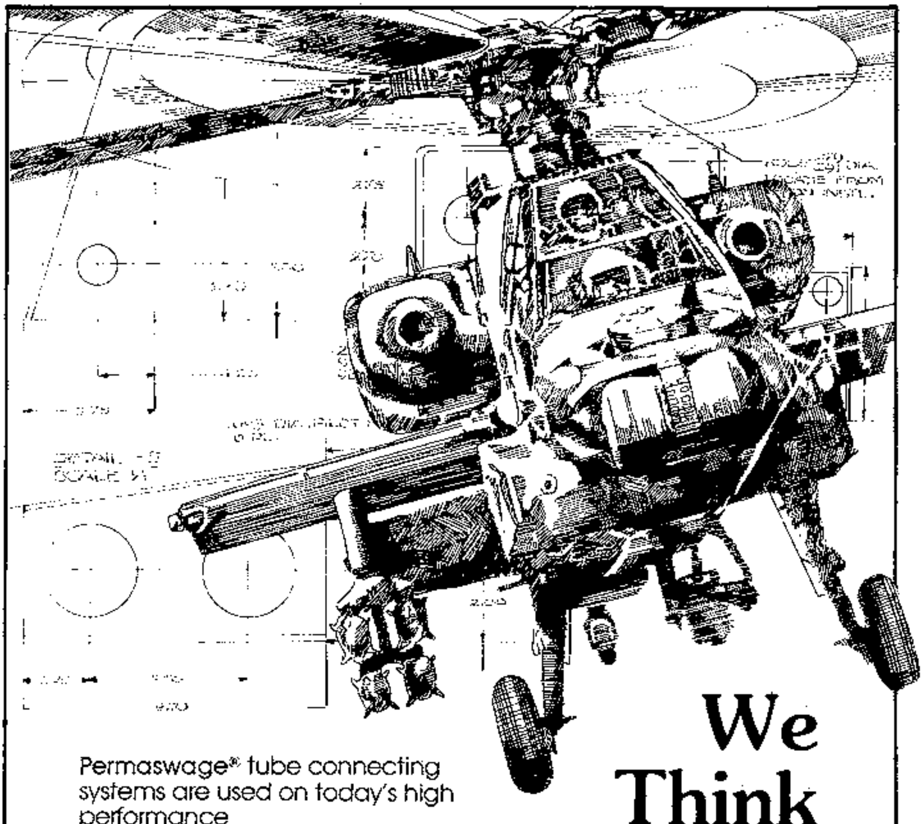
Under a typical scenario an aviation unit would "work order" a faulty component to AVIM for repair. The AVIM would connect the component to the AVIATE using the interface device and load the program. The AVIATE would then automatically fault isolate the component to the faulty part and provide the operator with a printout of the faults noted.

If the LRU was found to be operating properly during the initial diagnostic test, it would be returned immediately to float stock for reissue. If faulty, the component along with the printout, would be taken to a co-located facility, (i.e., Avionic's shop) and repaired.

After correction of the malfunction, the component would again be returned to the AVIATE and a quality assurance check will be performed. Only then would the component be returned to the AVUM or into float stock.

As a result of this scenario, the AVIATE would provide decreased repair times over manual methods; a higher percentage of corrective repairs would have to be performed, and fewer pieces of test equipment would be required.

The AVIATE will also be fielded with a self-test capability that would allow the



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machine to operate efficiently and reduce long maintenance downtimes on the AVIATE itself.

Electromechanical functions

As additional systems are integrated onto the AVIATE, it's envisioned that the machine will be augmented with other pieces of equipment. Work is already underway to develop an electro-optical bench that will allow the **Target Acquisition Designation Sight/Pilot Night Vision Sensor (TADS/PNVS)** system of the **Advanced Attack Helicopter (AAH)** to be diagnosed using the AVIATE. This would allow the AVIATE to measure and diagnose faults in the Laser, FLIR, and optical equipment found in the TADS/PNVS.

Sounds simple, doesn't it? However, the system is not without drawbacks; the first of which is cost.

The AVIATE hardware is expensive and complex. The TPS for each component is costly and as components are changed, the TPS must be changed. Also the size of the truck-mounted AVIATE could seriously degrade the using unit's mobility.

Additionally, if components are to be fully diagnosed by the AVIATE, test points must be designed into the component. The amount of testability within each LRU is in direct proportion to the design cost.

Current plans are to field the AVIATE to support the AAH. But its unique design will allow it to be integrated into virtually all aviation systems in the field today as well as those envisioned in the future.

Mandatory use foreseen

In summary, technology has made manual testing impractical when performing those functions necessary to support aviation systems. The use of AVIATE is expected to be mandatory if we are to maintain the readiness of our aviation assets. IIIII by Richard L. Long

Higher harmonic control

THE helicopter bas been described as the "world's best vibrating machine," and Army helicopters probably operate in the most severe environment from a vibration standpoint by flying nap-of-the-earth between 20 and 40 knots.

There are many wild, wild stories about how the early helicopters used to"shake, rattle, and roll," to include that of the cargo helicopter of the late '50's-early '60's in which it was common practice for the copilot to steady the center instrument panel with his right foot so the pilot could read the engine instruments on short final.

As advancing technology has provided improvements that have reduced the helicopter's vibration level, the Army's requirements have become more demanding. Until 1955 the "not to exceed"vibration level was 0.5g's and in 1972 this was lowered to 0.05g's. These requirements are spelled out in MIL-H-8501A, MIL-STD-810 and the systems specification for a particular aircraft model.

Although the reduction in vibration levels has been gratifying, the price in terms of increased weight and cost has been very high. The Army goal is to achieve the necessary vibration reduction with devices weighing about 1% of the gross weight of the aircraft.

However, in the real world the weight turns out to be 2½% to 3%. Perhaps a more dramatic way of making the point is to note that vibration reduction devices weigh from 15% to 18% of the helicopter's payload.

A difficult, complex problem

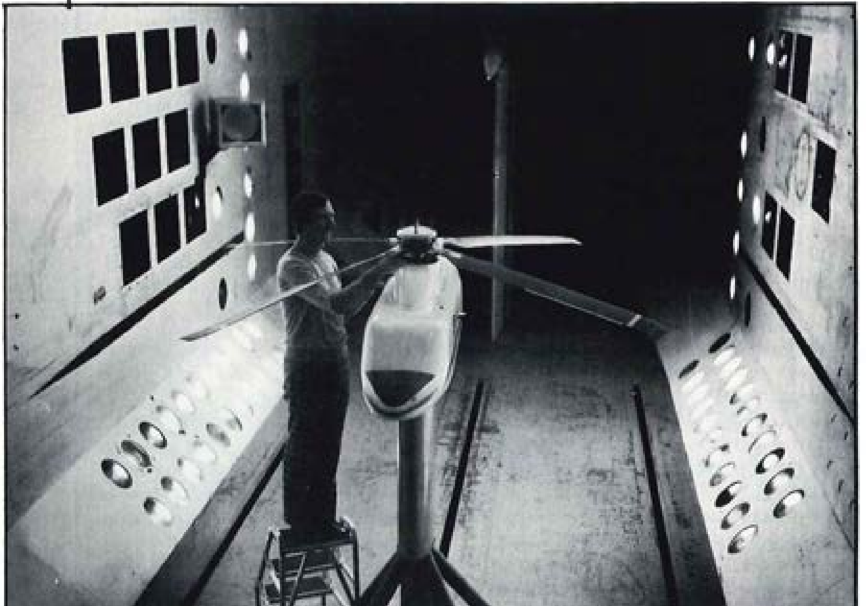
Helicopter vibrations present a very difficult and complex problem as compared to fixed-wing aircraft. There not only are many different sources of helicopter vibrations from the various rotating components, but the variety of aerodynamic and structural interactions between the rotor and fuselage are not completely understood.

During the design evolution of a new helicopter the initial engineering emphasis is given to preliminary design, performance, aerodynamics, and structures. The interest in structural dynamics and vibrations of the helicopter usually increases dramatically after the first flight and remains high until after qualification or certification.

The designer needs help since there are serious gaps in helicopter vibration technology, including our inability to accurately predict vibration loads.

ABOUT THE AUTHOR
A former Master Army Aviator, COL Richard L. Long (Ret.) brings special expertise to the position of Director of AVRADCOM's Structures Laboratory located at NASA/Langley Research Center.

FIGURE 1



ADJUSTING THE AEROELASTIC ROTORCRAFT EXPERIMENTAL SYSTEM

AVRADCOM's **Research and Technology Laboratories (RTL)** have developed a comprehensive Helicopter Vibration Plan that will provide the designer with better tools for vibration analysis and better control devices to improve on such systems as **Integrated Rotor Isolation System (IRIS)**, **Dynamic Anti-Resonant Vibration Isolator (DAVI)**, Bi-Filar, Nodal Beam, Pendulum Absorbers, and others that have been successful in varying degrees.

A leading candidate

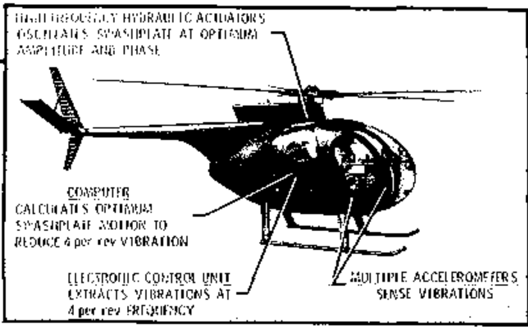
One of the leading candidate systems for vibration reduction is called **Higher Harmonic Control (HHC)**. This has been a joint Army/NASA effort since the mid-1970's, and most of the research to prove the concept has been done inhouse by personnel of the AVRADCOM's Structures Lab and NASA/Langley Research Center.

The system uses high frequency rotor blade pitch control to minimize the vibrations of the rotor at their source. This is done by superimposing nonrotating swashplate motions at the blade passage frequency or N-per-rev (four per revolution for a four blade rotor) which become part of the inputs of cyclic and collective pitch controls.

Higher Harmonic Control does for a helicopter what a set of super shock absorbers that could be adjusted for weight, speed, and road conditions would do for a car.

Initial testing of the HHC concept

FIGURE 2



MAJOR COMPONENTS — HIGHER HARMONIC CONTROL SYSTEM

was done in 1976-77 using the **Structures Lab Aeroelastic Rotorcraft Experimental System (ARES)** in NASA/Langley's 16 foot **Transonic Dynamics Tunnel (TDT). Figure 1** on the opposite page shows **Dr. Gene Hammond** making adjustments to the ARES model in the TDT. **Dr. Hammond** deserves much of the credit for the success HHC has shown to date. Another key Army team member is the Structures Lab HHC project engineer, **John Cline.**

Early tests in the TDT verified that the primary parameters which determined the success of the higher harmonic inputs in reducing the vibratory loads were the amplitudes and phases of the N-per-rev inputs. This open loop testing confirmed that a correctly chosen input would reduce vibration levels, but that the required input chaged significantly with helicopter configuration and flight condition.

To be fully successful, a systematic means of sensing vibrations and automatically determining the optimum HHC input had to be developed, and is now called the closed loop active control system.

An **electronic control unit (ECU)** was specifically designed and built at NASA/Langley and algorithms for the different control laws were programmed on the Sigma V computer in the TDT facility. In 1979 the ARES model was used to measure vibration levels with and without the closed loop HHC system operating and reductions of the N-per-rev vertical vibration levels of up to 90% were achieved as well as a substantial reduction of longitudinal and lateral vibrations.

Feasibility study completed

In June 1980 Hughes Helicopters completed a preliminary design study under a joint Army/NASA contract to determine the feasibility of retrofitting a higher harmonic control system to an OH-6A. **Figure 2** (above) shows an OH-6 with the four major components identified to incorporate HHC.

First, a means of measuring vibration levels would have to be installed on the aircraft, and it was decided that three accelerometers (one for each axis) would be installed at the pilot's seat and that vibrations at that location would be minimized in the flight test.

Second, a flightworthy electronic control unit similar to the one used with the ARES model would have to be built in order to extract the N-per-rev vibration levels from each accelerometer signal.

Third, a flightworthy, on-board minicomputer would have to be programmed with the HHC control law algorithms developed and tested at Langley Research Center.

Finally, the aircraft would have to be configured with a hydraulic control system to allow inputs of the HHC signals to be superimposed on the basic flight control inputs.

Hughes Helicopters was awarded an Army/NASA contract in September 1980 to modify a bailed OH-6 helicopter by installing an HHC system and then conducting ground and flight testing to demonstrate proof of concept. Instrumentation of the OH-6 includes triaxial accelerometers located at the pilot's seat to provide vibration feedback data to the HHC.

Additional parameters to be monitored during the flight test included blade loads, pitch link loads, main rotor shaft torque, HHC inputs, blade pitch, and flight conditions. Levels of vibration will be monitored at several additional fuselage locations.

A flightworthy ECU has been designed and built based on the one used in wind tunnel testing. The functions of the ECU include processing the feedback accelerations and passing the data to the computer. Another function is to convert voltage from the computer to drive the HHC servoactuator with the correct amplitude and phase.

This, in turn, controls the lower swashplate and finally the individual rotor blade angle of attack. The ECU also provides command control limiting, self-test, and system monitoring.

Flightworthy mini-computer

The mini-computer programmed with HHC algorithms is the flightworthy Sperry SDP-175 airborne data system which weighs 15 pounds. It is used on the AAH for fire control, stores management, multiplex bus control and navigation on a time-shared basis.

Hydraulic power is provided by a 3,000 PSI system using a Sperry-Vickers pump that is currently used on the F-16 primary flight control system. The hydraulic manifold and reservoir assembly has been bailed from the AAH program.

HHC hydraulic servoactuators were tailor made for this OH-6 installation by Moog, Inc., and have been fatigue tested over three million cycles without failure. Special attention has been given to system safety and the HHC is considered failsafe since it has limited authority (2% blade angle of attack) and has extensive self-test features built into the ECU and computer.

April flight testing planned

Flight testing of the HHC OH-6 should begin in the early spring of 1982 at the Hughes Flight Test Facility, Palomar, CA. The probability of success is considered to be high since there has been extensive research conducted at the Langley Research Center and most of the HHC components are common to other systems or have been extensively tested.

Following the completion of a successful flight test program, an industry demonstration to promote technology transfer to the U.S. helicopter industry is expected. The next logical step would be a prototype installation of HHC on a production helicopter to verify cost and operational effectiveness data.

HHC offers promise

In conclusion, **Higher Harmonic Control** offers a promising method of reducing helicopter vibrations throughout the entire flight envelope. In addition, by selecting the appropriate location for the feedback accelerometers, the vibration level at a specific fuselage station can be minimized such as: avionics bays, weapons pylons, fire control turrets, or passenger compartments.

The full potential of **Higher Harmonic Control** should be realized on the next generation of Army helicopters that will probably have Fly-by-Wire (or light) flight controls as well as onboard computers. IIIII

by Joel L. Terry, Jr.

Fly-by-Light: Flight control of tomorrow

IN the past, Army helicopter flight control improvements have been evolutionary rather than revolutionary. This is not surprising since flight controls are absolutely critical to flight safety and as a mission accomplishment.

The battlefield of tomorrow will present several challenges to Army Aviation that will require major changes to the helicopter in general and to flight controls in particular. This strongly suggests that something more than an evolutionary approach to flight controls is required.

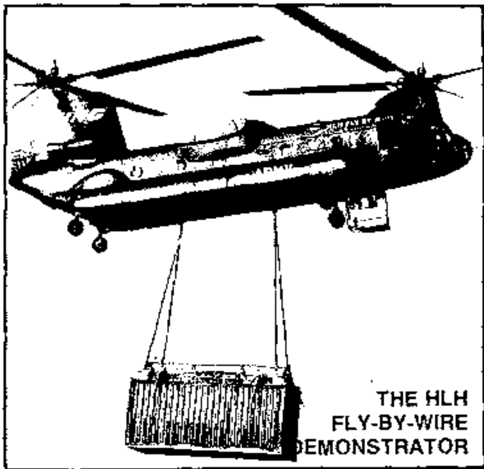
Three major challenges facing Army helicopter flight control systems of the future are as follows:

- The emergence of the electronic warfare threat which has the ability to inflict catastrophic damage on many electronic components.
- Improvement of conventional ballistic weapon threat capabilities in rate of fire, target acquisition, and aiming accuracy to the point that multiple hits on helicopters (and flight controls) is a real possibility.
- The Army's requirement to perform helicopter missions under all weather and darkness conditions while using **nap-of-the-earth (NOE)** flight techniques to maximize survivability from enemy threats.

ABOUT THE AUTHOR
Joel L. Terry, Jr., is the Team Leader, Flight Controls and Subsystems, at Aviation Research and Development Command's award-winning Applied Technology Laboratory.

Collectively, the above challenges generate a near-impossible design requirement for conventional mechanical flight control systems and lead one to consider a major change in design philosophy for future Army helicopter flight controls.

The all weather/night NOE requirement dictates that the helicopter be easier to fly. The control must be instinctive and must require a low workload and little or no attention inside the cockpit so that the pilot has more time to devote to his increasingly complex mission task. Also, the all-weather mission dictates that serious consideration be given to the lightning threat which in the past has been given a relatively low priority in that Army helicopters have generally avoided most electrical storm areas.



THE HLH FLY-BY-WIRE DEMONSTRATOR

FIGURE 1

The electronic warfare challenge means considering the effects of lasers, high energy microwave, and nuclear radiation. The ballistic challenge of multiple hit capability relates to the predicted improvement in target acquistition and aiming capability and the high rate of fire forecast for the threat weapons. This would dictate that more than two control paths be installed to provide the capability to accept multiple hits.

Conventional mechanical controls in a relatively stable helicopter could probably handle the electronic warfare threat in **Visual Meteorological Conditions (VMC)**, but loss of the stability augmentation in **Instrument Meteorological Conditions (IMC)** could be catastrophic or, at least, could result in mission abort.

Adding additional parallel mechanical control paths for the multiple hit capability produces a weight, cost, reliability, and maintainability penalty that is unacceptable. Adapting these multiple mechical flight control systems to a wide variety of piloting tasks is neither practical nor cost effective.

Early Fly by Wire Efforts

The **Tactical Aircraft Guidance Systems (TAGS)**, which first flew around 1970, demonstrated a triple redundant digital version at the **Vector Control (VVC)** concept optimized for a cargo mission. The program was highly successful in demonstrating the reduced pilot workload available through VVC.

The **Heavy Lift Helicopter (HLH) Advance Technology Components (ATC)** program initiated in 1971 provided the feasibility for a pure **Fly-by-Wire (FBW)** flight control system for the HLH. The ATC FBW demonstrator program was flown on the Boeing Model 347 (stretched CH-47) helicopter (**Figure** 1).

The HLH mission required precise hover hold, even over a moving ship deck, and accurate control to pick up and place external cargo. Automatic control modes which were optimized specifically for the HLH mission provided needed pilot workload reduction while significantly improving mission performance.

Analog controls as backup

The above digital programs, as well as several fixed wing fly-by-wire control systems, required analog control paths either as primary or backup despite the known advantages of digital computation. The apparent concern was that natural or man-made electrical interference would affect the antenna-like signal paths and cause a digital computer upset.

If the antenna-like behavior of the control system could be corrected, maximum system payoff could be achieved by eliminating the need for a backup control system.

Due to their non-electrical conducting characteristics, fiber-optic data paths were the obvious answer (**Figure 2**) if other problems, such as getting signals on the optical paths without having to run power leads out to all signal generating points, could be solved.

The **Advanced Digital Optical Con-**

trol System (ADOCS)** program received approval from the Assistant Secretary of the Army in August 1979.

The ADOCS Fly-by-Light program was set up in two basic elements: component development and flight demostration. The first two years of the program consisted of component technology development.

It should be noted here that although fiber optic systems are being widely applied to communication systems, the components needed to apply fiber optics to flight control systems do not currently exist.

In this phase, multiple contracts for linear and rotary motion transducers, differential pressure transducers, control media mechanization studies, and optical servovalves were awarded to spread electrically passive digital optical transducer technology throughout industry so it would be accessible to all the helicopter manufacturers.

Reducing the ballistic threat

Another significant item to be addressed during the component development phase is that redundant flight controls normally stop at the swashplate and upper controls somewhat vulnerable to ballistic threats.

An ongoing Advanced Rotor Actuation Concepts contract is considering approaches that place the rotor actuators and hydraulic and electrical power generation in the rotor head.

With this concept, only the optical control signals are transferred from the nonrotating to the rotating regime thereby reducing the vulnerability to ballistic threats.

Finally, the component phase includes an **Advanced Cockpit Controls/ AFCS** contract which is considering the cockpit controller, control law, and display selection and optimization to perform the attack-scout mission tasks.

FIBER OPTICS ELIMINATES ELECTRICAL INTERFERENCE

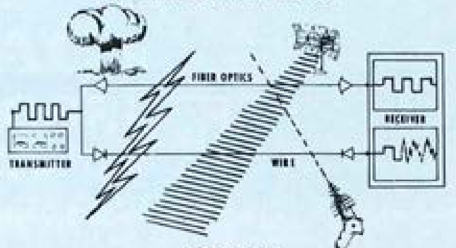


FIGURE 2

The attack-scout mission was selected because of the greater complexity of its mission and, therefore, the largest pilot workload.

Single four-axis control stick

This contract should be of particular interest to the aviator since the emphasis in this type of controller is on a single four-axis force controller instead of conventional sticks and pedals, and it offers the advantages of simplicity, improved reliability, and maintainability.

The second element of the ADOCS program combines the next generation of the component development hardware into a redundant **Digital Optical Control System (DOCS)** to be demonstrated on a UH-60A **BLACK HAWK** helicopter.

Flight demonstrator program

The flight demonstrator program has three major goals:

- To demonstrate the feasibility of controlling a helicopter solely by the use of an optical control system.
- To substantiate a reduction in pilot workload and to improve mission performance for the attack-scout mission tasks through use of a digital control system.
- To substantiate and recommend design requirements for a production application of optical controls.

Boeing Vertol has been awarded the contract for this element of the program which is now in the preliminary design phase. First flight is planned for late

1984 with all technical effort (including 100 hours of flight testing) to be completed in late '85. The **BLACK HAWK** will be configured (**Fig. 3** below) with the DOCS pilot in the present pilot's station.

The safety pilot will occupy the present co-pilot's station which will retain the mechanical controls. A DOCS co-pilot/flight test engineer's station will be located in the cargo compartment so that the DOCS co-pilot can set up various flight conditions for the control transfer tests.

Boeing has included the AH-64 **Integrated Helmet and Display Sight System (IHADSS)** in the program to provide the **Pilot Night Vision System (PNVS)** display symbology for evaluation. Boeing will conduct laboratory simulations of an NOE course and later take the DOCS-equipped **BLACK HAWK** to Fort Indiantown Gap, PA, for an actual NOE flight evaluation in the area previously simulated.

In summary, the ADOCS program has been established as an orderly approach to satisfy the Army's advanced flight controls' needs for tomorrow's helicopters. Electrical hazards, both natural and tactical, will be completely eliminated from all data paths; ballistic protection will be significantly improved; pilot workload will be reduced; mission and flight safety and reliability and maintainability will be greatly improved; and a control system weight reduction of 300 pounds for a vehicle the size of the **BLACK HAWK** can be realized.

The ADOCS program is very exciting and has the interest of all the major helicopter manufacturers. User interest will be determined in 1986 when it will be demonstrated at a number of Army facilities around the country. The most likely candidates for incorporation of the ADOCS technology into the Army helicopter fleet will be later models of the UH-60 and the AH-64, and the next generation family of **Light Helicopters. (LHX)**. IIIII

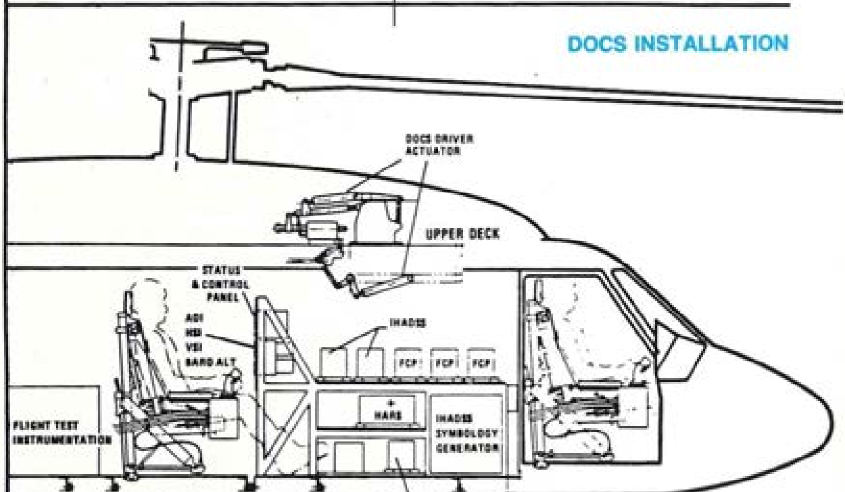
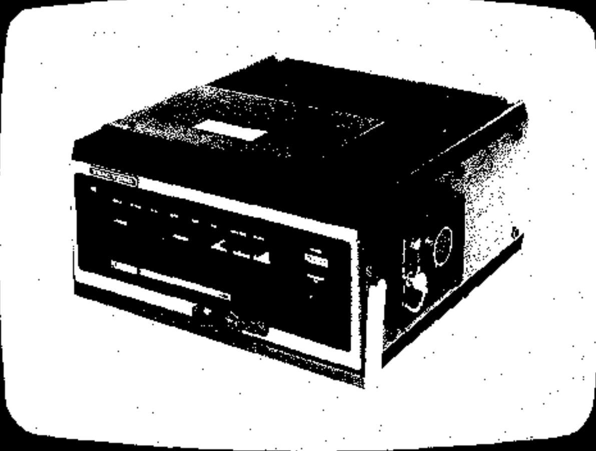


FIGURE 3

TEAC's VIDEO RECORDERS

FRIEND OF THE NTSH AIRCREW



TEAC offers congratulations to Bell Helicopter Textron, recent winners of the Army's NTSH contract, with their proposal for refurb and update of their OH-58 Scout Helicopter.

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AAAA Scholarship to Honor Memory of COL John Geary

Friends and associates of Colonel John C. Geary, (USA-Ret.), a pioneer in the development of Army Aviation following WW II, have established a major AAAA Scholarship in his name. Geary, 60, died January 31 in St. Louis of a heart attack.

A Master Army Aviator with more than 4,000 flying hours, the 1946 graduate of the U.S. Military Academy had logged flight time in 35 different types of fixed wing aircraft and 20 different types of rotary wing aircraft during his 26-year military career.

GEARY

Colonel Geary was one of Army Aviation's first qualified and experienced engineering test pilots having graduated from the USAF Test Pilot School in 1960, where he achieved the highest acadedemic grade in his class. He also held a Master of Science Aeronautical Engineering Degree from the University of Michigan.

His extensive aviation R & D work included duty at Edwards AFB; the Logistic Test Activity at Ft. Rucker (now the Aviation Test Board); AVSCOM (now AVRADCOM) where he served as the Director of Research, Development, and Engineering; and ODDR&E. During one tour at DOD, he was responsible for all helicopter and V/STOL programs.

In an earlier tour, he helped pioneer the Army's logistic test concept of accelerated "lead-the-fleet" testing in which new helicopters were flown in an accelerated schedule to uncover potential maintenance and logistic support problems.

A former Vice President on AAAA's National, Executive Board, Geary and his Ft. Rucker unit won the prestigious William J. Kossler AHS Award in 1959 for achievements and significant contributions to the operational upgrading of the Army's helicopter fleet. At the time of his death, he was the Manager of the St. Louis office of Hughes Helicopters, Inc., a position he had held since his retirement from the Army in 1974.

The John C. Geary AAAA Memorial Scholarship is being endowed by numerous Lindbergh (St. Louis) Chapter members; his AVRADCOM and St. Louis military associates; his employers, Hughes Helicopters, Inc.; his AAAA National Board contemporaries; and his many friends within Army Aviation and AAAA. The initial scholarship award will be presented in 1983.

A resident of Florissant, Mo., he leaves his wife, Rita; two sons, John, Jr., and Thomas; and a daughter, Sharon.

Donations to the John C. Geary Memorial Scholarship Fund should be made payable to the AAAA Scholarship Foundation, and sent to AAAA, 1 Crestwood Road, Westport, CT 06880.

RICHARD BRENT WASHBURN, JR.

Richard Brent Washburn, Jr., was killed in an automobile accident in Dallas, Tex., on Dec. 27, 1981. A member of USMA 1982, he was the son of LTC Richard B. Washburn, Ret., a Master Army Aviator, and the grandson of the late Colonel I.B. Washburn, an early Army Aviation pioneer and Commandant of the Aviation School at Ft. Sill, OK. As a Cadet Brent attended the Army Aviation School in the summer of 1960 making him not only third generation Army but a third generation Army Aviator as he planned to continue in aviation after entering the Army this June. Burial was in Arlington, Tex., on Dec. 31, 1981.

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'82 MEMBERSHIP ENROLLMENT CONTEST NEARS END

With substantial prizes and National Convention recognition in the offing, AAAA Chapters are concluding their six-month Oct 81—Mar 82 enrollment drive with "down-to-the-wire" stretch drives in both the "Membership Gain" and "Percentage Gain" categories. The contest ends on March 31.

LARGEST MEMBERSHIP GAIN
(Standings as as March 1)

Name of Chapter	Membership Gain
1..Corpus Christi Texas Chapter.	+72
2..Valley View Chapter..........	+65
3..Indiantown Gap Chapter......	+64
4..Army Aviation Center........	+62
5..Air Assault (Ft. Campbell).....	+43
6..Wings of the Marne Chapter...	+36

LARGEST PERCENTAGE GAIN
(Standings as as March 1)

Name of Chapter	Percentage Gain
1..Valley View Chapter.......	+110%
2..Indiantown Gap Chapter...	+106%
3..Mainz Chapter.............	+73%
4..Corpus Christi Texas.......	+48%
5..Taunus Chapter............	35%
6..Bonn Area Chapter.........	+32%

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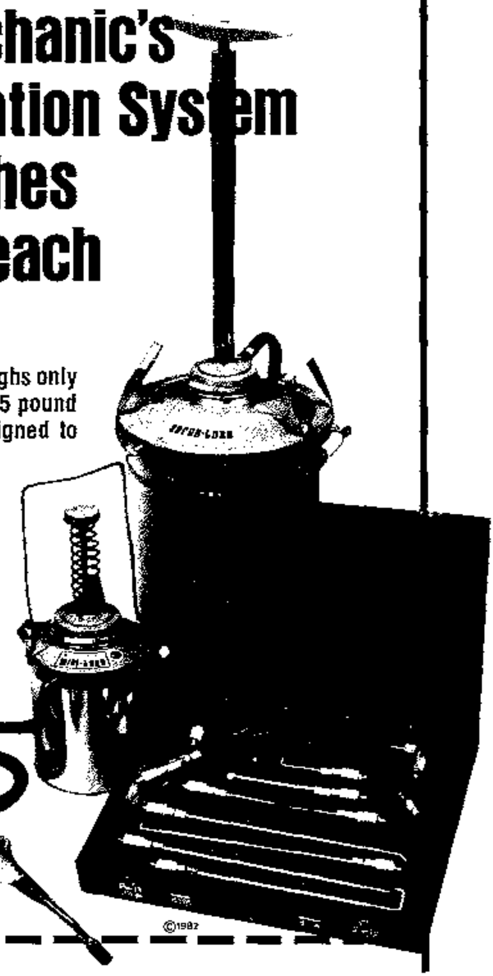

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Colonels

MORAN, John F., Jr
1226 Limit
Leavenworth, KS 66048

ZORN, Burl A.
USMTM (SA) Army, Box 1092
APO New York 09038

Lt. Colonels

BELLAMY, Mark L.
PSC Box 2164
APO New York 09130

BURBIDGE, John M.
HHC VII Corps G-4, Box 285
APO New York 09061

CAROTHERS, Dave
Quarters 2654
Fort Lewis, WA 98433

COOK, Theodore L.
Bx 27, Supp Co, 7th A CATC
APO New York 09114

DALY, Jerome R.
3317 Southgate Dr, Apt 203
Alexandria, VA 22306

HARRISON, William T.
611 Forest Road
Chambersburg, PA 17201

KERRIGAN, Robert J.
7140 Red Horse Tavern Lane
Springfield, VA 22153

MITCHELL, Richard R.
5010 Weber Street
Annandale, VA 22003

MULLADY, Brian P.
59th ATC Battalion
APO New York 09025

MURPHY, Thomas W.
US Army IX
Pres Of San Fran, CA 94129

PREDMORE, Keith E.
Us Army (PEP),Box 54
APO New York 09150

Majors

ALDRIDGE, A. D. Jr.
62d Aviation Company
APO New York 09039

BOHLEN, Paul N.
28 Hunt Street
Fort Bragg, NC 28307

BRANDT, William M
HHC, 4th, 69th Armor
APO New York 09185

BROWN, Connie A.
HHC, 2nd Engr Bn, 2d ID
APO San Francisco 96224

BYARS, Donald R.
2102 Kazmeier Plaza
Bryan, TX 77801

CINTRON, George I.
8061 Prelude Lane
Jessup, MD 20794

CULVERHOUSE, Jerry R.
HHD, 17th Cbt Aviation Gp
APO San Francisco 96301

DANDRIDGE, Wayne L.
HHC, CEGE, PO Box 36
APO New York 09166

EVERSON, Randolph L.
813 Cedar Ridge
Harker Heights, TX 76541

FAULKNER, Ronald W
1145 Leyte Avenue, AFSC
Norfolk, VA 23511

Majors

GEROT, Edwin L.
HHC, 21st Support Command
APO New York 09325

GESELE, Eugene C.
HD, Supp Gp NDL, Bx 418
APO New York 09069

HANLON, Thomas
117 Seville Way
San Mateo, CA 94402

HILL, Roger D
4411 Evansdale Road
Woodbridge, VA 22193

HOWARD, Hugh E., II
P.O. Box 6850
Fort Bliss, TX 79916

MEDVITZ, Charles M.
30 Pick Avenue
Fort Leavenworth, KS 66027

MILLER, Nicholas L.
HHC, 2d SUPCOM Corps
APO New York 09160

QUINTEN, Keith P.
1128 Biak Street
Norfolk, VA 23511

SCHAEFER, Raymond L.
480 Mitchell Terrace, No. 24
Fort Riley, KS 66442

SCHALIN, J. Gunnar
4512 Caminito Pedernal
San Diego, CA 92117

SHEPHERD, Johnnie L.
218 East Liberty Street
Savannah, GA 31401

SHIPLEY, Berchard R.
1012 Jackson Boulevard
Bel Air, MD 21014

VERITY, James E.
3181 Arrowhead Court
Woodbridge, VA 22192

WALLS, Osb. K., Jr.
79 3d Infantry Road
Fort Leavenworth, KS 66027

WARNE, Douglas E.
Hq USFK/EUSA J3-CC
APO San Francisco 96301

WILSON, Kenneth E.
53 Dragoon
Fort Leavenworth, KS 66027

WOOD, Gail W.
9-A Officers Circle
Fort Douglas, UT 84113

Captains

ADAMS, Benjamin F.
9 Simpson Drive
Daleville, AL 36322

ATKINSON, Alonzo M.
34451 Baldwin Road
Barstow, CA 92311

BELL, Michael L.
201st Aviation Bn
APO San Francisco 96271

BOWAB, Joseph W.
SMC 1993, Naval Postgrad Sc
Monterey, CA 93940

BREITHAUPT, Michael P.
8462 Rippled Creek Court
Springfield, VA 22153

CHAPIN, Robert L.
Recvg & Processing Company
Fort Gordon, GA 30905

COOK, Walter R.
c/o M. French, 1107 E. Alice
Phoenix, AZ 85020

Captains

CROSSAN, William, II
1920-A Butner Street
Fort Eustis, VA 23604

DUNN, Martin
118 Independence
Enterprise, AL 36330

FARRIS, John A.
105 Willow Oaks
Ozark, AL 36360

FOX, Timothy J.
USDAO, American Embassy
APO San Francisco 96404

GOLDBERG, Joseph
7340 Windsong Drive
El Paso, TX 79912

HESTER, Edward C.
327 Cimmaron Circle
Folsom, CA 95630

JOLLEY, Bev. C., Jr
105 Plumb Point Loop
Aberdeen Pvg Gd, MD 21005

KELLY, Kevin M.
5830 A Brett Drive
Fort Knox, KY 40121

KERNAN, Michael P.
501 Candleglo Drive
San Antonio, TX 78239

MANN, Paul A.
3701 S. Geo. Mason Dr.,
Falls Church, VA 22041

McKNIGHT, Kathryn G.
130 Greenbriar Court
Savannah, GA 31406

MUNDT, Stephen D.
8th Cs Ctr Mat Mag Co
APO New York 09111

NIX, Dennis R.
609 B Chelsea Place
Newport News, VA 23603

PARDUE, Leonard W.
20 Cedar Grove Park
Mantua, NJ 08051

PARHAM, Henry A., Jr.
55 Bomford Drive
Redstone Arsenal, AL 35808

RIPPEL, Raymond E.
177 Arnold Hall 3
Ft Riley, KS 66442

ROBINSON, Kenneth
8797 Harper's Point Drive
Cincinnati, OH 45242

ROOT, Mike E.
11107 Auldine Street
San Antonio, TX 78230

SCHUMM, Brian M.
P.O. Box 296
Fort Ord, CA 93941

SHAFER, Jack O., Jr.
1901 Sherman Drive
Killeen, TX 76541

STOCKL, Ludwig
760 S. Reynolds St., Apt 1102
Alexandria, VA 22304

SUBLETT, Michael F.
201st Aviation Co (AH)
APO San Francisco 96271

THOMPSON, William L.
73d Cbt Intel Company (AS)
APO New York 09359

TINDOLL, David D.
Box 1116, New Garden Station
Fort Knox, KY 40121

WELLS, Alexander
209 Foulois
Fort Sam Houston, TX 78234

Captains

WHITE, Donald J. Jr.
Route 7, Box 154
Elizabethtown, KY 42701

1/Lieutenants

BORNE, Ronald L
1446 Laranue St, No. 3
Manhattan, KS 66502

HOPPER, Gary B
E Company, 501st Cbt Aviation Bn
APO New York 09326

KASTNER, Patrick J.
5906-A Hanna Pierce Rd, W.
Tacoma, WA 98467

NEAL, Gordon S.
203 Orchard Drive
Clarksville, TN 37040

2/Lieutenants

BRAUN, William G.
BOQ Bldg 2997, Room 105
Fort Campbell, KY 42223

BRUMMETT, Harold M.
2009 Delia Drive
Clarksville, TN 37040

CLARK, Thomas A.
CMR 2, Box 4884, 64th Aviation Co
Fort Rucker, AL 36362

COMLEY, William A.
4062-18 Tamarack Drive
Fort Wainwright, AK 99703

GOODALE, John
A Co, 3d Cbt Avn Bn
APO New York 09036

LOURIGAN, George J.
105 Skipper Court
Ozark, AL 36360

MALLON, John D.
P.O. Box 357
Ardenvoir, WA 98811

SHERMAN, Patrick L.
111 Joy Drive
Clarksville, TN 37040

CW4'S

GRAY, David J.
5716 Friedman Street
Fort Hood, TX 76544

CW3'S

BABCOCK, Myron F.
P.O. Box 405
Barbers Point, HI 96862

CARR, Tyrus R
569 Waldorf Drive
Clarksville, TN 37040

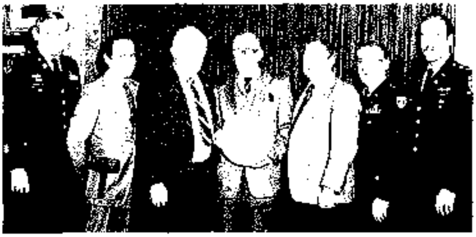
DICKERSON, Jay L.
Quarters 2450 B
Fort Lewis, WA 98433

DOUCETTE, Ronald R.
1611 Poyntz Avenue
Manhattan, KS 66502

HACKETT, Phillip G.
102 Lindsay Street
Enterprise, AL 36330

HOOPER, James M.
HHD, 17th Aviation Group
APO San Francisco 96301

INGLE, Larry M.
Cmr No. 543
Ft Mcpherson, GA 30330



PHILADELPHIA—Joseph P. Cribbins, center (holding seal), Spec Asst to the DCSLOG, DA, and guest speaker at the Delaware Valley Chapter's 18 Jan. dinner meeting, is shown with l-r, LTC Philip Grushetsky (VP, Mil Aff), George Smiley (Sec), Tom Nowrey (Pres), Cliff Holgate (Sr VP), CW4 James Gripp (VP Memb), and MAJ Al Weinnig (VP, Programs).

CEDAR RAPIDS, IOWA—Shown following a 9 February meeting of the Cedar Rapids (AAAA) Chapter are, l-r, Bob Lord (Chap Trea), Dick Derr (Sr VP); MG Story C. Stevens, AVRADCOM Commander and guest speaker; Don Justice (VP Publicity), and Jess Glance (Sec). Some 70 members and guests attended the new Chapter's third professional membership meeting.

CARLSBAD, CA—The US Army's Applied Technology Laboratory/DARPA/Hughes NOTAR (No Tail Rotor) helicopter successfully completed its first flight on December 17, 1981, at Carlsbad on the 78th Anniversary of the Wright Brothers' first flight.

FT. CAMPBELL—MG Charles W. Bagnal, Jr., center, stands with the members of the first BLACK HAWK Transition Course at Campbell AAF. The 3-week course augments the graduates from USAAVNC.

CW3'S

JONES, Larry K.
P.O. Box 208
Lafayette, KY 42254

PETERSEN, Peter G.
ERAU, Box A-215, Regl Arpt
Daytona Beach, FL 32014

RENSVOLD, Roger B.
108 Colony Drive, Apt 12
Enterprise, AL 36330

SMITH, Stephen S.
4243 Inlet Road
Marietta, GA 30066

CW2'S

DEFELICE, Mario T.
7 Anderson Road
Bernardsville, NJ 07924

JENKINS, Willie
No. 3 Holiday Cove
Savannah, GA 31405

KRASOWSKI, Bernard G.
62nd Avn Co, Box 728
APO New York 09039

LYNCH, Brian E.
P.O. Box 142
APO New York 09165

MEISBERGER, Theodore A.
301 Navaho Drive
Enterprise, AL 36330

WO'S

BRUCE, Craig A.
1027 B Chestnut Street
Fort Wainwright, AK 99703

HARTLEY, Jerry D.
C Company 3d Aviation Bn
APO New York 09702

LINK, Robert G.
13902 Russ Drive
Houston, TX 77039

SHIREY, Robert W.
6887 Sandridge Drive
Fayetteville, NC 28304

SMITH, Jeffrey D.
P.O. Box 961
Brentwood, CA 94513

Enlisted

ALLEN, Douglas E., 1SG
10664 Carswell Drive
Fort Bliss, TX 79908

DEGON, Paul A., SGT
E Co, 3d CAB, PO Box 136
APO New York 09047

FOX, Bruce, SFC
HHC, 1st Bde, 82nd Abn Div
Fort Bragg, NC 28307

HODGES, Patricia, SGT
1121 Old 440, Apt 208
Killeen, TX 76541

Enlisted

KERFOOT, Frederick J., SFC
245th Air Traffic Control
Fort Bragg, NC 28307

McKENNA, Mary, SGT
1451 Creekside Drive, No. 3094
Walnut Creek, CA 94596

THOMPSON, Arthur L., SGT
Quarters 774, Apt. B
Fort Devens, MA 01433

WILCZEK, Brian K., E6
C Company, 4th Medical Bn
Fort Carson, CO 80913

WITMER, Robert, SSG
247th Medical Detachment
Fort Irwin, CA 92311

Civilians

BARTLETT, Drew A.
624 Tuskawilla Point Lane
Casselberry, FL 32707

BILLINGS, Thomas E.
3809-H Laramie Place
Alexandria, VA 22309

CARNEY, Shirley R.
Rt 6, Bx 196D, Lot 252
Edwardsville, IL 62025

LESHER, Walter F.
Aero-Electr, 22119½ S. Vt.
Torrance, CA 90502

Civilians

MUSORRAFITI, Francesco
28 Warren Street
Rumson, NY 07760

STREIPS, Eugene A.
800 Spring Valley Road
Altamonte Springs, FL 32701

TABOR, Robert U.
Gould, 4323 Arden Drive
El Monte, CA 91731

VOS, Philip J.
1724 Morris Avenue, NW
Cedar Rapids, IA 52405

Retired

COREY, Robert R., COL
1125 15th St, NW, No. 500
Washington, DC 20005

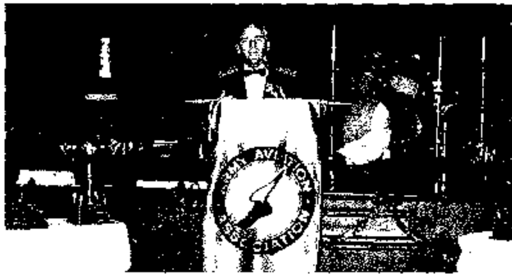
ELLIOTT, John W., COL
1815 No. Grant Parkway
Miami, OK 74354

GILE, Richard E., LTC
1315 Wildwood Avenue
Columbus, GA 31906

KING, Edward J., LTC
8507 Capricorn Way, Apt 72
San Diego, CA 92126

POST, Alton G., Ret., MG
507 N. Roosevelt, Apt C702
Falls Church, VA 22044

AAAA EUSA AWARDS



GUEST SPEAKER

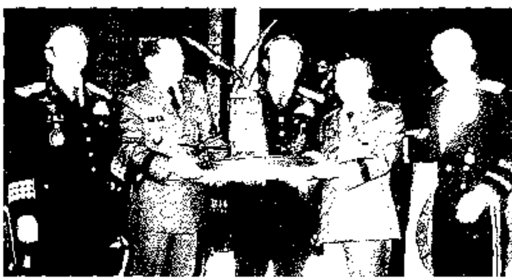
GEN John A. Wickham, Jr. addresses 300 AAAA'ers

The Cdr, USFK/EUSA is shown at the Morning Calm Chapter's Annual Christmas Formal/EUSA Awards Dinner held on 12 Dec. that was attended by over 300 Korean and American members.

HEAD TABLE

US and ROKA dignitaries attend Chapter Awards Dinner

Shown from left to right are BG Choi, 1st Avn Bde; Mrs. Song; GEN Wickham; COL Bissell, Morning Calm Chapter President; Mrs. Bissell; BG Song, Chief, ROKA Aviation; Mrs. Choi; Mrs. Teeter; and BG Charles E. Teeter, ADC, 2d ID.



ROKA AWARDS

202d Aviation Unit (ROKA) receives new AAAA award

Created by COL N.M. Bissell, Chapter President, the 1981 "ROKA Aviation Unit of the Year Award" is presented by GEN Wickham (far right) to, L-R, BG Song, Chief, ROKA Aviation; LTC Jun, Cdr, 202d; BG Choi, Cdr, 1st Avn Bde; and COL Bae, Cdr, 61st Avn Gp.

THE BEST!

"Aviator" and "Soldier of the Year" cited by AAAA Chapter

In left photo, GEN Wickham presents award plaque to SSG Donald K. Henry, 271st Avn Co (ASH), 1981 EUSA "Solider of the Year". In right photo, CW3 Ronald Deboom, left, 271st Avn Co (ASH), receives AAAA Award Plaque as COL N. Michael Bissell, Chapter President, looks on.

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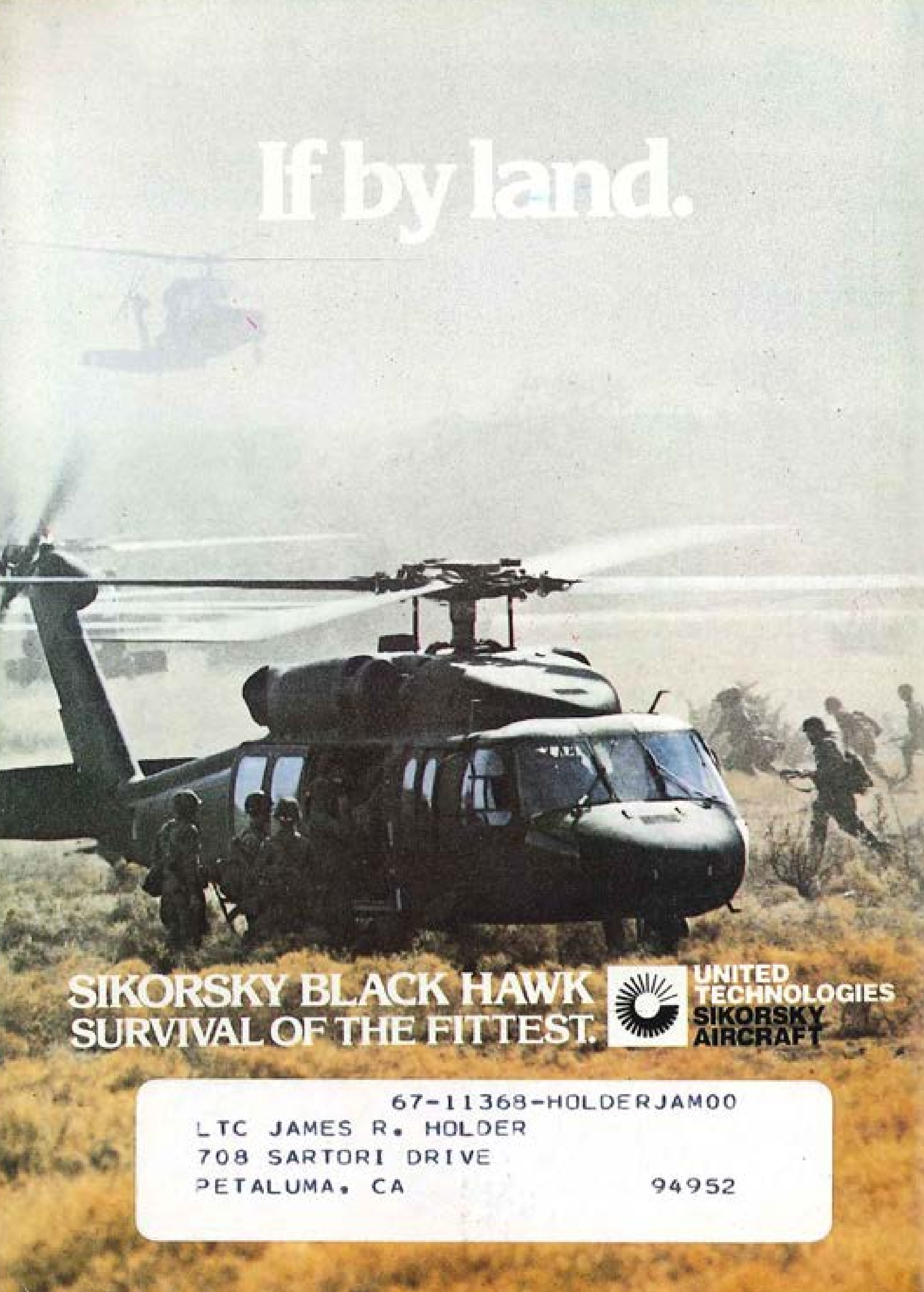

67-11368-HOLDERJAM00
LTC JAMES R. HOLDER
708 SARTORI DRIVE
PETALUMA, CA 94952