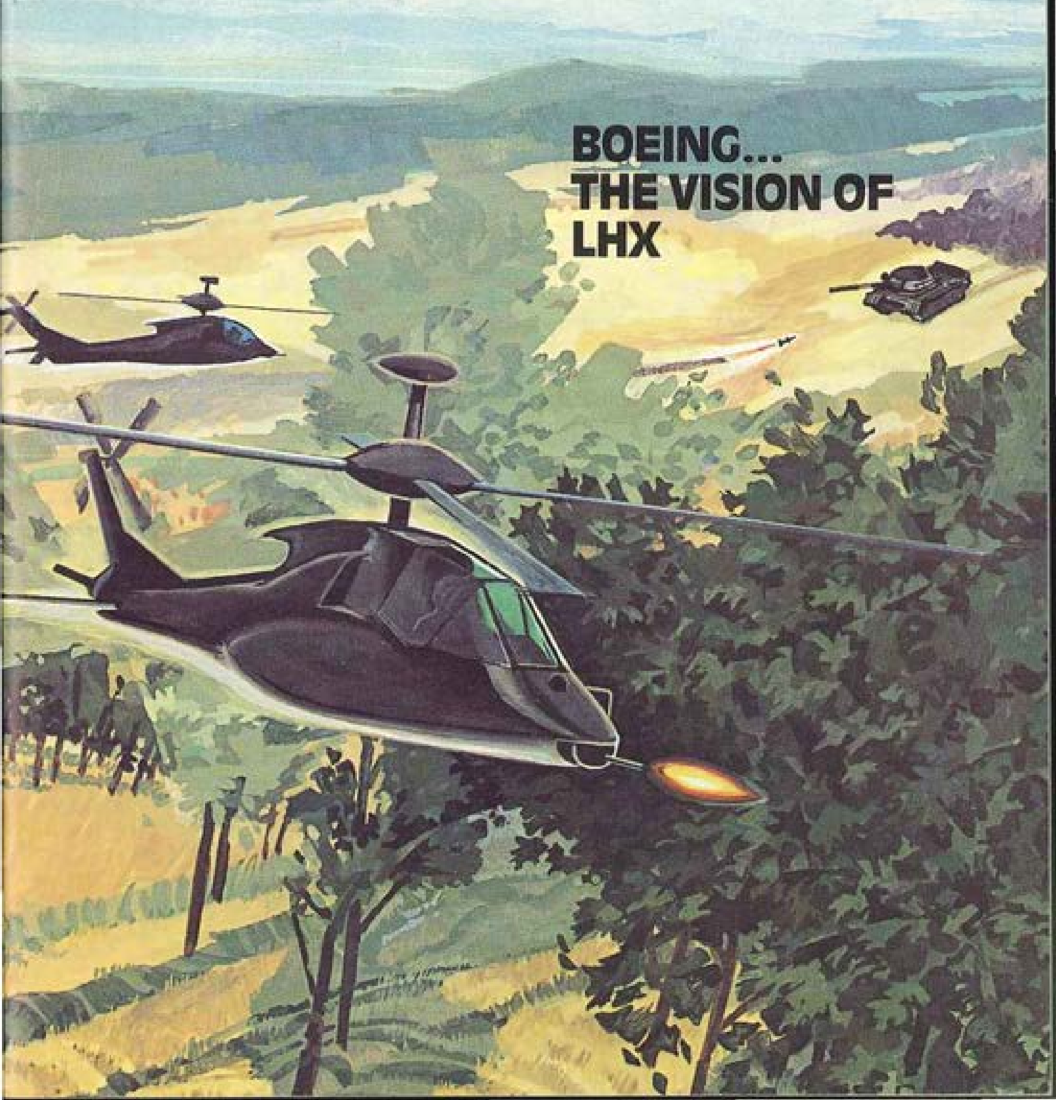
MID -'85 UPDATE: THE U.S. ARMY'S LHX PROGRAM

LIFTOUT DICTIONARY: "1985 ALPHABET SOUP"

Army Aviation

JUNE 30, 1985



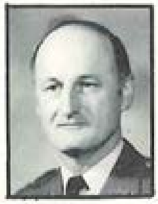
BOEING... THE VISION OF LHX


LTG Merryman


LTG Tolson


MG Parker


BG (P) Aguanno


COL Berdux


COL Gilbert


COL Townsend


LTC Peduzzi


CSM Putnam


Mr. Smith

12 to be appointed as National Members-at-Large on AAAA's Nat'l Executive Board

TWELVE National Members-at-Large will be appointed by Major General George W. Putnam, Jr., Ret., AAAA National President for the term ending April 13, 1986.

Ten of the twelve members have already been appointed — a Company Grade active Army member from the Ft. Eustis area, and an Aviation CWO from Fort Campbell, will be appointed in late June to complete the 1985-86 National Member-at-Large slate.

Accepting National Office were LTG James H. Merryman, Ret., Springfield, Va.; LTG John J. Tolson, III, Ret., Raleigh, N.C.; MG Ellis D. Parker, Hq, USAAVNC, Ft. Rucker, Ala.; BG (P) Edwin M. Aguanno, OD-DR&E, Washington, D.C.; COL Sylvester C. Berdux, Jr., Ret., Washington Office, Boeing Vertol Co., and COL Leslie H. Gilbert, Ret., Washington Office, Hughes Helicopters, Inc.; COL Harry W. W. Townsend, Ret., Silver Spring, Md.; LTC Lawrence P. Peduzzi, OCAR, Washington, D.C.; CSM Roger W. Putnam, Hqs, USAAVNC; and Gary L. Smith, Hqs, AVSCOM, St. Louis, MO.

MID-'85 UPDATE: THE U.S. ARMY'S LHX PROGRAM

"ALPHABET SOUP": LHX ACRONYM DICTIONARY

Army Aviation

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JUNE FEATURES

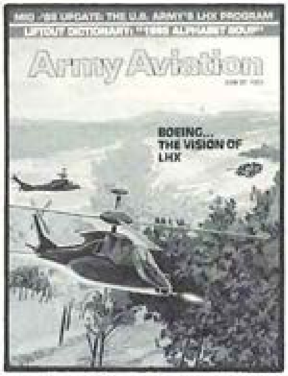
SPECIAL ISSUE: LHX — 1985

The Issue's 20 Authors:

OTHER FEATURES

MOVER AND SHAKER

The staff expresses its appreciation to Jeff Olson, Chief of the Power & Propulsion Branch, for serving as the POC and editorial coordinator for the LHX-PMO.



FRONT COVER

The June 30, 1985 front cover illustration was drawn by Boeing Vertol's senior illustrator, Marshall Osborne.

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The receipt of change of addresses is verified by the publication of the residence change in the PCS or "Takeoffs" column of the magazine.

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Second Class Postage paid at Westport, Conn.

1947

America's first light, bleed gas turbine engine powers up at a Garrett laboratory in Torrance, California.

By 1949, a derivative of that Garrett light turbine provides auxiliary power aboard the B-36 bomber. Radial piston engines continue to be the mainstay of aircraft power for several years.

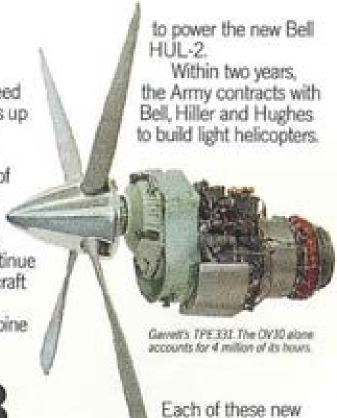
The era of the light turbine engine has begun.

1958

Allison begins development of the 250 SHP light turbine engine for the Army. Less than a year later, in April of 1959, the Allison Model 250 turboshaft runs for the first time. Its military designation is the T63.

By June, the Navy selects the Allison 250 to power the new Bell HUL-2.

Within two years, the Army contracts with Bell, Hiller and Hughes to build light helicopters.



Garrett's TPE331. The OV10 alone accounts for 4 million of its hours.

Each of these new helicopters will be powered by the Allison Model 250 engine.

1963

The Navy chooses Garrett's TPE331 turboprop as the T76 powerplant for the new OV10 Close Support Aircraft.

1965

An Allison 250-C13 powers yet another light helicopter, Bell's new Jet Ranger. Garrett's turboprop enters commercial service. Over 10,000 will be produced, accumulating more than 30 million hours.

The Army sets 22 unofficial world records in 1966. Each set by the Allison-powered OH-6A. By 1967 Garrett's TPE331 enters Navy, Air Force, and Marine service.

1970

Two growth versions of Allison's Model 250 are certified, raising its power level to 420 SHP. The C20 and C20B versions will prove to be the most popular light helicopter engines ever built. Garrett's T76 hits 840 SHP.

1972

Garrett introduces the TFE731 turbofan. It will become the most successful turbofan in aviation history. Nearly 5000 are produced, providing 8.3 million operating hours on 23 aircraft in 40 countries.

Perhaps the most popular helicopter engine ever built. Over 5,000 Allison light turbines in the Army inventory alone.

ONE LHX TEAM HAS A HISTORY

1975

A turboshaft derivative of Garrett's 331 wins certification to power the Sikorsky S55T. Enhanced OV10 mission requirements breed a TPE331 with nearly 50% higher SHP in the same frame size. The OV10 application alone will later accumulate over 4 million hours.

Allison's Model 250, with over 37 million hours. It powers 15 world records in 1985 alone.

Then in 1976, an around-the-world record. For the first time, a general aviation aircraft circumnavigates the globe in less than 60 hours.

The aircraft is powered by Garrett TFE731 turbofans.

1977

The Army awards Allison an Advanced Technology Demonstrator Engine (ATDE) program.

Allison soon will meet or exceed all Army goals. And will reduce SFCs by 25% at increased power to weight ratio.

In 1978, Allison certifies two new Model 250 growth versions at 500 and 650 SHP. Bell, Sikorsky and MBB select the 250 to power new military and commercial helicopters.

1981

A Sikorsky S76, powered by a Model 250, sets 12 helicopter altitude and speed records.

During the same year a Model 250 powers the Army to the World Helicopter Championship.

1982

Ross Perot Jr. and Jay Coburn first circle the globe in a helicopter. Dick Smith makes first solo transatlantic helicopter flight. Allison Model 250 engines power both ships.

Garrett's TFE731. Powering 23 aircraft in 40 countries.

U.S.A.F. selects Garrett F109 power for the Next Generation T-46 Trainer. During the same period, Allison further refines the ATDE. These designs will be the basis for a highly advanced turboshaft derivative.

1984

Allison's light turbine production passes 20,000 units, with 5000 in U.S. Army inventory alone. They announce a 735 SHP version of the Model 250 with improved power to weight ratio.

Garrett and Allison enter a landmark R & D program to design an LHX turboshaft for the U.S. Army. Technology from Allison's ATDE and Garrett's F109 turboshaft derivative, the TSE109, blend in the ATE109 turboshaft.

10 December 1984. An ATE109 prototype exceeds 1260 SHP within SFC requirements.

1985

Garrett delivers F109s to U.S.A.F. They are delivered on cost and ahead of schedule.

Allison flies an LHX adaptive fuel control.

On March 7th, a major milestone. A prototype LHX engine powers its UH-1B test bed aloft. It is the first LHX engine ever to fly.

After 280 million hours of combined light turbine engine experience, Garrett and Allison produce a superior LHX engine candidate.

1630 Hours. 7 March 1985.

Allison and Garrett. America's LHX propulsion team.

OF LIGHT TURBINE EXPERIENCE.

AAAA Overview

■■ MAJOR CONVENTION SITE CHANGES

At its recent quarterly business meeting, AAAA's National Board approved a proposal to hold its April 8-12, 1987 Convention in Ft. Worth, Tex., in lieu of Nashville, Tenn.; to hold its April 13-17, 1988 National Convention in St. Louis, in lieu of Ft. Worth. Tex.; and to hold its April 4-8, 1990 National Convention in Orlando, Fla., in lieu of Washington, D.C. In conjunction with this action, the AAAA National Office has reserved Convention Centers, headquarters hotels, and backup hotels in all three Convention cities on the foregoing dates.

■■ 1986 HALL OF FAME INDUCTIONS

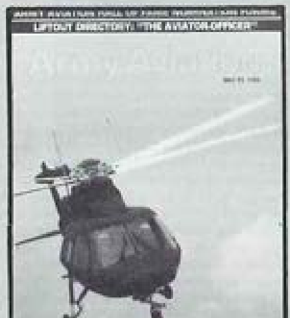
General Hamilton H. Howze, Ret., of Fort Worth, Tex., has accepted the Chairmanship of the Army Aviation Hall of Fame Board of Trustees for the 1985-1988 period, and is expected to appoint six or seven members of the Hall of Fame to serve on the Board of Trustees. The latter will select a qualified list of Hall of Fame candidates at an April 9, 1986 meeting in Atlanta, Ga., during AAAA's 1986 National Convention. By mail balloting, AAAA members with seven or more years of current, continuous membership will then elect a specific number of candidates from those appearing on the ballot. Those elected will be inducted at ceremonies to be held during "AAAA Week" at Fort Rucker, Ala., in November, 1986.

■■ FREE T-SHIRTS

AAAA Chapters are reminded that distinctive four-color AAAA T-shirts (front) are available as primary or secondary prizes for Chapter-sponsored meets, contests, and competitions in golf, tennis, softball, bowling, runs, etc. The back may carry a free four-line, 16-word distinctive Chapter "message" in black ink — Example: "I had a three-incher in the Lindbergh Chapter's 1985 Hole-in-One Contest!"

■■ NEXT MONTH — SPOOF!

The centerfold section of next month's July 31, 1985 issue of "Army Aviation Magazine" will carry some 800 professional-social listings of the retired members of the Association. The voluntary bi-annual listings are published under a "SPOOF" title — the "Society for the Preservation of Old Friends."



OOPS—Phone call from a very knowledgeable Ft. Worth retired general officer: "Art, what is the aircraft shown on the May 31 front cover? I can't make it out and it's not covered in the issue."

Embarrassed response: "We blew it. It's the Sikorsky ACAP. For the past two years, the Sikorsky people (bless 'em!) have given us a clean cover without a corporate logo and descriptive type. Their three covers each year normally are readily recognizable BLACK HAWKS. They ran an ACAP cover on our Oct. 1984 issue, and we placed a "Front Cover—Sikorsky ACAP" caption on the inside Oct. masthead page. We neglected to do this in the May, '85 masthead, and are "paying the piper" now. Our apologies to aircraft recognition buffs everywhere."

Moving towards modernization

AS we move closer to modernization of our fleet, it is appropriate that this issue of Army Aviation" be devoted to the aircraft of the future. The development of the LHX family of helicopters represents another milestone in the evolutionary process of modernizing Army Aviation.

It is apparent from the articles herein by the **Honorable James Ambrose,** Under Secretary, and **General John Wickham** that our senior leadership has placed great emphasis on modernizing the aviation force.

While the LHX represents our far term goal, we have made significant progress for the interim period. The product improvement program of the CH-47D; and the procurement of the now combat-proven UH-60A BLACK HAWK coupled to our combined arms role in the Airland Battle. These are indeed exciting times in Army Aviation.

Currently, the LHX **Cost and Operational Effectiveness Analysis (COEA)** is underway and is scheduled for completion in February, 1986. The first COEA performed must be done well as it influences up to 85% of future program costs. The system must be prepared to enter **full-scale development (FSD)** and be sufficiently defined to support formal Department of the Army approval as a requirement. The Milestone I/II decision is scheduled for April 1986 and will review the need as outlined in the **Required Operational Capability (ROC)**, COEA, and the acquisition program objectives.

Our unified goal in the LHX program is to

By MAJOR GENERAL ELLIS D. PARKER
Commanding General, U.S. Army Aviation Center

with the acquisition of the sophisticated AH-64 aerial weapons delivery system, are clear evidence of our intentions to build an aviation arm second to none. Development and procurement of an interim scout aircraft will permit us to exploit the vast capabilities of the AH-64 as well as enhancing the indirect fires of our artillery.

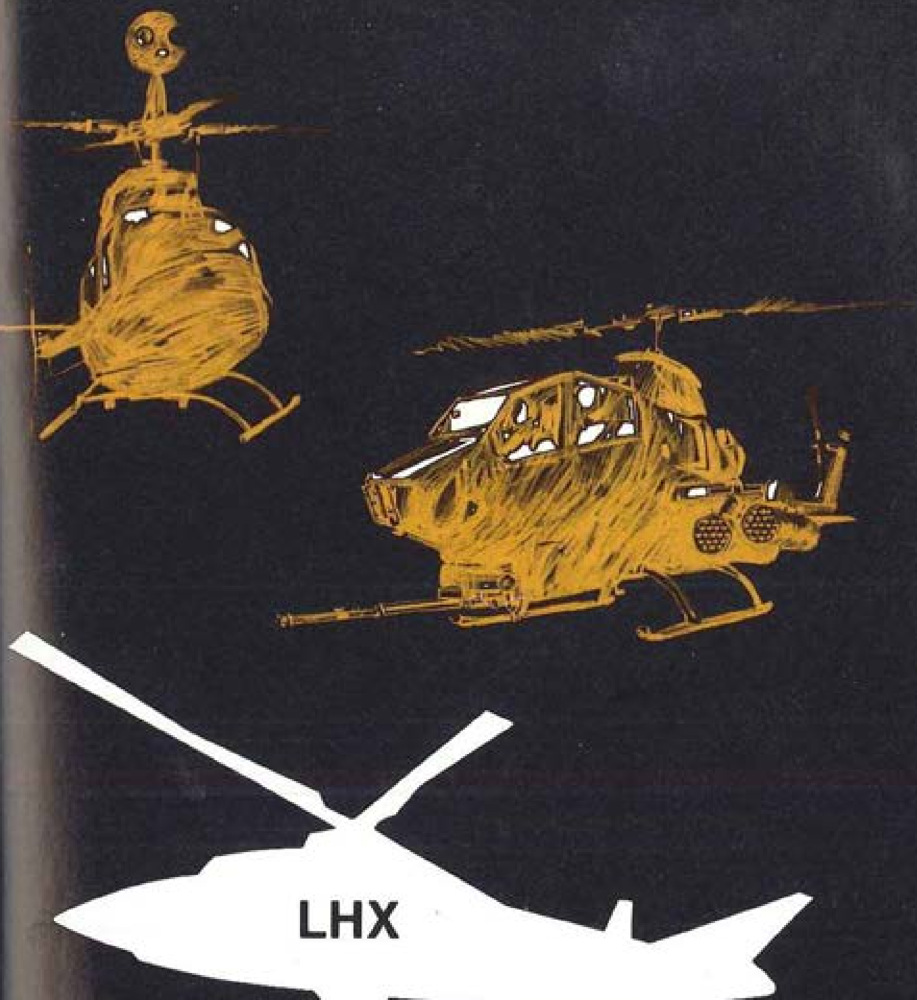
The Single Station Unit Training Plan is being refined for implementation at Fort Hood next summer. These units, equipped with AH-64's and OH-58D's will add a significant dimension

place the safest and most technically advanced aviation systems on the battlefield of the future.

UH-60 and CH-47D grounding

As safety is a major consideration in the development of the LHX, it is also a major concern with our UH-60 and CH-47D fleet of today. Both aircraft are currently grounded worldwide for analysis. I would like to provide you with an update on the status of these aviation systems.

(Modernization — Continued on Page 10)



SINGER

Modernization
(Continued from Page 7)

Preliminary investigation into the CH-47D incidents indicate a possible materiel failure in the aft transmission. High time transmission components are being examined to pinpoint the problem. AVSCOM and Boeing Vertol are working closely together to correct this deficiency. It's anticipated that we will begin to return the fleet to flyable status in mid-June.

The BLACK HAWK Special Task Force, under the direction of **BG Donald R. Williamson,** has identified a problem in the UH-60's main rotor spindle assembly. Sikorsky teams have begun modification of the UH-60 fleet worldwide. The first aircraft is forecast to be returned to flyable status approximately mid-June. The remainder of the fleet will be released for flight as the Sikorsky technicians complete the necessary modifications.

BG Williamson's task force will continue to evaluate the entire BLACK HAWK program concentrating on the major areas of maintenance, engineering, operations, training, and safety. We will continue to monitor this issue to ensure that we've fully examined all facets of this program. The ultimate goal is to employ man and machine as safely as possible. We will not compromise on the safety of our aviators.

As a departure from our equipment issues, let me update you on two recent matters of significance in the aviation personnel arena.

Specialty Proponent Committee

On 20-21 May, I attended the semi-annual **Specialty Proponent General Officer Steering Committee (SPGOSC)** convened by **LTG Robert M. Elton,** the DA Deputy Chief of Staff for Personnel. This committee provides a forum for the branch chiefs and the DA staff to discuss the personnel status of our branches.

I'm delighted to report that aviation is receiving an impressive slice of top quality soldiers into our branch. The forecast over the next several years is a bright one.

The opening address to the committee was presented by the Secretary of the Army, **John O. Marsh,** who reaffirmed the role and responsibilities of leadership in the Army. **Leadership** is the theme for the Army in 1985.

It's that ingredient which enables us to mold the personnel, capacities and equipment capabilities into a well-trained and well organized fighting force. **Leadership** is an investment in the future in terms of professional competence and safety. We must dedicate ourselves toward that end.

Total WO Study Workshop II

The second proponent workshop, the **Total Warrant Officer Study Workshop II (TWOS),** was held 7-9 May 1985. The aviation branch representatives were encouraged by the progress that's being made on behalf of all warrant officers. The development of a warrant officer management system is essential.

The majority of the aviation branch initiatives have received favorable consideration and will be briefed as TWOS proposals to the CSA on 24 June 1985.

Re-Enlistment Bonuses

In the past we've lost a significant number of quality soldiers upon completion of their first term of enlistment. In an attempt to retain these troopers who personify the backbone of Army Aviation, the VCSA has approved substantial re-enlistment incentives.

Bonuses were added to six aviation MOS's which previously had none. Increases applied to other skill areas such as the COBRA and APACHE crew chiefs are now at or near the absolute maximum allowed by law.

The message is clear. We have good soldiers today — we want them to be a part of aviation's exciting future. IIIII

Prolog 85 draws 3,700 visitors to Ft. Eustis

The Army's May 13-17 "Progress in Logistics" exposition, featuring daily demonstrations of logistics systems, concepts and operations, developmental equipment, and commercial items for potential military use, drew high praise from DOD officials. Air cushion vehicles and the Sikorsky ACAP were among the featured watercraft, rail equipment, and aviation items on display.

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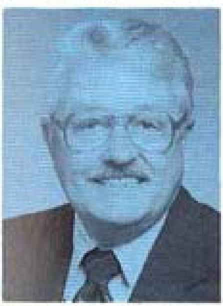
LHX — 1985

Sixteen key Army officials and four industry program managers with extensive LHX involvement view the aircraft that'll meet the challenges of the '90's






LHX: A Compelling Need

By GENERAL JOHN A. WICKHAM, JR.
Chief of Staff, U.S. Army

OUR Army is ready today and preparing for tomorrow. We are in a modernization program that is unprecedented in the Army's history, a program which capitalizes on advanced technology and innovation. One of the major challenges that we face in the future is the replacement of our light helicopter fleet, the UH-1, AH-1, OH-58, and OH-6. These combat proven aircraft are products of the 1960's and represent the technology of that era. While they continue to fulfill current missions, future missions of Army Aviation require far more capable aircraft, reduced maintenance, and a less diverse helicopter fleet.

Meeting the challenge

The Army has chosen the Light Helicopter Family — the LHX — as the means to meet the challenges of the 1990's and beyond. It will meet the requirements of our Airland Battle and Army 21 doctrine. The follow-on articles in this issue of "**Army Aviation Magazine**" describe the uniqueness and importance of the LHX. This development and acquisition program will be the most significant ever undertaken by the Army.

The LHX is not just a new aircraft. Rather, the LHX is a new concept consisting of two variant conventional helicopters, a scout attack aircraft (the LHX-SCAT) and a light utility aircraft (the LHX-U). The attack version can perform light attack missions and complement the APACHE, our heavy attack helicopter. The LHX helicopters will share common engine, transmission, rotor, and electronic components; a two-level maintenance concept that eases the workload in the field and the depot; and a training program that streamlines and enhances the training process for pilots and support personnel. Technology and cost permitting, both models will use a fully integrated/automated cockpit arrangement that permits single pilot operation.

A flexible weapon system

The essence of LHX, then, is flexibility, a multi-mission conventional rotorcraft that will perform a wide array of tasks. The aircraft will take advantage of the most modern aviation technology, and will demand the integration of man and machine at a level higher than any previous weapon system. Meeting the developmental goals for the program in terms of gross weight; reliability, availability and maintainability; and operating and support costs, will tax the innovation and efficiency of our civilian industry. We believe these ambitious goals are achievable. Industry and the Army — working together — should be capable of successfully executing this program.

The LHX will accomplish the Army Aviation mission as part of the combined arms team and will counter the threat well into the 21st Century.

I encourage you to read this issue of **Army Aviation** thoroughly. It will help you recognize the many ways in which the LHX program is being utilized by the Army as a pioneering effort to change the way in which the Army functions. It is intended to demonstrate that new approaches to systemic, complex, and deep-seated problems in the acquisition and fielding of new equipment can be found and successfully carried out.

I would like to use this brief introduction to point out some of these new steps.

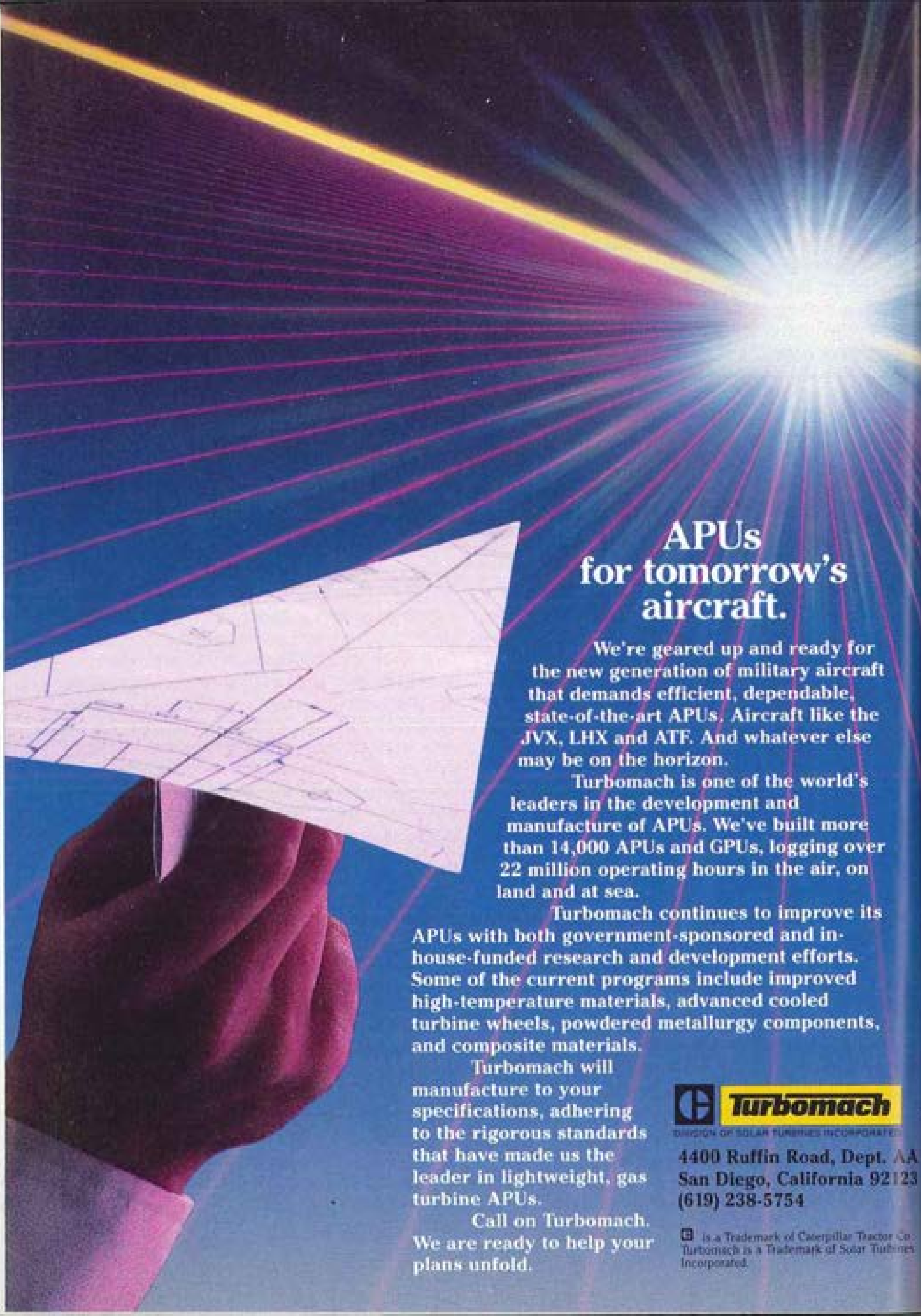
New approaches to problems in acquisition and fielding

By the HONORABLE JAMES R. AMBROSE
Under Secretary of the Army

- We have raised the consideration of economic benefit, including especially life cycle costs, to a high level. We have done this by emphasizing reduced maintenance cost and commonality. Commonality is to be achieved by concurrent development and production of versions which will replace the entire fleet of smaller helicopters. As a corollary to this, we expect to minimize future expenditures for major product improvements of the current aging fleet of OH-58, UH-1, and AH-1 aircraft.
- We have established a philosophy of designing in ample margin in both aircraft and engine performance, weight, etc., to provide both for potential initial weight growth and for new future mission packages, including weapons. This should be a clear example of **P³I (preplanned product improvement).** It should also allow us to avoid the costly weight reduction and re-engining actions which have plagued past aircraft programs.
- We have staked out specific goals for maintenance cost reduction and aircraft weight and cost. These have provided challenging definitive measures against which to judge the merit of an LHX project.
- We have established the challenge of attaining single pilot operation to foster the adoption of full cockpit automation and to achieve a greater ratio of pilots to aircraft.
- The engine has been put into development ahead of the aircraft development. Twin engine operation has been specified. These actions should avoid the historical problems of concurrent engine/aircraft development and subsequent design changes by the other Services to incorporate twin engines.
- Very substantial changes have been effected in the evolution of the requirements documentation, system specifications, and acquisition methodology.
- The overall approach has been one of focusing technological and simulation effort on demonstrating the credibility and feasibility of achieving these objectives **before** committing to full scale development.

The articles in this issue describe in detail these new approaches. They are rewarding reading not only as descriptions of the many facets of the LHX program, but also as indicators of the application of these approaches more generally to Army development and procurement.

We encourage comments and critiques of the changes that we are trying to carry out. We feel very strongly that change is needed to improve the quality, speed, and cost effectiveness of the Army acquisition process. IIIII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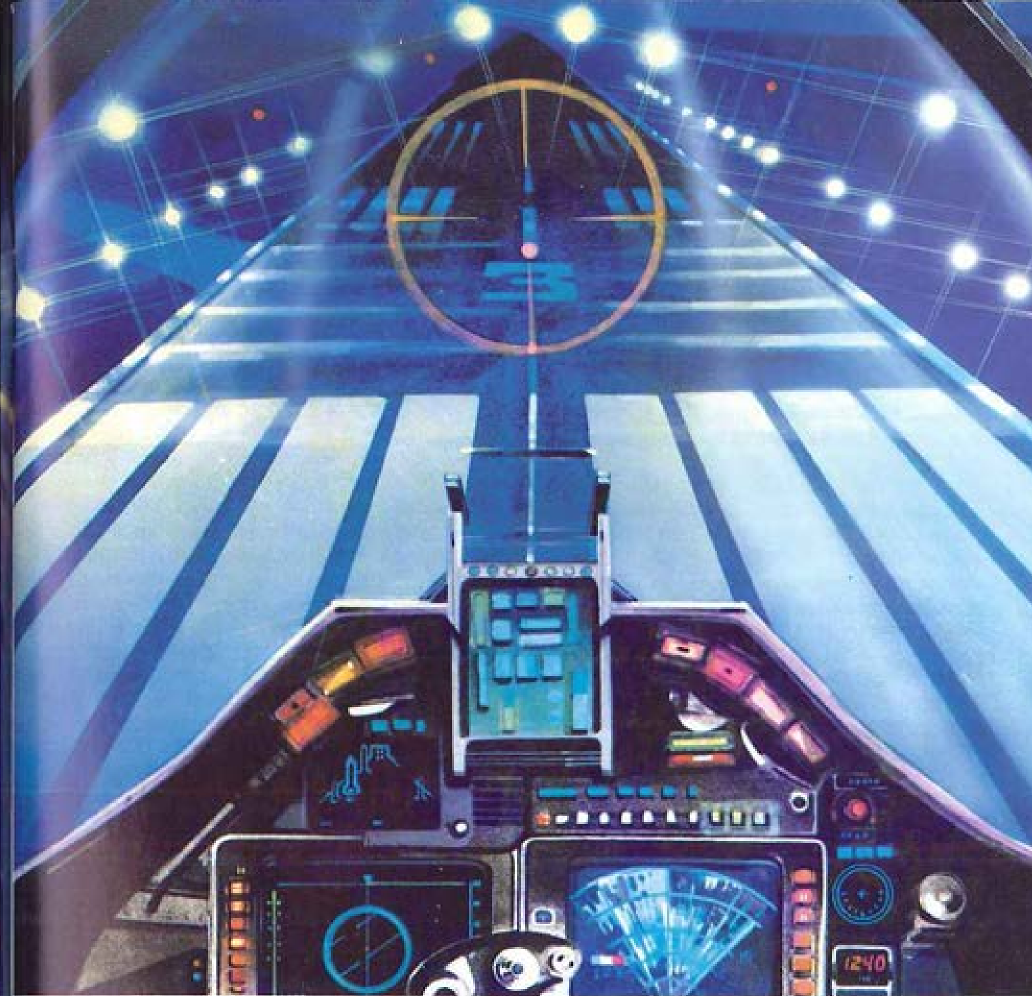


Which company explores new technologies for weapon system support?

The Integrated Diagnostic Support System termed "IDSS" represents a major technological achievement for the next generation of test systems. This new concept incorporates methods of collecting knowledge about the weapon system and processes it in a way that resembles human reasoning. Once established, the IDSS knowledge base is used to detect and diagnose weapon systems failures.

Harris is consistently exploring new and innovative ways of improving test technology, and the IDSS is just one example. Harris Corporation, Government Support Systems Division, 6801 Jericho Turnpike, Syosset, Long Island, NY 11791. 516-364-0400.

HARRIS

For your information, our name is Harris.

I welcome the opportunity to tell the readers of "**Army Aviation**" what the **Army Materiel** Command (AMC) is doing to provide the Army a new Light Helicopter, commonly called LHX. Moreover, I want to discuss the innovative acquisition plan which we have undertaken. This program represents a new approach in the way the Army does business.

The mission given to AMC is to replace an obsoleting fleet of aircraft — the AH-1, UH-1, OH-58, and OH-6 — with an aircraft which is considerably cheaper to operate, far more reliable, and, most importantly, more capable to fight and win on the battlefield of the 1990's and beyond.

LHX: Innovative Approaches in Management and Procurement

By GENERAL RICHARD H. THOMPSON, Commanding General, U.S. Army Materiel Command

The LHX program represents the largest acquisition of any type equipment in the history of the Army; therefore, we can well expect a lot of people, in and out of the defense department, looking to insure we do things right.

I welcome reasonable oversight because it keeps us on our toes.

For us to effectively fight and win, we need, not only highly lethal weapons, but highly reliable and maintainable weapons. American technology is capable of marrying lethality and reliability, especially when we plan up front for these highly sought after -ilities.

Too often people equate technology necessary to marry lethality and reliability with a complex piece of equipment, and that need not be the case. A television is a highly sophisticated item, yet it is reliable and has been engineered for anyone to use with ease. When we plan up front for how the operator must use the weapon in battle, as well as repair it, we can engineer the equipment for ease in both.

The LHX Scout/Attack is a single pilot aircraft; therefore, the LHX program is planned to use various computer technologies which will greatly reduce the pilot workload. For example, in existing aircraft the pilot is greatly task-loaded when he is required to tactically deploy the aircraft and then encounters in-flight emergencies. To aid the pilot, the LHX aircraft would automate most emergencies and provide the aviator a decision of either returning to base or land.

To apply such advanced technologies and reduce program risk, AMC has undertaken a series of innovative approaches which we believe will greatly enhance our abilities to meet the challenge; that is, provide the Army a lethal, small, lightweight, affordable fleet of LHX scout/attack and utility aircraft, and do that within an average flyaway cost of $6 million for the scout/attack version, and $4 million for the utility aircraft.

We will require a firm fixed price contract, while giving the contractor the flexibility in the full scale development phase to control the configuration of that piece of equipment. The Army is telling industry that we are more interested in the performance of that piece of equipment than we are with the countless changes that occur through the development cycle.

We are requiring the contractor to guarantee both the design to cost, and the operations and support cost, so that we can control in the future what it is going to cost the Army to operate the LHX aircraft.

To ensure that the Army gets the best buy, we have required competition in both the full scale development, and also competition for the system in production. The above is not just planned, it actually is in effect in the LHX engine program.

AMC is requiring that the systems specifications govern what we want. The contractor initially has the configuration management and, likewise, AMC is going to minimize our involvement on how they do business.

I am not saying that we will not have preliminary design reviews, in-process reviews, or critical design reviews. The Army is required, and should in all cases, insure that the taxpayer's dollars are being wisely spent. However, that does not mean that the Army will enter into a contractor's facility and start making numerous changes — the result of which increases the cost of the program, and may not in the end, improve the item that the Government is buying.

Reducing costs

This leads us into the area of management. The Army will use the contractor's work breakdown system. In the past, the Government has imposed their own work breakdown system, thereby requiring the contractor to develop an internal business structure, then change that around to meet what the Government requires, or what the Government needs for review.

Since we are holding the contractor responsible for how the end item must be, continuous review of the work breakdown system is unnecessary. This reduces the contractor's cost and subsequently again reduces the cost to the Government.

Furthermore, we are identifying up front the essential data that we want to review. This also reduces the contractor's cost and subsequently reduces the cost to the Government. Since the contractor is initially in charge of configuration management, the contractor has the latitude and the flexibility to make the changes where he deems necessary. This, however, does not relieve the contractor of the responsibility of insuring that that piece of equipment meets our performance requirements. That is the Army's responsibility.

When the contractor gets to the point of developmental/operational testing, the Army will then begin full configuration management of that item.

Another interesting part in the solicitation is the Executive Summary. Although this was not done in the past, we are doing this on all our future RFP's. By merely reading three, four, or five pages you can get the principal requirements of what the Army wants to buy.

Now let me talk about an area which is crucial to the LHX program. That is, **reliability, availability and maintainability (RAM)**, and **Integrated Logistics Support (ILS)**.

In past solicitations, RAM/ILS has been a portion of the technical evaluation. The life cycle cost and the logistics support of that system was married with technical requirements, and too often in the past, an item was selected because it was technically superior, yet lacking the reliability and maintainability necessary to fight and win the battle. I believe that the RAM/ILS must be weighed equally with the technical portions of the equipment.

We can develop equipment that is technically superior, as well as reliable and maintainable on the battlefield. Evaluating RAM/ILS equally with technical considerations greatly enhances RAM/ILS importance.

In the LHX program, the contractor is to meet stated goals in our full scale development. One immediate effect is that we'll have a good initial product and fewer engineering change proposals. Within RAM/ILS we're paying close attention to the MANPRINT (Manpower, Personnel and Human Factors Engineering) coordinated effort, thereby enhancing the force structure integration as well as considering how a person will use that equipment and maintain it.

Continuous reviews

In the past we have had only periodic reviews of **Logistics Support Analysis Report (LSAR)**. We will now have continuous reviews which we believe will improve provisioning and supportability of this weapons system.

A key to effectively field a system is being able to train the operators and maintainers of that system. To that end, we are going to develop all our training devices through the prime contractor. This is not to deemphasize training equipment. To the contrary, it places clearly the emphasis up front that the Army is serious about training and training equipment, and that we will hold the prime contractor as equally responsible for the training equipment

(AMC — Continued on Page 85)

Because we're always planning for the future, the Bell OH-58D takes aim with advanced technology.

The OH-58D – it's a fully integrated aerial scout. For target acquisition. Target designation. And target handoff. In adverse weather. Day or night.

Its mission: accurate control of all forms of firepower – with advanced systems that help the commander "see" the battlefield and synchronize the combined arms effort.

Atop the new all-composite rotor, a mast-mounted sight (TV, laser range finder designator, thermal imaging) enhances mission versatility in a number of ways.

It can operate with AH-1S and AH-64 attack helicopters, acquiring targets at extended range from a masked position so they can employ their weapons at maximum standoff distance.

For field artillery, the OH-58D can designate targets for laser-seeking Copperhead rounds, as well as direct conventional artillery firing for effect *several times* faster than standard means.

Additionally, the OH-58D can integrate Air Force fire support by designating targets for smart bombs.

Bell Helicopter TEXTRON

The future is ours by design.

Opportunity for Greater Teamwork

IN May of 1931, Army Chief of Staff, **General Douglas MacArthur,** participated in naionwide maneuvers of the Army Air Corps. Prior to joining the forces in the field, **General MacArthur** delivered a brief radio address designed to stir public interest in the Army's air activities and to show how the history of war had been affected by technology.

He concluded by noting that "A sure indication of health and virility in military thought is to refuse to be bound down by the limitations of equipment at present in use. We must hold our minds alert and receptive . . to the application of unglimpsed methods and weapons that the engineer, the chemist, and the physicist may provide. The next war will be won in the future, not in the past. We must go on, or we will go under."

The experience of five and a half decades and the accompanying pace of technological change have made it clear that **General MacArthur** was right. Yet it would be foolish today to think that going on is a task for journeyman labor, or a job that the Army can perform alone. On the contrary, it calls for the highest military, technical, and managerial competence. It calls for extraordinary teamwork within the Army and between the Army and industry.

Teamwork is vital to the **Light Helicopter Family (LHX)** program. As the replacement for the aging fleet of Vietnam vintage helicopters, the LHX program must provide the Army a light-weight, survivable, and efficient aircraft to move Army Aviation into the 21st century. The task is not an easy one. In an era of increasing fiscal constraints, the Army must necessarily do more with the new equipment we are fielding.

We must, for example, evaluate fully the potential of operating LHX with a single pilot. We need this capability so that we can operate and employ the LHX around the clock. This is our best option to fully capitalize on the LHX's day, night, adverse weather, and improved **reliability, availability, maintainability (RAM)** charactertistics.

We must likewise reduce the number of soldiers required to support the LHX. The Army is actively exploring the possibility of establishing a two-level maintenance system to reduce the operations and support cost of the LHX fleet. Above all, we must be ever mindful of our most treasured resource—the dedicated young men and women who will train, fly, and fight with the LHX.

To achieve these and other goals, innovative teamwork among TRADOC, AMC, and industry must be present throughout LHX concept formulation, development, and fielding. We have already initiated several actions that foster much

By GENERAL WILLIAM R. RICHARDSON
Commanding General, USA Training & Doctrine Command

closer coordination between the requirements community in TRADOC and the technical community at AMC and in industry. TRADOC supports fully the efforts to streamline the requirements and acquisition process.

In today's environment of high technology weapon systems and severe fiscal constraints, industry is to some extent our most critical team member since they must actually execute the LHX development and "bend the metal." But only as a team can we deliver a total LHX weapon system ready for battle. Industry has thus far made major contributions to the LHX requirements process and is actively contributing ideas on all major LHX issues.

Positive and enthusiastic cooperation and teamwork are very critical to both the big and little issues and tradeoffs on LHX. We must make those tradeoff decisions carefully and with a total perspective of the LHX's contribution to the Army mission.

The Primary Specifications

Through strong active dialogue and decisive leadership, we have already made progress in several major LHX issues.

- We have settled on a cruise airspeed for LHX of 170 knots.
- We have agreed that the LHX will be a twin engine aircraft. AMC has issued a very innovative and simplified engine **request for proposal (RFP)** and the engine source selection is ongoing.
- We also have decided that the LHX will have primary mission gross weight in a 4,000'/95º Middle East environment of 8,000 lbs ± 500 lbs.

Many similar tradeoffs are required for other subsystems of the LHX. Precise definition of the mission equipment package will certainly require a similar cooperative effort between the Army and industry. We must ensure that LHX is productive, survivable, and easy to operate and support.

LHX must also be affordable so that we can field the aviation force structure with modern equipment capable of meeting the threat in a wide array of battlefield environments. LHX equipped units must be able to defeat the threat as a key element of the combined arms team.

The Key to Success

In summary, the key to the success of the LHX program is teamwork. I encourage everyone associated with the LHX program to heed the theme of the March 1985 AAAA Convention in St. Louis: "Teamwork: Key to Success." I challenge all to seize this opportunity and join in and support this very exciting LHX team. As **General MacArthur** said, "We must go on or we will go under." Today, we must go on together. IIIII

PROCLAMATION—Governor John Ashcroft, 2nd from left, proclaims March 25-30, 1985 "Army Aviation Week" in Missouri during ceremonies held in the State Capitol in Jefferson City on March 27. The proclamation cited the AAAA's St. Louis convention involving 3,000+ military and civilian members. Looking on, left to right, are Missouri residents Paul Hendrickson, the AAAA's National Treasurer; COL Robert A. Wagg, Jr., AVSCOM Chief of Staff; and Ms. Georgia M. Crenshaw, Vice President for Membership of the Lindbergh (St. Louis) Chapter of the Army Aviation Association.

LHX Overview

THERE comes a time in the life of a weapon system when modification can no longer provide the means to upgrade that system to meet the needs of the Army. The technology used to create the weapon system becomes obsolete and nothing short of redesigning the system can effectively overcome the shortcomings of that system. Such is the emerging state of the Army's light fleet of helicopters.

In a decade, these Vietnam-vintage aircraft will have an average age of over 20 years. The technology that is available and maturing today cannot be incorporated into today's light fleet without complete redesign.

Faced with this reality the Army is pursuing a fleet modernization program which will replace over 7,000 UH-1, AH-1, OH-58, and OH-6 aircraft with a 5,000 aircraft fleet known as the warfare), and an ever increasing threat level.

The LHX program is presently in the concept exploration phase of the acquisition life cycle. The purpose of the concept exploration phase is to verify the feasibility and benefits of the LHX. The Army materiel and combat developers are currently conducting preliminary design; technology assessments trade-off analysis; **Reliability, Availability, Maintainability/Integrated Logistics Supportability (RAM/ILS)**; and Life Cycle Cost Analyses.

These are scheduled for completion this year by Bell Helicopter, Boeing Vertol, Hughes Helicopters, and Sikorsky Aircraft. All efforts of the concept exploration phase are planned to merge in mid-1986 with the issue of the LHX **Request for Proposal (RFP)** to industry **(See Figure 2).**

By BRIGADIER GENERAL RONALD K. ANDRESON
Project Manager, LHX, U.S. Army Aviation Systems Command

Light Helicopter Family (LHX). It is the Army's plan to competitively develop and produce the LHX as a lightweight, affordable, and capable system which incorporates the technology of the '80s.

The LHX will be suitable for the Airland Battle and Army 21 missions and will be able to survive in the future battlefield which is characterized by sophisticated combat systems, far flung command and control, mobility, integrated battle (nuclear, chemical, biological, and electronic

The LHX will be a conventional rotorcraft with two variants, **scout/attack (SCAT)** and light utility, which utilize demonstrated technology to achieve a small, lightweight design. The LHX will be substantially more supportable, survivable, and significantly less manpower intensive than the existing light helicopter fleet.

The critical program goals are:

- Single Pilot SCAT.
- 8,000 (± 500 lbs.) primary mission gross weight for the SCAT.

- Not more than $6 million for the SCAT and $4 million for the Utility aircraft (in constant 1984 dollars).
- 70% commonality between the SCAT and Utility versions.
- 40% reduction in operating and support costs compared to the current light fleet

These program goals must be substantiated before the Army will seek to obtain Department of Defense and Congressional approval to start full scale development of the LHX air vehicle system in FY 87.

The focus of the ongoing advanced development activity centers on the **Advanced Rotorcraft Technology Integration (ARTI)** effort. In December 1983 contracts were awarded to Bell Helicopter Textron, Boeing Vertol, Hughes Helicopters, IBM, and Sikorsky Aircraft. The principal objectives of the ARTI program are to demonstrate the technical feasibility of the single pilot SCAT aircraft and reduce the risk of full scale development through design of the integrated/automated cockpit.

"The goal of ARTI is to prove that the co-pilot can be eliminated . . "

The goal of ARTI is to prove that the co-pilot can be eliminated by incorporating such technologies as an integrated cockpit, automated navigation, digital map, automatic targeting, interactive voice controls, sensor fusion, wide field of view displays and a workload-relieving automated flight control system.

In the near future, modifications to the ARTI contracts will be issued to incorporate two additional tasks: preliminary design of the **Very High Speed Integrated Circuits (VHSIC)** based LHX computer system, **The Electro-Optical Target Acquisition Designation System, (EOTADS),** and the **Night Vision Pilotage System (NVPS).**

"EOTADS offers a potential improvement of 90% better accuracy . . "

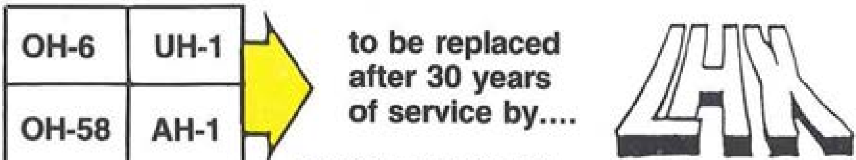
VHSIC is the foundation of the processor package necessary to achieve a single pilot SCAT. With VHSIC-based processors, data inputs from the navigation system, communication system EOTADS, and other aircraft subsystems can be processed and relevant information will be presented in near real time to the pilot via a helmet mounted display.

In addition to high computational speed, VHSIC technology offers a substantial (5 to 1) processor weight reduction and higher reliability. Under the ARTI program, a VHSIC-based LHX system processor and associated oper-

FIGURE 1

LHX CONCEPT

A Modern Replacement for the Current Light Helicopter Force

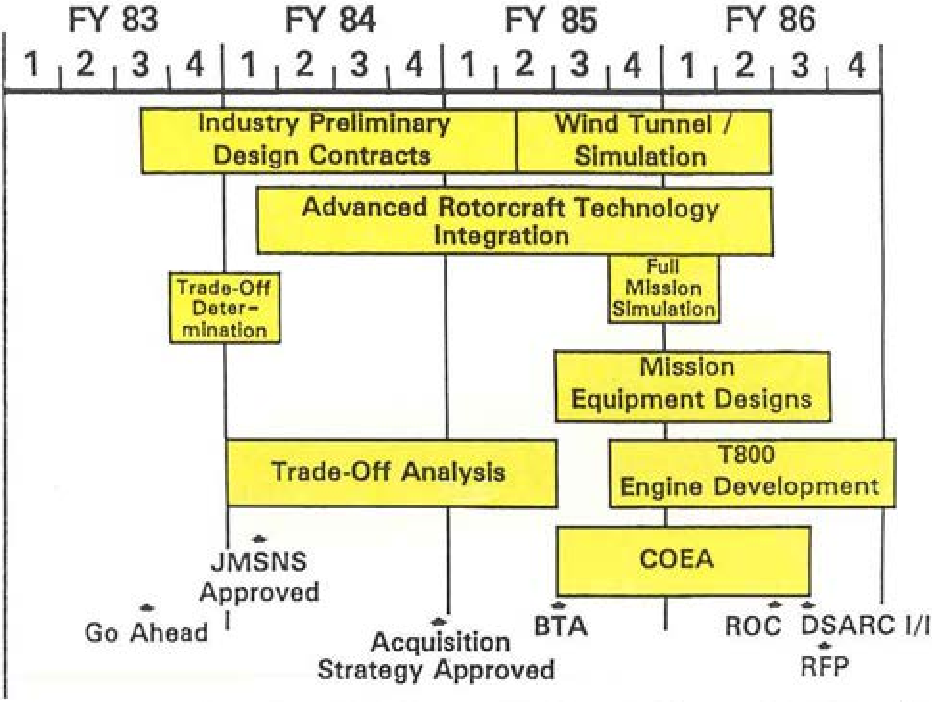


RESULTING IN

Improved Fightability	Higher Readiness
Lower Support Costs	Fewer Personnel
Standardization/Commonality	Improved Safety

FIGURE 2

LHX CONCEPT EXPLORATION



ating system and system executive software is being designed for the LHX mission equipment package.

EOTADS is an evolutionary system derived from the APACHE TADS and the AHIP mast mounted sight. EOTADS combines a second generation **Forward Looking Infrared (FLIR),** a low light level TV, and a laser rangefinder/designator into a semi-automatic system with automatic target detection and recognition and improved performance in speed, accuracy, and range.

When compared to the above-mentioned systems, EOTADS offers the following potential improvements:

- 10%-30% longer day/night manual detection ranges.
- 10%-14% longer laser designation ranges.
- 50% faster navigation and laser tracking cueing.
- 90% better gun accuracy.
- 70% better target handoff accuracy.
- TV/FLIR signals formatted for automatic target data processing.

In addition to the above ARTI efforts, a cooperative effort exists between the **Army Aviation Systems Command (AVSCOM)** and the **Air Force Aerospace Medical Research Laboratory (AFAMRL)** to demonstrate the virtual cockpit display technology for transition to LHX **full scale development (FSD).** The core of the effort is a **Helmet Mounted Display (HMD).**

The HMD features a heads up, spatially relevant presentation of flight and mission information. The display is transparent to permit "see through" of the outside scene for day/night operations. The helmet incorporates a head tracker and an integral sight, and affords chemical and biological defense as well as laser protection. This effort will yield criteria for the LHX FSD RFP and will improve the Army's position as a "smart buyer."

"Three contracting teams have made proposals . . to develop the T800 engine for the LHX."

The T800 engine FSD RFP was released to industry in December 1984. The T800 engine is a 1,200 horsepower class turboshaft engine of metric design which will be incorporated into the LHX in a twin configuration. Responses to the RFP were received in March 1985.

A **Source Selection and Evaluation Board (SSEB)** is currently evaluating industry's proposals and will make recommendations for selecting the contractor teams to develop the T800 engine. Three contracting teams have made proposals: Allison-Garrett, Lycoming-Pratt & Whitney, and General Electric-Williams International. Contracts for two of these teams are scheduled for award in July 1985.

"Wind tunnel simulation is to verify the best technical approach for the SCAT and Utility versions."

Contracts being negotiated with Bell Helicopter-Textron, Boeing Vertol, Hughes Helicopters and Sikorsky aircraft for wind tunnel tests and engineering simulation of air vehicle handling qualities. The objective of the wind tunnel simulation is to verify each contractor's **best technical approach (BTA)** for the SCAT and utility versions of the LHX.

The data generated from these contracts will be a significant addition to the technical basis for the selection of the FSD aircraft configurations.

In March 1985 a Letter of Agreement, which describes the essential LHX characteristics, was signed by the U.S. Army **Training and Doctrine Command (TRADOC)** and the **Army Materiel Command (AMC).** Some of these characteristics shown in **Figure 3.**

FIGURE 3

LHX/LOA REQUIREMENTS

- Highly agile, maneuverable, single pilot, conventional rotorcraft.
- Four HELLFIRE, two STINGER, and gun system.
- Self-deployable 1,260 nautical miles.
- High altitude/hot day (4,000 ft.,95°) performance:
  - —SCAT has 500 fpm rate of climb, cruises at 170 knots.
  - —Utility will hover out of ground effect, cruises at 160 knots.
- Transportable in C-5, C-17, and C-141.
- Crashworthy design, wheeled landing gear, NBC protection.
- Twin T800 engines (1,200 hp each).
- Six troop seats in Utility, space for eight.
- Integrated target acquisition system.
- Wide field-of-view optics.

Summary

The need for LHX is compelling. Survivability and effective battlefield operational capability of today's light fleet of helicopters are steadily diminishing — in significant part driven by increasing Soviet counterpart capabilities. Manpower requirements resulting from the diverse mixture of aircraft in the current fleet represents a major burden to the constrained military personnel ceiling of the Army.

The LHX solution, to develop and produce a closely related family of scout/attack and utility helicopters which have a high degree of commonality and can be effectively operated by a single crewmember, will save billions of dollars over a 20-year life cycle while conserving scarce manpower resources.

Over the next year, concept exploration will conclude. The close working relationship established among the materiel developer, the combat developer, and industry should assure that all aspects of the program stay on track.

We plan to do it right the first time — develop and field a total weapons system with organizational, doctrinal, leadership, technical, and training components considered up front and integrated in an effective, systematic manner. IIIII

IN order to enhance its combat power through mobility, the Army generated a helicopter force, second to none, to fight the highly fluid insurgency conflict in Vietnam. The success of the helicopter in that war is history. But the Army's present 1950's technology light helicopter systems are becoming technologically obsolete, operationally ineffective, and costly to maintain.

As modifications needed to retain necessary capabilities are applied, the present light fleet is becoming increasingly complex to manage. The Army is committed to a course of action to improve, simplify, and make more affordable its light helicopter systems. Focusing on the essential combat tasks, the replacement system will be required to accomplish their combat, combat support, and combat service support missions in the close-in, deep, and rear battle environments of the early 21st century.

The LHX requirements: Developed by the user

By MAJOR GENERAL ELLIS D. PARKER
Commanding General, US Army Aviation Center & Ft. Rucker

Specific deficiencies, recognized by the Army, were examined in detail during the 1982 **Army Aviation Mission Area Analysis (AAMAA).** The result was identification of 77 major doctrine, training, organization, and materiel deficiencies in which Army Aviation's capability to fight the battles of the future was inhibited.

One of the most significant results of the AAMAA was the verification of the need to begin a program to replace our aging and obsolescing fleet with more capable and efficient aircraft for the 1990's and beyond.

The AAMAA conclusion was to replace the light fleet of proliferating models with a single family of rotorcraft. Army Aviation's response to solve these deficiencies was to initiate concept formulation and requirements definition of a new family of light helicopters through submission of the LHX Justification for Major Systems New Start in the summer of 1983.

The user's role in developing the requirements during concept formulation is threefold:

- First, determine mission requirements based on threat, operational environment, mission needs, and identified deficiencies.
- Second, using the trade-off determinations identified by the materiel developer, the USA Aviation Systems Command, conduct a trade-off analysis to determine aircraft systems design parameters which yield the most benefit to the user, and
- Third, conduct a **cost and operational effectiveness analysis (COEA)** which will evaluate the best technical approach identified by the materiel developer.

Requirements being generated for the LHX are based on Airland Battle Doctrine and the concepts of employment embodied in Army 21. The end product will be the **Required Operational Capability (ROC)** document which is scheduled to be approved in time to support a Milestone I/II decision, scheduled for 3rd quarter 1986, to enter into **full scale development (FSD)** of prototype aircraft.

The task of tailoring Army Aviation assets to maximize the synergistic effect of combined arms and joint operations in land combat has become increasingly crucial and complex. In looking at our current and future worldwide requirements, our current light fleet has significant operational and survivability problems in many parts of the world.

For example, in the Middle East high altitude/high temperature environment, the current light fleet is not mission capable. Under these conditions, while hovering out of ground effect, the AH-1, with its crew of two, and one hour of fuel, can carry only two TOW missles; the UH-1 with a crew of three and fuel can carry a single passenger; and the OH-58 with a pilot and fuel cannot carry a useful load.

"Our current fleet has significant operational and survivability problems in many parts of the world"

Other performance limitations also carry over into survivability.

- Nap-of-the-earth flying is severely restricted; thereby, opening the vulnerability window to ground fire.
- Our current light fleet of OH-6, OH-58, AH-1, and UH-1 were not designed with emphasis on aircraft signature reduction (radar cross section, infra-red, acoustic and visual), nor ballistic tolerance and protection. The survivability capabilities of the light fleet were in the form of add-ons and modifications.
- The crashworthiness of these vehicles is not up to today's standards.
- The ability of today's fleet to survive in a **nuclear, biological and chemical (NBC)** wartime environment is also severely limited.

The LHX requirements will address all these deficiencies, and the capability to survive and perform in the battlefield of the future will be an integral part of the LHX design.

The current light fleet is neither self-deployable, nor easily air transportable. This characteristic is important for all Army aircraft, but particularly the LHX, **scout/attack (SCAT)** aircraft will be placed in units having a requirement to rapidly deploy. The LHX again solves this deficiency with a capability for year round deployment to Europe.

Limited adverse weather capabilities, restricting both navigation and target acquisition, exist in our light attack, scout, and utility aircraft.

Navigation systems presently in use include map and compass, and CONUS navigation sensors (which will be phased out by the year 2000).

Although deficiencies in target acquisition systems have been identified for the current light attack fleet, modifications have not been made due to cost and aircraft concept.

The LHX will afford us the vitally needed capability to respond to the future threat and contingencies, and will enable us to effectively protect Army Aviation interests worldwide. It will increase our survivability and productivity by operating day and night, in adverse weather, and through battlefield obscurants.

"The ability of today's fleet to survive in an NBC environment is severely limited"

Additionally, it will standardize the light fleet, reduce maintenance and training costs as well as training time. It will substantially increase our survivability on the battlefield, while providing a technologically advanced, affordable rotorcraft that incorporates advanced target acquisition and weaponry.

Above all, it will provide Army Aviation the urgently needed capability to win on the battlefield of the 1990's and beyond. IIIII

Who shot John? Tune in next month!

The realism that has been experienced in recent years by countless Infantry and Armor soldiers using **MILES** is just now being experienced by Aviation and Air Defense units during New Equipment Training using the **Air Ground Engagement System/Air Defense (AGES/AD). Miles** stands for the **Multiple Integrated Laser Engagement System,** a concept that simulates the effects of direct fire weapons using eye-safe laser beams. **LTC Bradford M. Brown,** who served as the FORSCOM NET Chief on AGES/AD and is currently assigned to ODCSRDA, will write about this system in the July 31 issue citing the positive effect that MILES AGES/AD has on Army Aviation. IIIII

Planning Perspective

A great deal has recently been spoken and written about the military acquisition process. A large part of this information has been uncomplimentary. The criticism covers the entire spectrum of military acquisition and includes high procurement cost; inattention to **Reliability, Availability, and Maintainability (RAM)** criteria; inefficient applications of technology; and an acquisition development cycle that, simply stated, takes too long. Unfortunately, many of the criticisms have been valid.

The LHX program is different. From its inception this program was designed to avoid the pitfalls uncovered in the past. I can say, unequivocally, that LHX is not following the classic life cycle acquisition model. Rather, the planning guideline has been development of a program that yields results faster and at lower cost.

By LIEUTENANT GENERAL LOUIS C. WAGNER, JR.
Deputy Chief of Staff for Research, Development and Acquisition, DA

The idea of doing things a certain way because we have always done it that way is being replaced in the acquisition area by the concept of avoiding the "business as usual" approach.

For this special issue of **Army Aviation,** I have been asked to address the planning perspective in the LHX program. I will do this in two distinct parts.

First, I'll give you a historical perspective of the events that led to our present position in the program. Then, I'll present some of the key issues in the LHX program and address our plans for each of these issues.

The Army's initial planning for a light helicopter family approach to future helicopter development began in the late 1970's. Analyses of future requirements showed that with the addition of the heavier APACHE Advanced Attack Helicopter and the BLACK HAWK Utility Tactical Transport System, and with the subsequent retirements of the Vietnam-era utility, scout, and attack aircraft, a new aircraft development, beginning in the mid-1980s, was needed to replace the light fleet.

Technology base programs were redirected and focused on critical technologies required for any follow-on aircraft system. So was born the **Advanced Technology Demonstrator Engine (ATDE)**, the **Advanced Digital Optical Control System (ADOCS)**, **Advanced Composite Aircraft Program (ACAP)** and the **Advanced Rotor-Advancing Blade Concept (ABC)** and Tilt Rotor programs.

In 1983, the LHX Special Task Force was established to address concept formulation and to do the preliminary design and analysis. In lieu of a **Mission Element Need Statement (MENS)**, a **Justification for Major System New Start (JMSNS)** was prepared and subsequently submitted to OSD along with the FY

1985 **Program Objective Memorandum (POM)** goals.

The new concept of a JMSNS formally tied the LHX concept exploration to the Planning, Programming, and Budgeting cycle.

While OSD reviewed the JMSNS, both the Army and industry continued to refine the LHX concept and the program acquisition strategy. Upon official OSD approval of the JMSNS in December, 1983, the Army was prepared to award initial contracts for the **Advanced Rotorcraft Technology Integration (ARTI)** program which defines the cockpit and provides for the final major demonstration of the single pilot concept before entering Full Scale Development.

At this point, those familiar with the classical or normal acquisition cycle will notice that LHX has yet to step onto this familiar path. Rather, through application of results obtained from technology base demonstrations, and the ARTI program, the conventional Concept Exploration and Demonstration/Validation phases have been bypassed.

"The Army intends to continue competition throughout the life of LHX procurements."

Simultaneously, as industry prepared to demonstrate capabilities of advanced technology, LHX strategy, utilizing proven concepts, was being finalized.

The coupled technology base, ARTI/concept exploration, and demonstration/validation efforts enabled the Army to suggest, and OSD to approve, consolidation of Milestone I and II DSARC reviews as the approval point prior to entering Full Scale Development. However, to assure adequate oversight of the program, OSD has requested and will receive an unnumbered DSARC review in late spring 1985.

That's where we are today.

Our planning and innovation does not stop at this point. On the contrary, what has happened in the past is really only a foundation for the future. I would like to turn now to what I feel are some of the major issues within the LHX program, and the plans that are on-going for each. The areas I will address are competition, cost, reliability, availability and maintainability, force structure, and training.

- **First of all,** LHX planning is built on the principle of competition. While competing for production is not a new idea, the competitive strategy for LHX is unique. Where affordable, we intend to carry competition for the two major government procurements, engine and air vehicle, through both full scale development and production.

"The LHX cannot be designed as the Utopian aircraft that'll do all things for all people"

The government reserves the right to award more than one development contract, with subsequent selection to one contract at the production milestone. However, all contractor teams competing for the production contract must propose and be prepared to execute competition for production units at production Lot 3, the third year of production. The Army intends to continue competition throughout the life of LHX procurements.

While a strategy carrying two contractors through development is initially more costly, it's believed that the initial investment will be more than recovered through lower costs in production, as well as through follow-on savings in spare parts and support costs. Of course, there are innumerable intangible benefits to be accrued through an extended competitive environment. Among these are the sparking of technological innovations, timeliness of delivery, and continued quality of the product, to name only a few.

- A **second key area** in our planning is cost. To even the most casual observer, it should be obvious that replacing 7,000 of our existing light aircraft is an expensive undertaking. It should be equally obvious that the climate of budget deficits, and other high priority Army procurements, sets upper limits on the resources available for LHX. Therefore, the Army established firm developmental goals of a unit flyaway cost, in FY 84 dollars, of \$3 to \$4 million for the utility model and \$5 to \$6 million for the **Scout/Attack (SCAT)** model.

These cost goals are challenging but achievable. Meeting them requires American industry

to make maximum use of modern manufacturing methods in engineering simulation and manufacturing. On the other hand, meeting cost goals sets limits on what LHX can be. The Army recognizes that the LHX cannot be designed as the Utopian aircraft that will "do all things for all people". Work is underway to carefully analyze what LHX **must** accomplish, and design it to meet these requirements. The recent decision to restrict LHX to conventional helicopter technology is a product of this analysis.

"The benefits of meeting the goal of a single pilot LHX are enormous."

● Reliability, availability, and maintainability is **another key LHX planning area.** Too often in the past RAM criteria have fallen out from product design rather than from the design's foundation. The LHX program is different. The RAM criteria, with subsequent improved aircraft availability and operation and support cost savings, are one of the major building blocks of LHX. As a matter of fact, the reduced O&S cost of LHX is one of the key factors that makes the program affordable.

In the LHX, reliability, availability, and maintainability is so important that as part of the Request for Proposal for the T800 engine, RAM was a major area of evaluation. In a similar context, these criteria will continue to receive heavy emphasis, and will be part of bidding contractors binding commitment. That is, each contractor will be expected to contractually guarantee his RAM factors prior to contract award, and to meet this guarantee as aircraft are produced and fielded.

● A **fourth key planning area** is related to the Army's force structure and LHX. In view of the Army's commitment to maintain its active force level at approximately 781,000 soldiers, demographic statistics that highlight reduced availability of service aged manpower, and the high cost of military personnel, steps taken at the front end of the design process to reduce manpower requirements will yield substantial benefits in the long run. LHX planning addresses this issue in two specific areas: reduced maintenance personnel requirements and the concept of a single pilot.

I have already addressed the attention being given to RAM criteria. A very beneficial fallout of improvement in RAM is the need for fewer personnel to maintain the the aircraft. An achievable goal of reducing maintenance manhours per flight hour by 50%, but to increase its capability to fly and fight by nearly 100%.

● The **final area** I'd like to address is training. As in the case of RAM, training has also been an area that, in my opinion, has received insufficient attention in the design of our major weapon systems. In the case of LHX, this shortcoming will be eliminated. As a matter of fact, in the minds of many, the critical path of success on LHX is through training.

Recognizing this fact in the early planning stages of LHX has allowed a total review of how the Army analyzes training requirements and procures training devices. For the first time in Army Aviation history, the training system will be provided through the prime contractor. The Army does not intend to procure each device separately as has been the traditional method.

By following this strategy of assigning responsibility to the prime contractor we will allow the forces of the marketplace free play as hardware and training system contractors team together, eliminate the configuration inconsistencies between hardware and training devices, and assure that training devices are available prior to delivery of the aircraft.

"For the first time in Army Aviation, the training system will be provided through the contractor"

The Light Helicopter Family LHX Program is the largest program ever undertaken by the Army. Current estimates for flyaway cost for 5,000 LHX aircraft hover at $30 billion in FY 84 dollars. The life cycle cost is estimated by some to exceed $100 billion.

A program of this magnitude obviously requires detailed planning and attention to minute detail. Likewise, the program's magnitude, coupled with today's military acquisition climate, screams for innovation and sound business sense decisions. The LHX program is on track on both of these points. IIIII

Continuous Comprehensive Evaluation of the LHX

THE U.S. Army **Operational Test and Evaluation Activity (OTEA)** is doing business under a new concept called **Continuous Comprehensive Evaluation (C^2E)**. Under C^2E, selected major systems are subjected to a broader, more inclusive evaluation that assesses the system throughout the entire acquisition process; continually reviewing and frequently reporting, system status to the decision makers.

This assessment process uses multiple data sources including observation of factory demonstrations, both developmental and operational tests; more user tests (FDT&E); and modeling and simluations, as opposed to relying on data generated from classical operational tests, such as OT I and OT II.

C^2E is designed to not only assess current in the system as a whole or, at the very least, they will be issues for discussion at OSD or Congressional level.

The Vice Chief of Staff of the Army has directed that OTEA stay in the acquisition process as part of C^2E, even as late as production and fielding, if necessary, to verify correction of deficiencies identified during test and evaluation.

OTEA is presently conducting C^2E on 20 systems, one of which is LHX. An additional 17 systems have been selected for a limited form of C^2E. Additionally, OTEA is monitoring approximately 30 other systems, some of which will become appropriate for C^2E. Example of systems under full C^2E, such as LHX are AHIP, MLRS, PJH, RPV, SGT York, SHORAD C^2, and SINCGARS.

By MAJOR GENERAL WILLIAM G.T. TUTTLE, JR.
Commander, USA Operational Test and Evaluation Agency

system performance, but projected future performance as well. To accomplish this, OTEA must get into the system acquisition cycle early and stay late.

Getting in early implies that OTEA must be involved in the development of the system requirement documents, the RFP's, and even the system specification. The Army must insure that the base against which one does an evaluation makes sense. Deficiencies in requirement documents could well blossom into deficiencies

What brought about this dramatic change in OTEA's direction? The genesis of the C^2E concept and the transition from operational tester to the Army's Continuous Comprehensive Evaluator were the result of three major catalytic occurrences in 1983. In February, 1983, the Deputy Under Secretary of the Army for Operations Research, **Mr. Walt Hollis**, informed the Commander of OTEA that the **Army System Acquisition Review Council (ASARC)** principals were dissatisfied with the reporting of evaluations at milestone decision reviews. The essence of their criticism was that operational testing and evaluation, as practiced, was "too late, too early, and too narrow".

Until one understands the core issues which were being surfaced, their complaints appear to be a contradiction in terms.

Historically, OT&E did not play a significant role in the materiel acquisition process until Full Scale Development, owing to the frequent waiver of early **operational testing (OT I)**. More often than not, OT II was the first time a system was subjected to the rigors of an operational test environment. Consequently, it served as the primary source of information regarding a system's operational utility.

"The GAO concluded that . .the results reaching acquisition officials. . were often fragmented."

Testing a few prototypes just before the production decision is "too late", because time needed to correct deficiencies found in OT is almost nonexistent. Changes to hardware design, and contractural and production parameters, normally frozen at this of development, impact severely on program cost and schedule. OTEA tested "too early" in that hardware available for operational testing was rarely configured to the final production specifications.

Finally, system evaluations were "too narrow" in that the evaluation report was limited to the results of a single major test, and frequently only addressed the question of whether the system had succeeded or failed to attain its required operational capabilities. Classical operational testing, and its inherent "pass-fail" approach, did not provide sufficient diagnostic information and lacked a comprehensive assessment of decision risks.

The second major force in forging the C^2E concept was an expansion of the OTEA mission when, in the summer of 1983, the Army Vice Chief of Staff directed OTEA to track correction of major systems' deficiencies found during testing and report progress made toward their resolution.

Soon after, the Under Secretary of the Army directed OTEA to evaluate systems throughout their acquisition cycles, from concept definition through to fielding. Both expansions in OTEA's mission supported the emerging awareness in senior Army management that continuous evaluation is inherently better than "snap-shot" evaluations oriented toward major decision milestones.

A third impetus for C^2E was provided in the fall of 1983 when findings in a GAO draft investigation report entitled, **The Army Needs More Comprehensive Evaluations to Make Use of Its Weapons System Testing** confirmed the shortcomings identified earlier by the ASARC. The GAO concluded that many, varied Army organizations contribute to the preparation of evaluations, and that the results reaching acquisition officials at critical decision points were often fragmented as a result.

Moreover, the GAO found that the evaluations seldom adequately interpret the test findings in terms of potential operational consequences, and that they needed to be broadened and integrated to provide a more meaningful and coherent picture of system development and potential operational effectiveness.

The GAO recommended that one principal agency, with access to **all** information generated by other agencies, be designated to interpret and integrate test results into one comprehensive evaluation. OSD, in coordination with the Army, replied to GAO that OTEA would be such a "Comprehensive" evaluator for a pilot program.

"OTEA tested 'too early' in that hardware for operational testing was rarely configured to the final production specifications"

In May, 1984, DA planning guidance for the LHX program stated in part that, "Testing will be a continuous process. OTEA and TRADOC presence will begin during the **Advanced Rotorcraft Technology Integration (ARTI)** Study, even before formal program initiation and will continue throughout the development cycle. Early operational testing will be an integral part of the **Test and Evaluation Master Plan (TEMP)**".

This statement is indicative of senior Army management's commitment to OTEA's role in

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continuous, comprehensive evaluation and helped introduce the concept of C²E to the testing and acquisition community within the Army.

OTEA has been involved early in the LHX program, far earlier than has ever been the case before in a major weapon system acquisition. There has been open and constructive dialogue between OTEA and the LHX program office. **BG Ronald Andreson**, LHX Program Manager, has visited OTEA and discussed the C²E concept. He has voiced his support and taken positive steps toward the early resolution of issues relating to the operational testing of the LHX.

Issues discussed during **BG Andreson's** visit included:

- the number of test items required to conduct a credible operational test during the DT/OT competitive fly-off in 1991,
- the feasibility of incorporating eye-safe lasers in the LHX for testing and training,
- the designation of an operational aviation unit to act as the initial operational capability unit, and
- the early identification of aerial target requirements for the operational testing of LHX.

If not resolved early, issues such as these could result in a less than satisfactory operational test and evaluation.

"C²E will make the tester-evaluator a contributor to LHX development, rather than just another hurdle"

OTEA has also been involved in the ARTI study as a member of the study advisory group. OTEA's contribution has been to work with TRADOC to ensure that operational considerations are incorporated into the analysis of the results of the ARTI study. We "got in early" in the T-800 engine RFP development and, as a permanent member of the RAM Working Group, assisted in writing the RAM Rationale Report which will support the ROC.

TRADOC has afforded OTEA an early opportunity to review the LHX requirements documents. This will provide OTEA a solid base from which to develop a sound evaluation plan as well as assure Army leadership that ROC requirements are written in a manner conducive to constructive evaluation. OTEA observed the T-800 engine source selection, and has been an active member of the **Test Integration Working Group (TIWG)** in the development of the TEMP required at the Milestone I/II review.

A management document within OTEA, which supports C²E is the **Test, Evaluation, Analysis and Modeling (TEAM)** Plan. A TEAM plan is prepared for each specific system undergoing C²E, such as LHX. It contains the evaluation concept, consolidated issues (to include Congressional and DOD issues), and a data source matrix to identify the nature and source of data for evaluation and how the data will be applied to each issue to derive trends.

"The most important part of C²E is OTEA's commitment to report all its conclusions to the PM and TSM continually"

For instance, we will probably use the AMSAA Reliability Growth Curve as a management tool to determine periodically whether the system is on track with regard to reliability. Finally, the OTEA TEAM plan supports the LHX TEMP with the necessary detail to ensure that as the LHX is developed; an adequate evaluation of the LHX is made; and all issues are addressed with no redundancy of testing.

Perhaps the most important part of C²E is OTEA's commitment to report all of its conclusions to the PM and TSM continually. All indications are that C²E will make the tester-evaluator an important contributor to the LHX development rather than just another hurdle.

C²E is an evolving concept. In implementation of policies, methodologies, and procedures, the process is still in its infancy. Significant effort is being directed at defining the "nuts and bolts" of the process. OTEA's major task is to develop an executable strategy which incorporates multiple-input data management procedures, compatible evaluation technologies, and, of greatest importance, the formation of cooperative partnerships within the acquisition community to support C²E efforts.

LHX is the first Army system to be subjected to this new evaluation process. As LHX matures so, too, will C²E. IIIII

LHX: Integrating Man and Technology

IN January 1955, the Army conducted a design competition for a new helicopter. The winning design was submitted by Bell Helicopter Company with its Model 204 and was powered by a Lycoming XT-53 gas turbine engine. The helicopter had a total weight of 8,500 pounds and its engine produced 770 shaft horsepower.

The Model 204's military designation was the HU-1, which was later changed to UH-1, and became known as the "Huey". The "Huey" was early 1950's technology designed to meet the requirements of an Army just out of the Korean War — 30 years ago.

Ten years later, Army Aviation was forced to use this same technology and, through dramatic production rates, produce an inventory of UH-1, AH-1, OH-6, and OH-58 helicopters to support the service life of the systems, we have also caused larger maintenance burdens.

As late as 1983, this same light fleet required 16 different series of engines and 15 different series of transmissions. We continue to be faced with marginal systems for many missions and limited survivability of our light fleet. It's important to note that these aircraft constitute the largest share of our attack and utility fleet which perform missions less rigorous "but not less essential," than BLACK HAWK and APACHE.

In the **Army Aviation Mission Area Analysis (AAMAA)** 77 major deficiencies in Army Aviation were identified. Fifty-six of these deficiencies were associated with the current light fleets of OH-58, OH-6, AH-1, and UH-1 helicopters and are primarily in the supportability and combat capability categories. The UH-60, AH-64,

By BRIGADIER GENERAL WAYNE C. KNUDSON
Deputy Director of Requirements, ODCSOPS, DA

the Vietnam War. The residual portion of this light helicopter fleet—some 7,000 aircraft—are still serving the Army today and, although still airworthy, they have become both cost and operationally insufficient to meet the requirements of the Army of Excellence and tomorrow's threat.

Our effort to sustain combat capability has compelled us to modify the current light fleet and has led to a proliferation of categories. While improvement programs have extended

and AHIP have overcome most of the remaining deficiencies which we identified in our mission area analysis.

As the Army evaluated various alternative programs to overcome this situation, we saw a unique opportunity. Maturing rotorcraft technology might provide the means to replace the current capability with the required capability at nearly one-half the structural cost.

If this proposition was realized, the Army could either avoid the cost or reinvest the savings in other priority force programs short of manpower and/or operating and support financing. With this framework and a stategy to replace the current light fleet in the low side of a high-low mix of attack and utility force structure, LHX was established.

As the next generation light helicopter, LHX will incorporate emerging dramatic opportunities in rotorcraft technology, including areas of aerodynamics and dynamics, structures and materials, avionics, flight controls, propulsion and systems research. LHX will expand the performance and reliability for Army aircraft to meet the challenges of the 1990's and the doctrine of Airland Battle. LHX is the signal of a new direction for Army Aviation and heralds the arrival of future technology in the fleet.

"As late as 1983, our light fleet needed 16 different series of engines and 15 series of transmissions"

Designed as a family of light helicopters in the 8,000 pound class (±500), LHX will center around three basic mission areas: scout, attack, and utility. To accomplish these missions, LHX will be designed in two basic versions: utility and **scout/attack (SCAT)**.

The LHX utility will augment the UH-60 and replace the outdated UH-1 and OH-58 helicopters in those units where a full squad carrying capability is not required. LHX-SCAT uses a common airframe for both its scout and light attack missions and shares common dynamic components with the LHX utility. By adding or deleting weapons and other mission equipment, the unit commander can quickly tailor his aircraft to perform either the scout or attack mission.

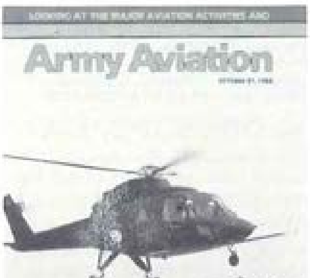
While the AH-64 and AHIP fill the heavy attack force structure, LHX-SCAT will round out the lighter side of the heavy/light **Army of Excellence** organization. LHX-SCAT will replace the AH-1 series of attack helicopters, as well as the OH-6 and OH-58 series of scout helicopters. Standardizing the force with AH-64, AHIP, UH-60, and LHX will reduce the number of individual types and models of helicopters in the current fleet.

Accordingly, the focus of LHX is clear. Marry the pilot, the aircraft, and the mission with tomorrow's technology to produce a light, reasonably priced, survivable, and reliable weapons system that will meet the challenge of the **Army of Excellence**.

Army Aviation is moving toward a new dimension — integrating man and technology. LHX is Army Aviation's primary vector into the 21st century and with extraordinary and imaginative efforts by military and industrial teams will be the aircraft necessary to support our future combined arms forces.

Work hard and work smart. Good Luck!

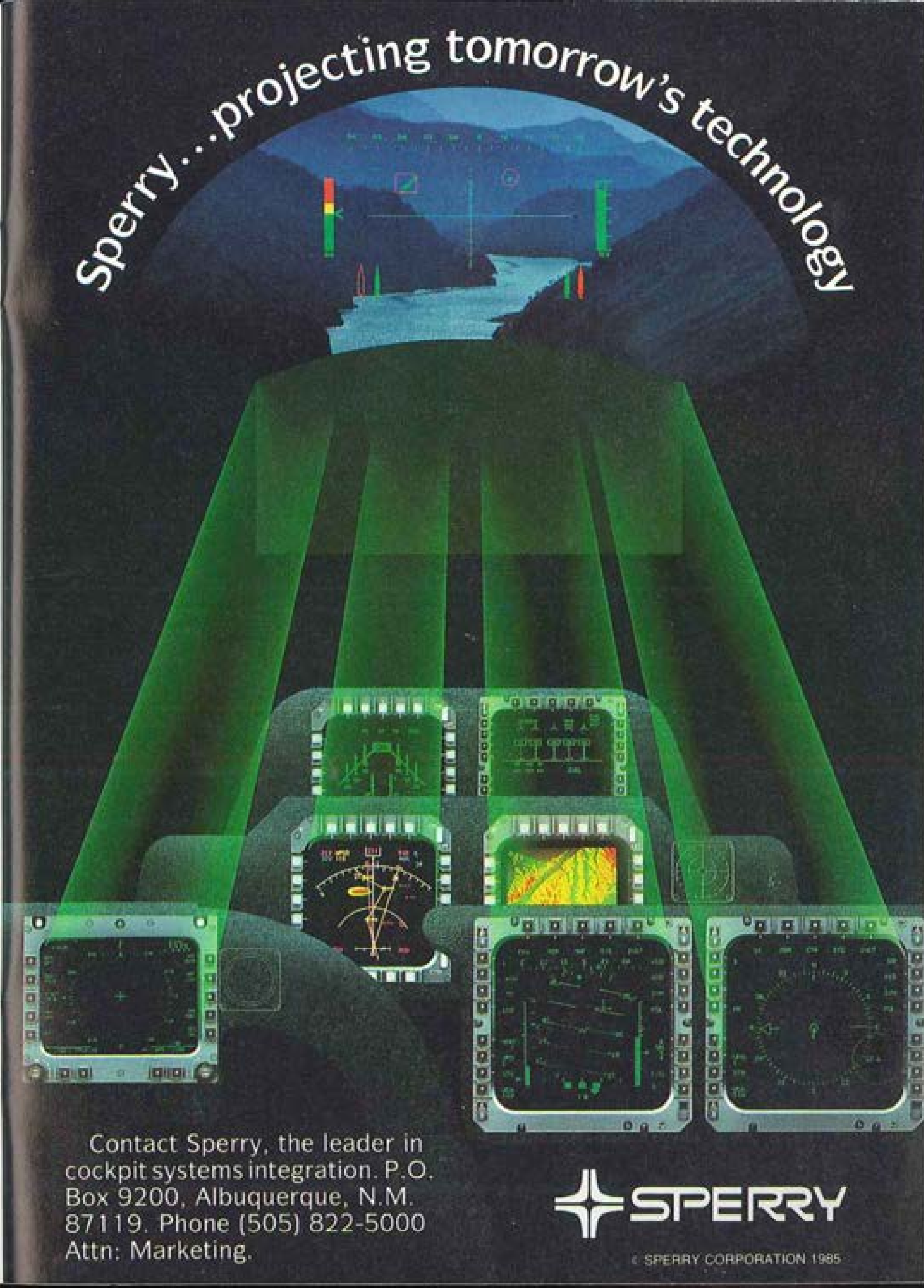
Army and Sikorsky win Grover E. Bell Award



The U.S. Army was named a co-recipient of the prestigious Grover E. Bell Award for 1985 along with United Technologies' Sikorsky Aircraft for the **Advanced Composite Airframe Program (ACAP)** helicopter. It was the latter's seventh Bell Award since 1959 when founder Igor I. Sikorsky won it.

Also receiving the 1985 award from the American Helicopter Society was the U.S. Army's Applied Technology Laboratory at Ft. Eustis, Va., which funded the effort.

The Sikorsky ACAP (pictured at the left as it appeared on **Army Aviation's** October, 1984 front cover) is the world's first all-composite-structure helicopter to fly accomplishing its first flight in August, 1984. It is the also the world's first fully militarized composite aircraft — fixed-or rotary-wing. IIIII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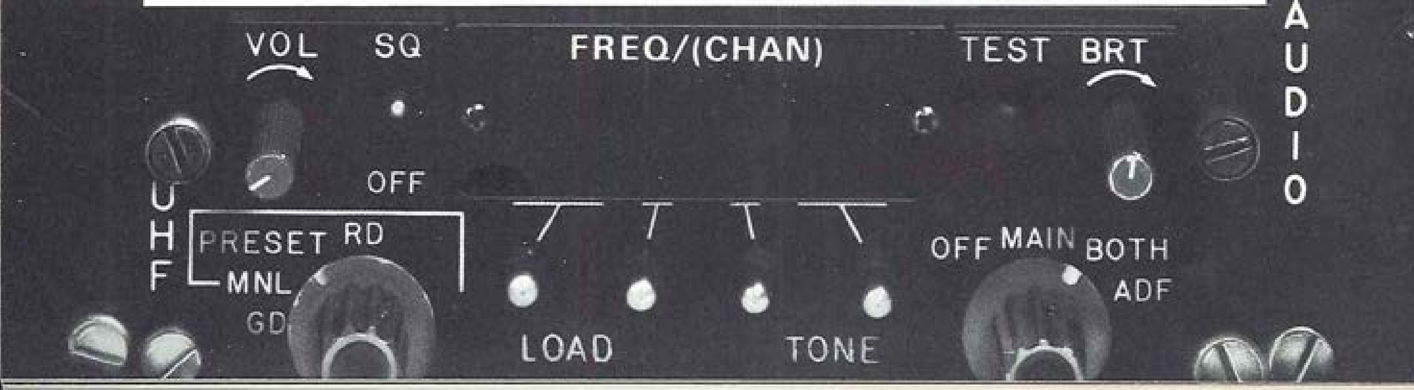
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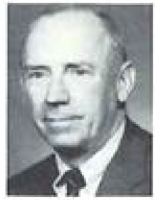


LHX Sustainability (RAM/ILS)

THIS may not be a completely new approach to **Reliability, Availability and Maintainability/Integrated Logistics Support (RAM/ILS).** However, I do believe that too often we in the ILS business become more enamored of what we are doing in ILS than we are in looking at the potential returns from the aircraft as a total weapons system. The greatest potentials in Reliability and Maintainability can only be realized when RAM/ILS are built into the design and hardware of a weapons system at the very beginning.

My rationale is based on what I have found over the years. We in logistics support do not move in on the aircraft early enough to really influence the design and hardware. As a long-time logistician, I do not point the finger at the R&D community for not incorporating RAM/ILS and life support costs upfront. Rather, I blame the logistician for not getting in the action when a new system is a gleam in the eye of the designer. This is truly the time when potential problems in ILS begin.

For LHX, RAM and ILS are joined into one entity. This is an initiative long overdue. To me, RAM equates to Inherent Availability in a weapon system which we call A of i. ILS equates to the supportability of a weapon system which we call Operational Availability or A of o. For obvious reasons, Ao will never exceed Ai. The major thrust needs to be pointed at maintaining as much of the Ai as can possibly be done; i.e., able to be done and affordable.

I would suggest the first thing that needs doing is to integrate **Reliability, Availability, and Maintainability (RAM)** with **Integrated Logistics Support (ILS)** into a RAM/ILS program with every bit as much importance, attention, priority, and funding as the things that usually drive selection of a new system; e.g., performance and costs of production. This is being done for the LHX. In order to assure that RAM/ILS receive the priority I believe is necessary, we must be able to show the payoff in the form of operational and support costs throughout the life of the system.

This is not easily done. Certainly, not so easy as estimating design to unit production cost which is usually the criterion for selection provided the aircraft meets technical specifications and performance requirements.

By JOSEPH P. CRIBBINS
Special Assistant to the DCS for Logistics, DA

First let me give you my view of the relationship of RAM/ILS with the original design and ultimate fielding of an aircraft system.

Reliability/Availability/Maintainability (RAM) must be incorporated in the design and hardware of the aircraft as a total weapon system. RAM thus becomes the Inherent Availability or A of i of the aircraft. In fact, if RAM meets all the established goals of readiness or mission capability, then this is the ultimate which that aircraft can attain unless modifications are made to improve the inherent RAM.

Integrated Logistic Support (ILS) must play a very strong role in influencing the initial design and hardware of the weapons system to assure that the ultimate affordable RAM or Ai is incorporated in the design, test, and production stages. Thus, when the aircraft is fielded, ILS has, from the beginning, been involved and driven operational availability or Ao.

As mentioned, Ao can never exceed Ai and very rarely, if ever, attain Ai. Once an aircraft becomes operational, everything that is done to or happens to that aircraft, including: operational missions and flying hours, adequacy and effectiveness of the support base of people and things, operational damage, fair wear and tear — all the above tend to lower Ai.

Ai has limiting factors. If the LHX were going on a moon shot, it would have to be as realiable as human ingenuity could make it. We can't afford to incorporate such reliability into the LHX, but we are giving as much emphasis to RAM/ILS as other selection criteria.

"The importance of RAM/ILS in selection (must) be recognized from the very beginning."

We in logistics have to look critically at weapon systems management, support, readiness, and sustainability of the system to keep Ao at its peak; i.e., as close to Ai as can be accomplished. Here again we are faced with what is able to be done and affordable. All of this equates to life cycle costs.

I trust that this more clearly delineates the interface between RAM and Ai and ILS and Ao. Most importantly, is the fact that RAM and ILS must be integrated when the aircraft system is being designed.

ILS funding is critical, I can remember so many instances when we have been in competition for a major aviation system and, for whatever reason, found we were short of funds. We had to find billpayers. The PM was faced with telling the competitors to "go best effort." Each time, the competitors recognized that their system would be selected based upon performance, technology, and cost. RAM/ILS became the billpayer.

How do we overcome this problem? I would suggest that RAM/ILS funds be fenced and that the importance of RAM/ILS in selection be recognized from the very beginning as is now being done for the LHX. Only then will RAM/ILS be pursued for what it's worth.

I have an example and a very simple analogy. In looking at some of our earlier helicopter systems, I found that the twenty year **Operation and Support (O&S)** costs were 4 to 6 times the fly away cost of the aircraft, just using costs per flying hour for three hundred hours per year. It is sort of like getting married — where the costs of the license and the wedding become incidental when compared to the costs of O&S during the next thirty-forty years.

"We are in a position to move toward diagnostic electronic maintenance in lieu of wrench turning."

Having set the stage, I would now talk to the things I believe we need to emphasize in establishing an **Inherent Availability (Ai)** for the biggest payoff in **Operational Availability (Ao).** Some of these I am sure we will recognize as being "motherhood" but, I am afraid, have not been given the degree of attention and specificity needed.

- Reduce requirements for people. There are certain limitations on reducing aircrews but in my view, there is a really fertile field in looking at ground crews. Obviously this reduction of ground crews can only be accomplished by increased reliability, decreased maintenance manhours and taking advantage of the Inherent Availability in the aircraft as a total system.
- Using a replacement versus a repair concept, compare the resources required to fill the supply spare/repair parts pipeline.
- Diagnostics, in the form of **Built In Test (BIT),** now includes a capability known as **Fault Detection Location System (FDLS).** BIT must be able to give a "go - no go" diagnosis as well as prognosis in the form of trend analysis.
- The vital link is the maintainer. Not only how many, but what skill levels are needed; what training is needed to attain such skill

levels; and, when these skill levels have been attained, how the people can be motivated to be retained in the system.

- A new look at our maintenance concepts. We must challenge the way we are doing business in maintenance. With the current state-of-the-art in high technology, we must take advantage of capabilities to reduce the workload and the workforce at all levels of maintenance with special emphasis on the user in the field. We are in a position to move toward diagnostic/-prognostic (or electronic) maintenance in lieu of wrench turning/mechanical maintenance. New aircraft systems must be designed to take advantage of this capability.

"In my view, depot maintenance does not necessarily have to be restricted to CONUS."

- Our organization and levels of maintenance needs to be challenged and the LHX is doing this.

Here is how I see two levels of maintenance, which I believe are attainable and will have a very real payoff in reducing support resources and increasing readiness:

Aircraft maintenance for operational units in the field, and these operational units I define as Division and below (including like units assigned to a Division), should be "user" maintenance. My definition of User maintenance is that maintenance needed to support aircraft readiness and required operational tempo or flying hours. This means a total concentration upon the aircraft in lieu of dissipating our efforts toward supporting the supply system. Maintenance above the user level should be that maintenance which is ultimately responsible for any and all repair and/or overhaul or rebuild, which we now call depot maintenance.

In my view, depot maintenance does not necessarily have to be restricted to CONUS, rather those elements of depot maintenance that may be needed closer to the user should be aligned where needed.

- The two levels of maintenance does not necessarily dictate that there be only two levels of supply, although this would be desirable. However, it is recognized that it may be necessary to have an intermediate level of supply highly responsive to the user. This intermediate level of supply should not become another maintenance level, rather it should be a point at which spare/repair parts returned from the user can be expeditiously returned to the depot for repair/overhaul.

The bottom line to maximizing Ai through Ao is that we must shed ourselves of the way we have done business over the years and challenge ourselves and the system to do more with less.

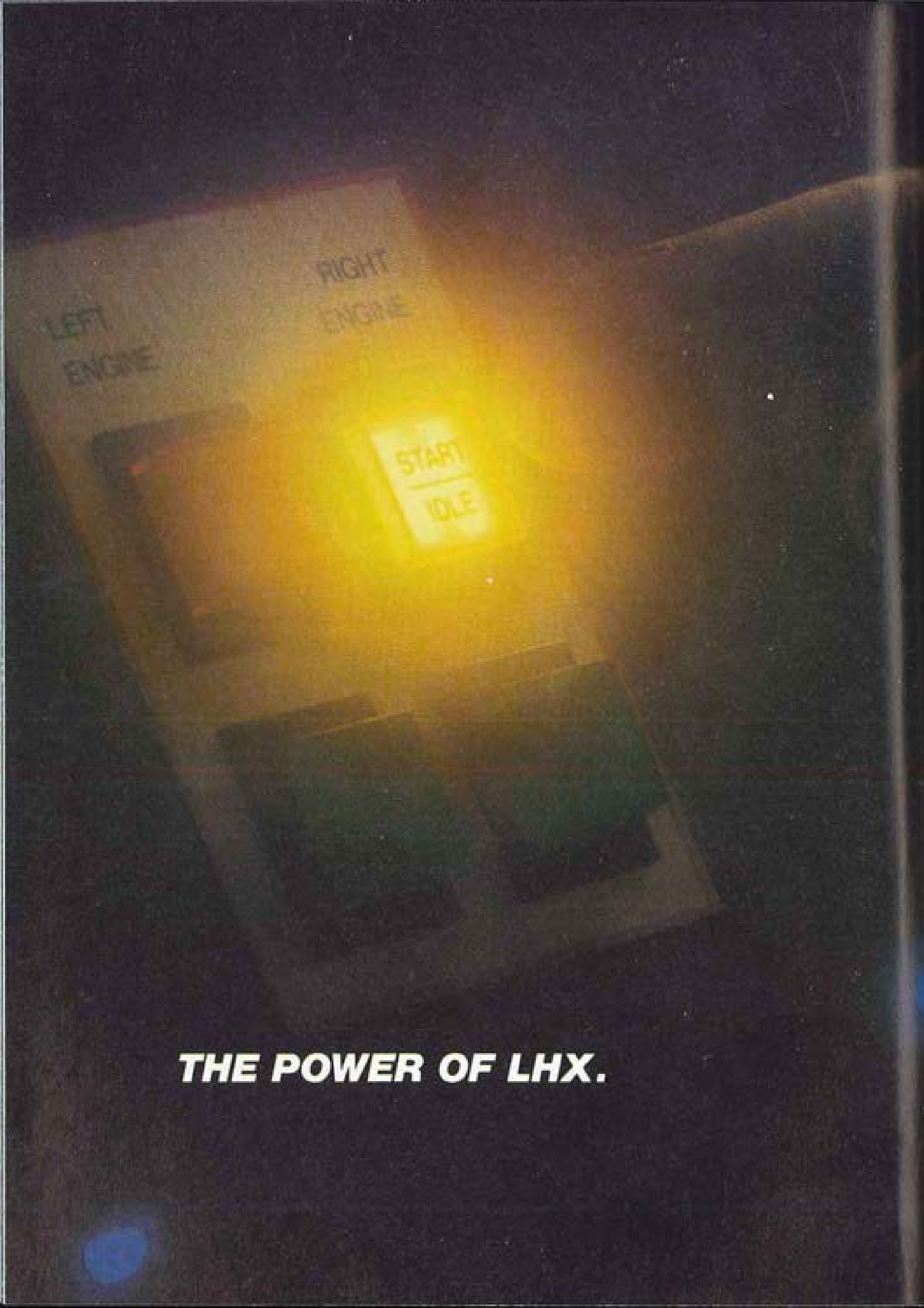
"We did many things in Vietnam that we never believed possible until they were done."

Vietnam was an eye opener. We did many things in Vietnam that we never believed possible until they were done. Many emergencies dictated our doing things differently and when they worked they became the norm.

However, Vietnam is over ten years behind us and we must not be wed to organizations, practices, and procedures learned in Vietnam unless they fit in with the future and what high technology and new ways of doing business can do for us. IIIII

AAAA offers APACHE Posters

A four-color 8½ x 11-inch "Join the Profesionals!" poster showing four U.S. Army AH-64A APACHE attack helicopters in formation flight "on the deck" is available to interested AAAA members. The attractive poster - the third in a series of posters provided to the Army Aviation Association by its industry member firms - appeared as the December, 1984 cover of **Army Aviation.** Three souvenir copies may be obtained - as long as supply lasts - by forwarding $1.00 in postage and handling costs to: AAAA, 1 Crestwood Road, Westport, CT 06880. IIIII


RIGHT ENGINE
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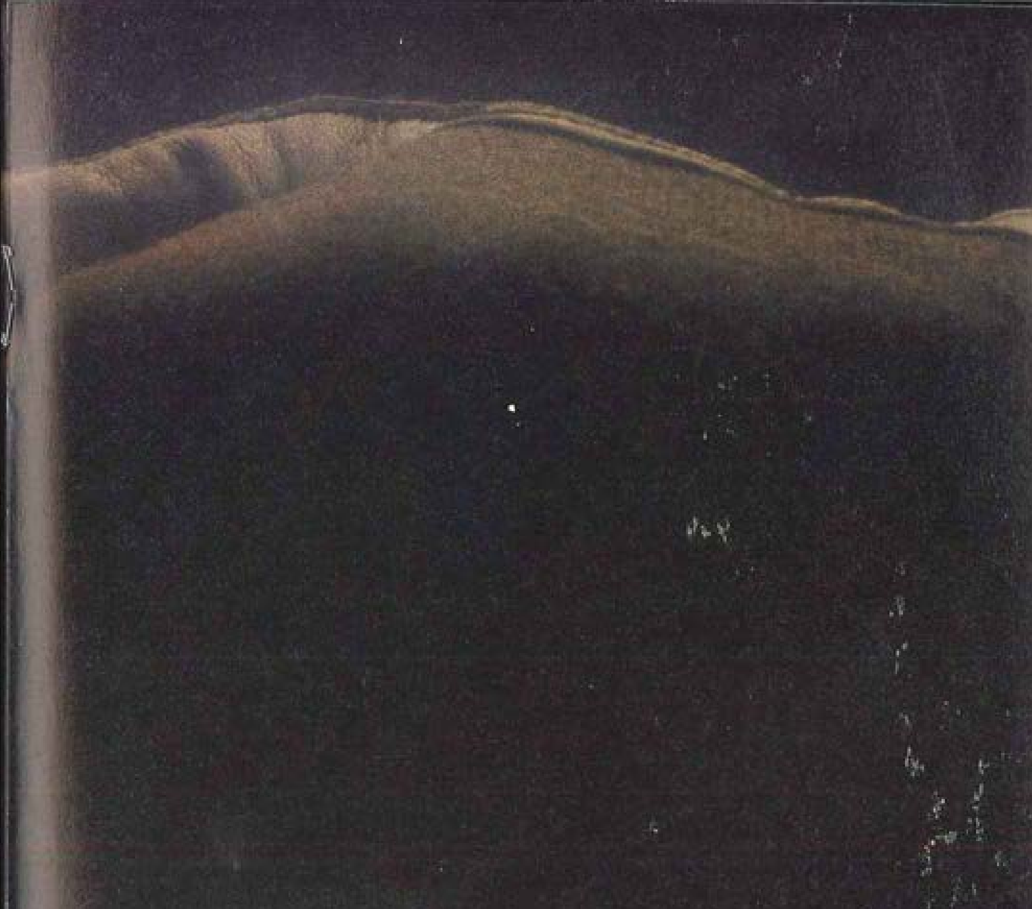
THE POWER OF LHX.



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EARLY in the evolution of the **light helicopter family (LHX)** concept it was determined that a single crew (pilot) aircraft offered potential for substantial reductions in life cycle cost when compared to the more traditional two-seat designs.

It was evident, however, that achievement of an acceptable single pilot design would require high levels of automation to assist the pilot in accomplishing the multiplicity of tasks associated with the anticipated LHX missions.

The first order of business was to determine if a highly integrated and automated cockpit, using advanced technology concepts projected for the late 1980s, had sufficient potential to support a single crew objective. A preliminary assessment was conducted in 1982 under contract with the Boeing Vertol Company and included extensive experiments in the Contractor's simulation facility.

ARTI: Proving the single pilot thesis

By THOMAS L. HOUSE
U.S. Army Applied Technology Laboratory, Fort Eustis, Virginia

A group of **cathode ray tubes (CRTs)** were used to represent a cockpit wide field-of-view display. The cockpit was equipped with a single four-axis controller which operated a set of automatic flight controls representative of digital controls systems currently being demonstrated under the Army's **Advanced Digital Optical Control System (ADOCS)** program.

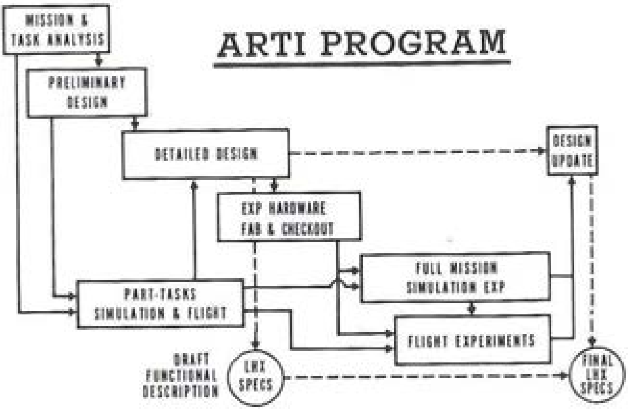
A computer program was developed that caused the simulation cockpit to perform in a manner similar to that which would have been expected if a fully integrated electronics architecture had been designed and applied to the simulation experiments. This approach was selected since the principal issue at this time was to determine the general feasibility of accomplishing the LHX mission with a single pilot aircraft.

The preliminary assessment was considered highly successful and provided strong evidence that a single pilot could accomplish the full range of scout and attack missions if a fully integrated and automated cockpit — meeting the defined performance capabilities — was available. However, there were a number of limitations associated with this demonstration effort that required further investigation before the Army could logically commit to a single crew design.

As mentioned earlier the Boeing cockpit design was a makeshift arrangement that was in no way acceptable for an operational aircraft. Similarly, these early simulations made no attempt to demonstrate that a highly integrated electronics architecture could actually be developed within reasonable weight and cost constraints. It was clear that demonstrations of such an integrated electronics system would be essential prior to the commitment to the single pilot approach.

Subsequent to the above events, the Under Secretary of the Army endorsed the concept of the LHX, but established several "proof-of-thesis" objectives to to be completed prior to entering engineering development. One of the critical thesis was the concept of LHX being a single crew system for the scout and attack missions.

This lead to the LHX Project Manager's Office establishment of the **Advanced Rotorcraft**



Technology Integration (ARTI) program and tasking the Applied Technology Laboratory, Fort Eustis, Virginia, to award multiple contracts for evaluation of the practicality of a single pilot design approach. To that end, ATL awarded five contracts in late 1983 for pursuit of the ARTI objectives. All contract effort is scheduled to be completed by April 1986.

The ARTI program has been developed to provide a thorough assessment of the practicality of the single pilot concept. Every attempt has been made to make the demonstration program as "real-world" as possible. ARTI recognizes that four major combat aviation tasks must be accomplished by a single crewman under the complete range of operational conditions that exist on the modern battlefield. The pilot must be able to:

- **Aviate** (fly the aircraft along the desired flight path and maneuver as required)
- **Navigate** (know where he is, where he is going, and the best route for getting there)
- **Communicate** (choose the correct radio, tune the desired frequency, and then transmit the desired information) and
- **Operate** (manage his target acquisition and weapons systems as required).

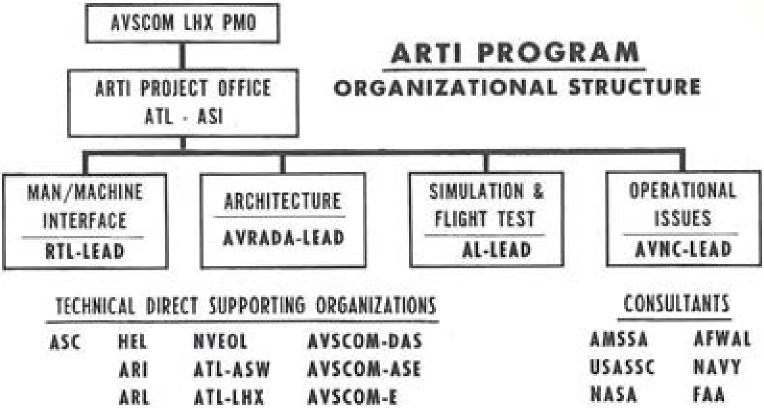
The ARTI contracts are divided into seven tasks. All effort is intended to be completed by April 1986 to assure the availability of critical information required to support the LHX single pilot decision and to also provide data essential to the definition of system functional requirements specification prior to entering engineering development. The objectives of each task are as follows:

Mission and task analysis

A detailed time-line analysis is being conducted of the multiplicity of tasks associated with each mission for the LHX. Results of the analyses are used to develop a pilot workload versus time relationship for each critical portion of each mission. The initial analysis is based on present day aircraft technology in which the pilot is expected to use a high level of cognitive (thought and reasoning) power to accomplish each element of the mission.

Such an analysis readily indicates those areas where pilot workload reaches unacceptable levels for extended periods of time and thereby identifies where automation will be required to offload the pilot to a point that it becomes practical to believe the mission could be achieved by a single crewman.

The most impressive aspect of this task is the early assessment of human factor engineering issues in the definition of cockpit functional requirements. This means that man-machine interaction will be considered before and during the design as opposed to previous programs where human factor was generally considered after-the-fact. The Task I findings are being used to identify critical automation areas and establish objectives for a wide range of cockpit design studies which are being conducted during preliminary design.



Preliminary Design

During preliminary design, the Contractors are identifying a preferred arrangement for the aircraft crew station and supporting avionics architecture that will provide the desired level of automation and human engineering features that will permit the pilot to accomplish the various LHX missions without experiencing sustained workloads above the threshold limits.

One of the major issues during this task is to conduct a detailed technology risk assessment to assure that those technical approaches essential to achieving the desired levels of automation are available and affordable during the LHX development time frame. The Contractor's efforts during this task are supported by a group of part-task analyses conducted both in simulator and in-flight experiments.

A major area of concern relates to the potential of automatic flight controls to simplify the basic flight path management task to a point that the pilot will be relieved of the traditional high workload task associated with nap-of-the-earth and high-speed, low-level flight. Results of Task II will determine if the Army believes that the single pilot concept for LHX is promising enough to warrant the detailed design of a representative cockpit and the conducting of mission simulations and associated flight experiments during the remainder of the ARTI program.

Detailed design

During this task the Contractor will develop the detailed design of a representative crew station for use in conducting detailed mission simulations to be performed later in the program. The Contractor will also develop a proposed electronics architecture design that is representative of the system arrangements that might be used in an engineering development program.

Collectively, these two design efforts will provide the Army realistic information pertaining to the configuration of an LHX cockpit as well as the weight and cost of its associated electronic systems. The Contractor is also faced with the task of developing a computer program that is capable of driving the simulator to be used in this subsequent task of the ARTI contracts.

Mission simulations

Following fabrication and checkout of the proposed crew station, the Contractor shall use Government furnished operational pilots to conduct a series of detailed mission simulations. The mission profiles to be used during these simulations are being developed by the Army and are a composite of various proposed LHX missions. The composite missions have been carefully designed to assure they are representative of the types of tasks that would reasonably be expected to be accomplished by either a Scout or Attack pilot.

A highly sophisticated range of measurements will be taken during these mission simulations to provide detailed data with respect to pilot workload and the overall efficiency with which the pilot was able to accomplish the various mission tasks. Results of these simulations will be the principal source of information leading to the final decision as to whether or not the single pilot concept is a practical approach for the LHX aircraft system.

Flight test experiments

A major concern in any cockpit simulation investigation is the question of whether the simulator is representative of actual flight conditions. Accordingly, the ARTI contracts include a range of part-task flight experiments which the Contractor will use to demonstrate that the simulator is in fact representative of the way an LHX aircraft will fly.

Typical flight experiments to be conducted to verify the simulator include: assessments of automatic flight controls, the capability of voice activated controls under aircraft flight noise conditions, the impact of limited field-of-view pilot displays, and the practical utility of automatic navigation aide.

Specification development

Ultimately, the Army will be required to specify the functional capabilities of the LHX cockpit. The Army contracts are therefore constructed in such a manner that the Army will receive the Contractors' best assessment of those functional charactertistics that represent the most optimum configuration and electronics architecture capabilities.

The Contractors will submit a draft functional specification at the end of the detailed design and then update this document throughout the simulation and flight test leading to a final recommendation at the conclusion of the ARTI contracts. These documents will subsequently be used by the Army to develop a "best" functional description for the LHX cockpit and associated electronics architecture.

Five contractor teams are conducting contracted investigations of the cockpit and supporting architecture concepts for meeting the LHX single pilot capability. The Army is benefitting from a broad base of technical expertise in satisfying the LHX objectives.

Additionally, the ARTI program is benefitting from a wide range of ongoing technology demonstrator programs that are providing evidence that the integrated automated approach being developed for the LHX is a practical expectation. Typical of the tech base programs which are supporting ARTI are as follows:

- **Advanced Digital Optical Control System (ADOCS):** demonstrates the value of automatic flight controls.
- **Helicopter Automatic Targeting System (HATS):** demonstrates practicality of automatic target recognizers.
- **Advanced Digital Avionics System (ADAS):** demonstrates practical concepts for integration of digital electronic systems.

Recognizing the importance of the crew size question, each Contractor's efforts are being reviewed and critiqued by a team of personnel representing every major agency associated with Army aviation.

The ultimate findings of the ARTI program will be totally relevant to the Army's interest and provide relative and meaningful data for use in the final determination of the acceptability of a single pilot LHX aircraft. ARTI has been recognized by the Department of Defense as being on the leading edge of technology demonstrator programs which marries together the human factors, engineering, and operational consideration which ultimately make up a total systems design.

Results of the ARTI program to date are clearly indicating that early integration of human, technical, and operational issues can be achieved and will ultimately provide the best possible system within the minimum development cost, time, and risk. ▮▮▮▮

ARTI PROGRAM TEAMS

Bell Helicopter Textron
Honeywell, Sperry Flight Systems, and Texas Instruments

Boeing Vertol Company
BMAC, Harris, and Westinghouse

Hughes Helicopters, Inc.
Honeywell, Hughes Aircraft, McDonnell Douglas, and TRW

IBM
Aerospatiale, BEI Defense Systems, DCS Corporation, Starmark Corporation

Sikorsky Aircraft
Hamilton Standard, Martin Marietta, Northrop, Rockwell Collins, and TRW

THE Army has tasked Aviation with the official mission "to conduct prompt and sustained combat operations." In doing this mission, Mr. Aviator, do so as a member of the combined arms team and incorporate your operational capability not only in the day-to-day training of this team, but also into the "how to fight" of the other branches.

What this really means is that the aviation brigade commander must perform the various combat, combat support, and combat service support functions while at the same time fitting all this into the tactics of the numerous players who must operate on the battlefield (tankers, artillerymen, infantrymen, communicators, logisticians, etc.).

LHX: The User's Perspective

By COLONEL FRANK H. MAYER
TRADOC System Manager — LHX

Therefore, not only does the aviation commander and his staff need an in-depth knowledge of how to fight his organization (should it be required to operate as the fourth brigade of a Division) but the same in-depth knowledge and expertise in the tactical method of employment of the supported units is also required. Demanding, to say the least!

This is not all bad until we get to the question of what the battlefield of the future will require and what the aviation units today have at their disposal to conduct operational missions and fulfill the simplistic mission statement.

First, let's take take a quick look at the battlefield of the mid-1990's and beyond. The battlefield will be the Airland Battlefield, or modern battlefield as it is sometimes called.

The battlefield may be relatively unsophisticated, as Vietnam was during the early years, on which Army Aviation enjoyed freedom of movement, both night and day; or it may be a highly sophisticated battlefield on which the enemy emphasizes the principles of mass and maneuver -seeking victory through relentless prosecution, utilizing nuclear and chemical weapons, a large array of air defense systems, laser and directed energy weapons, and sophisticated fixed and rotary winged aircraft.

The modern battlefield is expected to be nonlinear. The enemy can be expected to sustain rapid movement during the offense using every available weapon at his disposal. It will be the kind of battlefield which will force us to gain the initiative, retain it, and aggressively and violently exercise this initiative to defeat the enemy.

Secondly, let's look at what the commander has been provided from an organizational and equipment standpoint. Aviation organizational structures have undergone almost continuous change (ARCSA I, II, III, IV, DIV 86, AOE) meaning different numbers of spaces and faces to do the job and ever fluctuating quantities of equipment all the way from radios to major end items, such as aircraft.

The problems associated with organizational personnel changes can be overcome with proper functional organizing and prioritization by the commander, but if he doesn't have the proper equipment in the necessary numbers, to conduct the battle, he is in a virtual "no win" situation.

In most of today's aviation organizations, the commander continues to be provided with aging, obsolete, less combat-capable aircraft that performed well in Vietnam, but cannot operate and survive on the sophisticated battlefield of the 1990's.

Is the Army fixing this problem? Yes! **How?** LHX!

The LHX will enable the aviation commander and the ground maneuver force commander to gain the initiative, retain it, and defeat the enemy. Because of its overall low signature, small size, exceptional maneuverability and agility, aircraft survivability equipment, and speed, the LHX will enable the aviation arm of the combined arms team to synchronously fight the battle and provide the ground force commander with the decisive edge to win.

By applying the basic principles of war—objective, offensive, mass, economy of force, maneuver, unity of command, security, surprise and simplicity (particularly economy of force, maneuver, security, and surprise) the aviation commander can significantly influence the battle by rapidly finding, fixing, and destroying the enemy through fire and movement. LHX is being designed to allow just that.

The LHX will be able to perform a variety of missions based on 48 mission profiles developed for LHX. The functional areas covered by these mission profiles consist of reconnaissance and surveillance; local area security; air defense suppression against air to air and ground threats; forward air controller support; anti-armor, area suppression escort duty; containment; interdiction; and harrassment. These are the starting points for the engineers and designers to initiate the development of the LHX.

" . . most commanders continue to be provided with aging, obsolete, less combat-capable aircraft"

It's important to understand that these mission profiles were not developed from a superficial lay down or made up haphazardly. The final mission profiles came into existence only after an exhaustive and detailed analysis of the battlefield, its characteristics, and its components, and how a battle is intended to be fought.

The basis for the LHX mission profile was the **TRADOC Standard Scenarios,** which is a common base of conditions and assumptions for all schools and centers to use in combat development studies. These studies are used as a standard from which various tactical scenarios can be developed, but limits a School or Center from tailoring a scenario to complement a specific weapon system being developed. Such as the case with the development of the LHX mission profiles.

In late 1982, the Aviation Center received from the Armor and Infantry Centers (at that time the proponents for attack, cavalry, and assault helicopter units) their respective mission profiles, analyzed them, and developed 48 scenarios (24 European and 24 Middle East) which were reflective of the Airland Battlefield requirements and Army Aviation deficiences identified in 1982 through the **Army Aviation Mission Area Analysis (AAMAA).**

" . . the single pilot answer . . will be further analyzed before entering production"

The profiles were then sent to the field and detailed comments were provided back to the Center. In most cases, the comments were based on comparing the profiles against real world "go to war" plans and, where required, the profiles were modified to reflect the coorelation between computer model developed scenarios/profiles and actual requirements.

This has resulted in having realistic mission requirements before entering any design effort for the LHX. As of today, the user has stated his requirements based upon realistic mission requirements (profiles), and the materiel developer is now funneling that information into preliminary designs which will result in a system that will be fully mission capable.

The fightability and versatility of the LHX has been its cornerstone, and as such, the LHX will enhance Army Aviation's contribution as a force multiplier in all mission areas. The design of LHX will expand Army Aviation's ability to perform its missions 24 hours a day in all types of terrain, weather and battlefield conditions.

The mission capabilities for LHX will be: conduct nap of the earth operations by incorporating a self-contained, low signature navigation system with worldwide application, to include a precision landing capability; incorporate a fully integrated, automated, single pilot cockpit

(TRADOC — Continued on Page 85)

The T800-XX-800 Turboshaft Engine: Out Front in Spirit and Commitment

THE time has come for the Army to move out front, meet the challenge, and set the standard for procurements now and well into the future.

In response to this challenge, Army Aviation is pursuing a comprehensive fleet modernization program to replace the aging Vietnam-vintage light helicopter fleet, which, in a decade, will average more than 20 years old.

The current LHX program schedule plans for the award of the T800 Engine contract in June 1985. In response to that schedule, the T800-XX-800 Engine **Request for Proposal (RFP)** was written and released on 5 December 1984 to industry. The RFP was structured to define what the Army wants; it is performance-oriented and does not specify how to do it. The specific intent was to permit maximum flexibility and cluding incorporation of an executive summary up front and a full table of contents.

The RFP contains a T800 System Specification which is truly a performance-oriented specification at both the system and subsystem levels. It allows the contractors to do the highly iterative process of design without being stopped or delayed by the approval of the Government for each iteration by the laborious and costly **Engineering Change Proposal (ECP)** process.

The design freedom required by the contractors in iterating to a final design solution will be accomplished by requiring only a final production specification upon completion of the Qualification Testing. This, then, will become our build-to specification. Plans and design proposals were made a part of the

By LIEUTENANT COLONEL WILLIE A. LAWSON
Assistant LHX Project Manager for the T-800 Engine

latitude in corporate initiatives.

Each engine contractor, utilizing his special skills in developing, qualifying, and producing engines, will be contractually bound to fulfill our mutually agreed-upon requirements. The contractors would provide the "how to's" plus their commitments and guarantees that would carry not only through the **Full Scale Development (FSD)** but be binding for the follow on Production contract. The formatting of the RFP was changed to make this RFP very readable, in-

response to the RFP. This allows an evaluation of the contractor's management capability without telling the contractor how to do his job.

The important thing about this RFP is that we did not blindly copy other specifications, but clearly understood what was needed. We tailored each specification for specific application and then included it in the RFP. Throughout this process, we maintained a Contractor/Government cooperation through essential feedback with RFP drafts provided to industry for comments.

T800 strategy and innovation

The strategy for the T800 engine program is to develop, qualify, and competitively procure an advanced, highly reliable, low life cycle cost engine. A **firm fixed price (FFP)** contract will be executed for the development effort. This limits the Government liability, shifts the cost risk to the contractor for successful completion of the contract, and allows contractors the maximum flexibility to accomplish the program within the contract price.

The thrust of the overall program is to achieve a balance of commitment and risk. Program costs have continued to climb in all programs; therefore, given the flexibility to utilize their ingenuity, contractors can go a long way in reducing this trend of spiraling weapon system costs. The T800 RFP allows them that flexibility.

The second major focus of the T800 RFP is competition which achieves the following objectives: a lower acqusition cost; better logistic supportability; increased Small, Small Disadvantaged, and Woman Owned Business industrial base; and less Government "in house" acquisition and management resources. Competition will be maximized beginning with development and coontinuing through production.

By requiring competitive contractors, or teams of contractors, to focus attention on being ready for production toward the end of the Full Scale Development program, we will:

- Improve production planning.
- Maximize dedication for on-cost/on-schedule effort.

"The program's thrust is to achieve a balance of commitment and risk"

- Provide for entering of production on time.

Reliability, Availability and Maintainability (RAM), on previous programs, was established as a goal. Testing effort required to prove the end item RAM levels was often completed during the initial production phase. Correction of RAM deficiencies then required redesign and additional testing with the Army bearing the burden of this expensive effort.

The T800 program requires the contractor to meet RAM requirements during Full Scale Development, therebydecreasing the expensive additional testing, minimizing production changes, and increasing user satisfaction.

Previous RFPs emphasized performance with RAM and ILS being of lesser importance and being considered as trade-off issues. The RAM and ILS influence on **Operation and Support (O&S)** costs have been recognized in the T800 program, and emphasis has been appropriately elevated in this RFP.

Manpower Personnel Integration (MANPRINT) efforts (which include human factors, manpower, personnel and training) spelled out in this T800 RFP will require emphasis sufficiently early to influence the design. In other words, the engine will be designed to fit the soldier in the field.

Continuous review of **Logistic Support Analysis Record (LSAR)** data will provide a more accurate data base which leads to better source data. This should result in better **Logistic Support Analysis (LSA),** design influences, provi-

AWOs seek an H-19C for the Museum

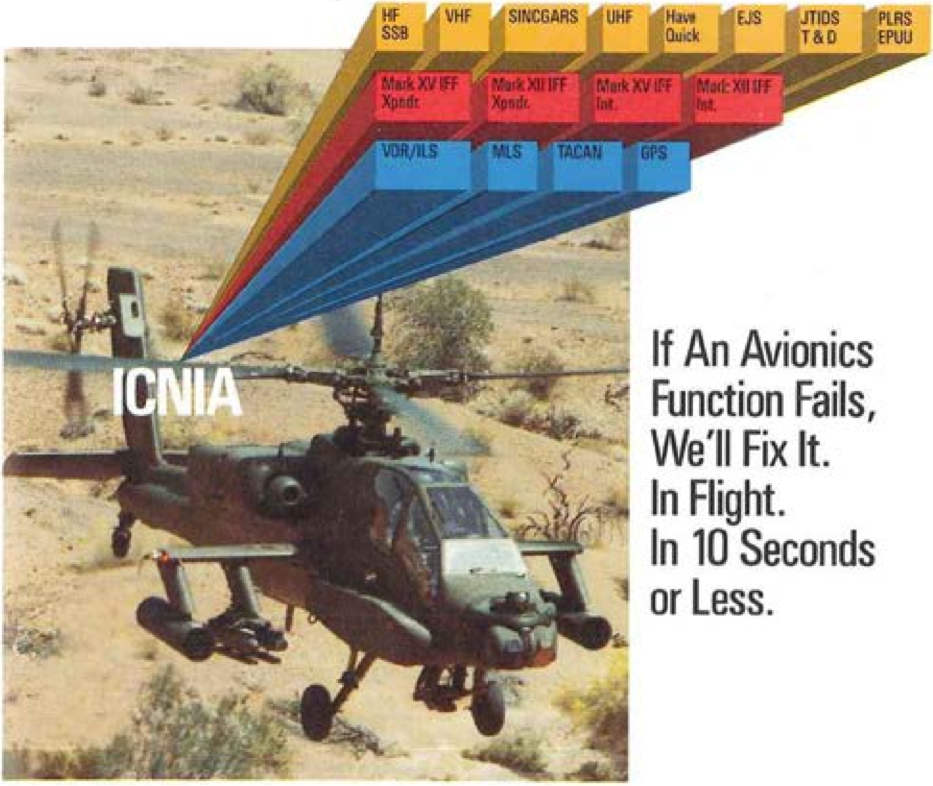
The members of the first three AWO classes - Classes 51A, 51B, and 52A - are spearheading a drive to locate and purchase an U.S. Army H-19C "Choctaw" helicopter. If purchased, the H-19C will be presented to the U.S. Army Aviation Museum in early 1987.

The first cargo/passenger type helicopter in the US Army inventory, the H-19C served in combat, resupply, and medevac roles during the latter part of the Korean War.

Only 72 of the "C" model helicopters were built by Sikorsky Aircraft, and it's assumed that there are very few of this model in use today.

Contributions may be made the "The H-19C Helicopter Museum Fund" and mailed to Jim Mowry, 3233 Gano, Houston, TX 77009. Should the drive be unable to obtain the necessary funding to buy an H-19C helicopter, all donated funds will be given to the U.S. Army Aviation Museum at Ft. Rucker, Alabama.

NEXT MONTH: The July, 1985 issue features the **1985 SPOOF (Society for the Preservation of Old Friends) Roster,** a directory of the AAAA's retired members.



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*Integrated Communication Navigation Identification Avionics sioning, training, publications, and cost analysis.

Prime contractor responsibility for training device development as a part of the "system" will result in effective training through timely delivery (to support Operational Testing training), fewer interface problems, and improved configuration fidelity with the end item.

"History shows that the competitive base has never been set so firmly"

The results of the above initiatives have yielded a shorter, simpler RFP than generally issued by the Government for a major development program. This is a visible, but superficial outcome. The more important, long term benefits of this strategy will be a reduction in the life cycle cost of the engine and an expansion of the industrial base to include the **continued development** of the small and minority business base.

Summary

In response to the T800 Request, the engine industry has taken our performance-oriented RFP and provided us with innovative proposals with many improved commitments and guarantees. The proposals are truly precedent setting.

It's always been our desire to maintain a spirit of stiff competition within the industry for all development and production programs, but only on rare occasions have we come close. This time we've managed to bring the largest and strongest engine companies into the competition.

The teams that have emerged as a result of this RFP are:

- LHTEC - **Allison Division of General Motors** and **Garrett Turbine Engine Company** in a partnership.
- APW - **Avco Lycoming** and **Pratt & Whitney** in a joint venture.
- GE/WI - **General Electric Company** and **Williams International** in a leader-follower arrangement.

Few people in the engine business, whether in the Government or private sector, would have guessed two or three years ago that we would be able to team the manufacturers and still promote the competitive environment that we believe to be so necessary.

The following outlines that strategy:

T800 Engine Competition Strategy

PFR	OT	Production
Competitive Develm't	Select One Contractor/ Team	Competitive Procurement
Two Contractors/Teams	One Design	Two Sources
Two Designs		One Design

Although only time and experience will tell whether today's acquisition strategy will meet all of our objectives, there can be little doubt that we've already accommplished a great deal. A glance at history shows that the competitive base never has been set so firmly nor as early as it is now.

The following depicts why we elected to have Full Scale Development competition within the T800 Engine Program:

- Final engine selection based on "hard" data, not "paper" data.
- Contractors have more incentive to meet/ exceed government requirements.
- Contractors do more up-front testing, analysis and verification.
- The lower tier production base is expanded.
- We expect an improved quality product.

The result? Competition Yields Better End Product Design.

We've seen thus far that the giants of the engine industry are willing to team and compete (and compete again) with a fixed-price attitude. Issuance of the T800 RFP was our first step in achieving innovativeness in our acquisition process.

Competition is our main deterrent against over-pricing. By providing the Army with two viable engine sources, both of which are capable of manufacturing the single engine design, we've provided for a broader production base and have ensured a positive impact on readiness within the Army.

True, we haven't awarded the first contract but we've taken a significant step forward. Industry, as a whole, has agreed to our basic conditions and adopted a favorable approach toward achieving the most for each taxpayer's dollar spent. IIIII

Virtual Panoramic Display for the LHX

MODERN scout/attack helicopters, flying nap-of-the-earth missions at night and with a single crew member, may require cockpit controls and displays which differ radically from traditional configurations.

Current cockpits usually require the pilot to view several instruments in order to organize a mental picture of the world and to understand the state of his aircraft and weapon system relative to this world.

The newer, multi-function, electronic controls/displays are essentially complex, programmable computer terminals through which information on a digital bus is selected for presentation in a highly coded form (i.e., alphanumerics and/or simple graphics) in various locations in the cockpit.

This sensor imagery is constrained by small panel-mounted displays that limit the combined field-of-view of the sensors, thereby reducing stimulation to the pilot's peripheral vision which mediates a sense of spatial awareness. Although most crew members can eventually adapt to these control/display configurations, this inefficient organization and portrayal of information taxes his perceptual capabilities.

Many mental transformations are required to glean the overall mental picture of what's going on. Within a highly dynamic combat environment, especially where there are many uncertainties, a single pilot may become quickly saturated and lose his sense of spatial awareness.

By DR. THOMAS A. FURNESS, III
AF Aerospace Medical Research Laboratory, WPAFB, Ohio

The virtual cockpit

In order to solve these problems, AVSCOM, and the Air Force Aerospace Medical Research Laboratory, Air Force Systems Command, have undertaken a cooperative project to pioneer a revolutionary cockpit control/display system termed the "virtual panoramic display" or "virtual cockpit".

This interactive control/display system provides the pilot with a visual panorama of sensor and aircraft avionics information organized both spatially and temporally in three-dimensional virtual space. This control/display system communicates to the pilot an overall awareness of the battlefield and provides control of his weapon system state relative to the world, its threats, and targets.

This system concept is based upon the use of advanced head-eye-hand position sensing and display devices coupled to the flight helmet. The purpose of the project is to mature these technologies to enable a virtual panoramic display design alternative for the prime LHX contractors during full scale development.

VIRTUAL COCKPIT

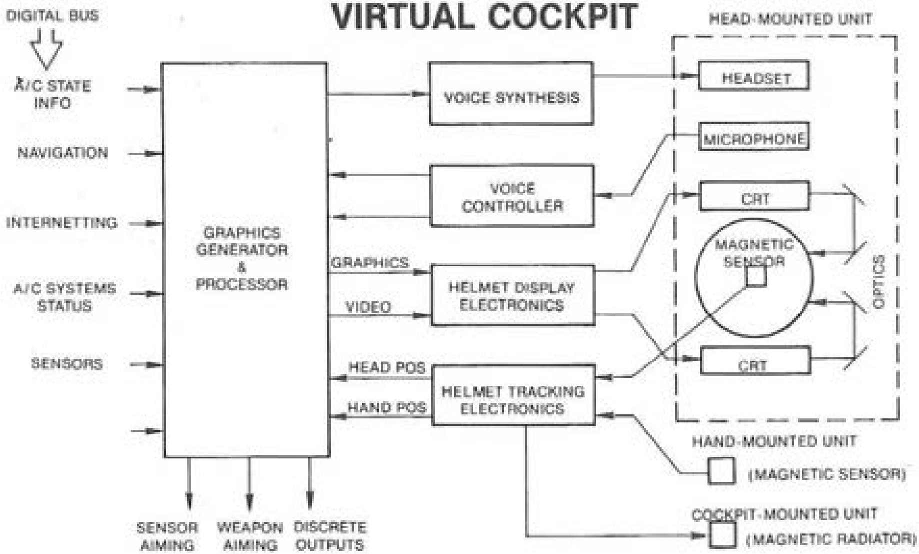


Figure 1 depicts the functional components of a virtual panoramic display which may be envisioned for the LHX. In the virtual panoramic display, electronic images, instead of being presented on a panel display as in current systems, are generated on miniature **cathode-ray tubes (CRT)** mounted on the helmet and projected through visor optics into the pilot's visual field. A magnetic head position sensor tells the CRT where to aim and the graphics computer where to position the visual information based upon where the pilot is looking at any given time.

"The design goal is to maintain helmet weight at less than 3.5 pounds."

In this way, a global, sterographic, electronic world can be presented which is registered with and can overlay the real world. Hence, information relevant to the states of the aircraft and environments are represented in spatially relevant directions and locations (as they would appear in the real world) allowing the pilot to easily form an overall context or "gestalt" of this display world that matches his normal interaction with the real world.

Information from sensors, threat warning systems, terrain maps, and weapon delivery envelopes are decoded from the mission avionics digital bus, organized and presented appropriately in the proper location in the global display. **Figure 2** (on the next page) indicates what the pilot might see on this display.

The pilot interacts with the display by pointing his head or hand at objects in the display and verbally giving commands. Functions can also be activated by merely looking at a displayed switch and saying "select" or "on" or "off" or "go there" or "stop here". Hand orientation once placed in preselected portions or virtual space can also be sensed and used to command functions relative to virtual switch panels which are presented on the virtual panoramic display.

Headgear design

Perhaps the most critical component of the virtual panoramic display is the design of the headgear containing the helmet-mounted display image sources, relay optics, and helmet position sensor. This modern headgear must serve several functions, not only as protection from impact and noise, but also a platform for communications and the virtual panoramic display. The mass of the headgear is also critical. In order to maintain an acceptable weight to minimize the potential neck injury in case of impact, the design goal is to maintain helmet weight at less than 3.5 pounds. Laser flash protection and chemical and biological defense protective components must also be designed into the headgear.

> **"The pilot interacts with the display by pointing his head or hand at objects in the display."**

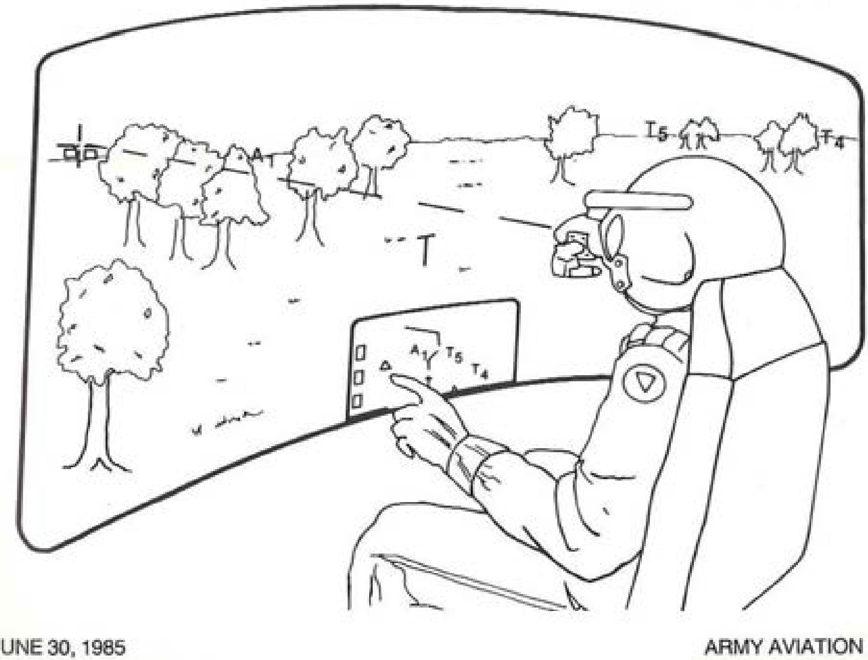
The design goal of the virtual panoramic display is to provide a binocular presentation with a total instantaneous **field-of-view (FOV)** of at least 90° in the horizontal axis and 60° in the vertical axis. Such a FOV could be obtained by providing two 60° oculats (i.e., one for each eye) with a common overlapped FOV of 30° in the horizontal dimension. Within the binocular overlapped region, information could be presented sterographically.

A total of five binocular optical designs are being considered in the project with varying development risks and each taking different approaches for relaying the image from the CRTs to the eyes. One such approach makes use of catadioptric binocular optics, two 0.8 inch diameter cathode-ray tubes, a magnetic sensor for helmet tracking, and various chemical defense components.

Since the display must be used under both daylight and night conditions, tradeoffs must be made in light transmission from the outside world and the cathode-ray tube image sources so that the images on the display are visible under high luminance daylight conditions.

The simulations

In order to test the viability of the virtual panoramic display, several experiments have been conducted with a special purpose simulator developed by the Air Force Aerospace Medical Research Laboratory to test virtual cockpit concepts. Termed the **Visually-Coupled Airborne Systems Simulator (VCASS)** the simulator uses a high accuracy magnetic helmet



position sensor and wide field of view (120° horizontal by 60° vertical field of view) helmet-mounted display interfaced with computer-generated information to represent both the virtual cockpit and the outside world.

Preliminary experiments conducted on the VCASS, using operational Army pilots, have shown an enthusiastic response to the virtual cockpit approach as well as a desire for a wide field-of-view virtual panoramic display for the LHX mission.

The payoff

It's anticipated that the real advantages of the virtual panoramic display will be realized from improved operator interface, design flexibility, and cost effectiveness standpoints. Since the virtual panoramic display can convey almost all of the cockpit information, it's now possible to eliminate many conventional cockpit instruments (with the exception of a few backup instruments), significantly reducing system life-cycle cost.

Because very little hardware is needed to implement the virtual panoramic display, there can be a large reduction in the weight of the system as compared to a conventional cockpit. Only one system needs to be developed to serve the **whole** cockpit for not only the operational mission, but also crew member training. The display, in essence, serves as its own visual simulator for either ground training or embedded training (i.e., the helicopter doesn't have to takeoff in order to fly the mission visually).

A third advantage is that the display can grow with mission equipment upgrades. Since the display formats and operator interactions are now configured in software, the total cockpit configuration can be changed instantly by changing the program. One vehicle can be used in a multi-mission role with the same cockpit hardware.

Harvesting the potential

Even with these cost and flexibility advantages, the ultimate payoff of the virtual panoramic display will be seen in the pilot's ability to perform the intended LHX mission as a **single operator.** The virtual cockpit approach has the potential of providing the most useful display interface to the pilot, matching his perceptual and psychomotor capabilities, and thereby harvesting the enormous potential in skill and cunning which is afforded by the human in the system.

Wind Tunnel and Engineering Simulation Program

FOR helicopter manufacturers the **Light Helicopter Family (LHX)** represents an opportunity to participate in the largest planned procurement of rotary wing aircraft in the history of the industry. For engineers, scientists, and technologists in industry and Government, LHX is also the most significant opportunity to demonstrate their accomplishments since the development of the BLACK HAWK and APACHE in the 1970's.

The LHX Utility will cruise significantly faster and lift a ton more than its venerable predecessor, the UH-1 IROQUOIS. For **nap-of-the-earth (NOE)** flying, the **Scout/Attack (SCAT)** LHX, and to a lesser degree, the Utility, will also have maneuvering capabilities which will far exceed the capabilities of the aircraft they replace.

These requirements demand the use of the best technology we have available. Aerodynamically cleaner fuselages, rotor systems which are more refined aerodynamically but simpler mechanically, and innovative alternatives to the conventional tail rotor can be expected to figure prominently in designs proposed for **Full-Scale Development (FSD).**

The **preliminary design (PD)** of LHX SCAT and Utility configurations has been completed by four contractors—Bell Helicopter-Textron, Boeing Vertol, Hughes Helicopters, and Sikorsky Aircraft. Dozens of possible configurations generated by rough layouts, parametric sizing, and approximate analyses appropriate for preliminary design were compared with design requirements resulting from consideration of possible threats and the tactics of AirLand Battle 2000.

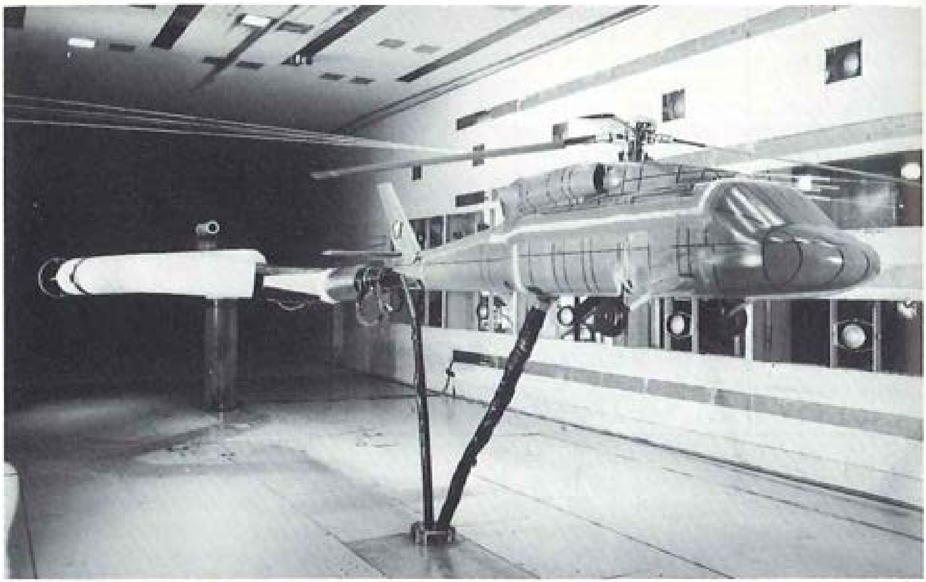
Each of the contractors has determined a **best technical approach (BTA)** which he feels meets the design requirements and conforms to cost, weight, and configuration guidelines provided by the Army. Their next step is to refine their BTAs so they will be ready for FSD consideration. During this phase much more sophisticated analyses will be used to define the geometric and structural properties of the rotor system, airframe, and directional control/anti-torque system.

Although our analytical methods, data base, and design practices are an excellent basis for preparing advanced designs, acceptance of any of these designs **without** substantial and directly applicable testing of their aerodynamic and mechanical characteristics still constitutes an unacceptable risk to maintaining cost and schedule goals for FSD!

This seemingly harsh opinion is solidly based on the Army's experience in major recent helicopter development programs including BLACK HAWK, APACHE, and AHIP.

By DR. RICHARD M. CARLSON

Director, U.S. Army Research and Technology Laboratory



Accordingly, the **Applied Technology Laboratory (ATL),** a Ft. Eustis, Va.-located element of the Research and Technology Laboratories, in conjunction with the LHX Program Manager and AVSCOM Directorate for Engineering, has undertaken a contractual program with each of the airframe manufacturers who participated in the PD phase to develop comprehensive wind tunnel data bases for their BTAs which will provide acceptable risk for FSD.

"Wind tunnels . . must be capable of attaining transonic speeds in the neighborhood of 760 mph."

The Government-sponsored work will complement contractor-funded testing and engineering simulation prior to FSD but will **not** eliminate the need for further testing as the designs change during the detail design phase of the LHX rotorcraft. Data will be available by the fall of next year, just in time for consideration by the **Source Selection and Evaluation**

ABOVE: A powered scale model of the UH-60A BLACK HAWK undergoes wind tunnel/simulation tests at AVSCOM's Research and Technology Laboratories at Moffett Field, CA.

Board (SSEB) which will help select contracttors to enter pilot production of six SCAT and three Utility aircraft.

In addition, the data obtained in this series of tests will be used to upgrade simulations developed for the **ARTI (Advanced Rotorcraft Technology Integration)** Program described in another article in this issue. The types of tests that will be conducted during the next year or so are described below. Keep in mind that the Government is not sponsoring all the testing and that the sponsored tests vary from contractor to contractor, depending on the availability of relevant data and the contractor's own research plans.

The first wind tunnel tests to be performed will also be the least complex because they do not include any rotating machinery. The airfoils to be used on the LHX will be tested over the complete range of airspeed and wind incidence (angle of attack) that they'll be expected to encounter within the flight envelope of the aircraft. These tests will typically be performed with uniform airfoil sections that are about 6" wide

ABOVE: An airframe model of the AH-64A APACHE undergoes wind tunnel/simulation tests (left), while a full-scale model of an APACHE composite tail rotor shows the size of the facilities available at Moffett Field.

and one to two feet long.

Wind tunnels suitable for such testing may have small test sections but must be capable of attaining transonic speeds in the neighborhood of 760 mph, simulating the environment of the rotor blade tip in high speed forward flight. Pressure taps on the upper and lower surfaces of the model will be used to determine the forces acting on the airfoils. Desired characteristics of rotor blade airfoil sections include high lift at low speed, low drag at high speed and freedom from abrupt changes in torsional moments at any condition.

"LHX is the most intense wind tunnel program ever conducted within the helicopter industry"

A second kind of wind tunnel testing that does not require the rotor is **airframe aerodynamic testing.** The basic fuselages of both the Utility and SCAT LHX will be tested alone, and then other components, such as the tail surfaces, weapons, and antennae, will be added until the flight configuration is attained. This type of testing is necessary to understand the effects each component has on the aircraft drag (and, therefore, the power required for forward flight and maximum forward speed) and other forces and moments which determine the aircraft handling characteristics.

Forces and moments will be measured by internally mounted balances. Pressure taps in regions of particular concern, probes to determine velocity profiles around the airframe, and tufts on the model which give a visual picture of flow direction at the surface will also be used. Flight conditions tested will include the full flight envelope—forward, sideward, rearward, climbing, and descending flight. Much larger wind tunnels will be used for this type of testing because the test section walls must be far away from the model to avoid interference effects.

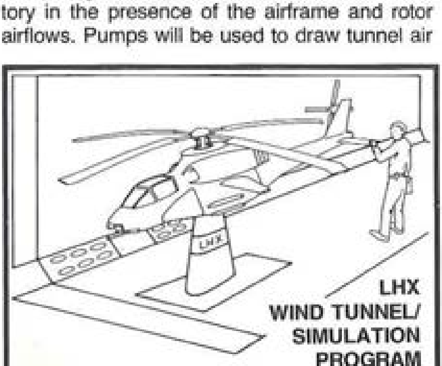
For powered model tests, the main rotor and tail rotor will be added to the fuselage and the objectives of the test will be expanded greatly. Prime concerns will be the performance and loads on the main rotor and the highly complex aerodynamic interactions between the main rotor, directional control device, and airframe. Furthermore, testing will be done in and out of ground effect. Additional data from these tests will include rotor blade loads and rotor forces.

The models for aeroelastic stability tests will look similar to those used for the powered model tests. However, instead of being directly and solidly mounted to the test stand, the rotor is attached to a gimbal which permits the entire rotor system to move and respond the way it would in flight or on the ground. The objective of these tests is to assure freedom of the designs from catastrophic instabilities which can literally tear a helicopter apart.

Although the tail rotor or its replacement will have been adequately represented aerodynamically in the powered model test described above for the purpose of determining overall aircraft characteristics, its smaller size (usually about one-fifth the size of the main rotor) makes it hard to represent detailed mechanical characteristics. A larger scale test of the tail rotor will be performed to determine structural loads, performance, and freedom from instabilities.

"The objective is to assure freedom . . from catastrophic instabilities which can literally tear a helicopter apart."

Engine installation tests will be a further complication of the powered model tests. The objective here is to determine that the aerodynamics of the engine inlet and exhaust will be satisfactory in the presence of the airframe and rotor airflows. Pumps will be used to draw tunnel air into the inlets and hot gas generators will expel gas at representative temperatures and velocities from the exhaust.



Pressure losses and flow distortion of the inlet and exhaust, heating of adjacent airframe components, and recirculation of exhausted hot gases into the inlet which could cause sudden severe reductions in engine power output will be monitored with many pressure probes and quickly reacting thermocouples.

'Accepting any designs without substantial tests of their aerodynamic characteristics (is) an unacceptable risk.'

Probably, the ultimate risk reduction test is one conducted at full-scale. Of course, a 100% identical model cannot be tested until the LHX flies but some very satisfactory work can be done with similar large scale models. Contractors' exact plans for doing large scale testing are not available as this article is written but might include whirl tower or wind tunnel testing of just the rotor system or actual flight testing of the proposed rotor system scaled up or down to fit on a test aircraft. The primary purpose of the full-scale tests will be to verify that the extensive data base collected at smaller scale will be applicable to full-scale designs.

The wind tunnel program I have described is the most intense such activity ever conducted within the helicopter industry. (The JVX involved a similar number of tests, but for a single configuration.) Indeed, there was some initial concern that there might not be enough suitable test facilities in the country to perform the program in the required time, especially in view of the unavailability of some Government facilities which are being renovated.

Fortunately, this has not been the case. We look forward to the challenge of obtaining and interpreting the vast amount of data that will be forthcoming for these advanced LHX configurations.

We also can't help feeling a bit of pride that the work that we have been doing in the areas of advanced analyses and experimental investigation of advanced concepts has helped make it all possible! ▮▮▮▮▮

Training Support System

THE one word "innovation" which occurs throughout the LHX program also best describes the Training Support System. Unlike more traditional approaches, the LHX **Request for Proposal (RFP)** will require each contractor, or contractor team, to design and develop a total training support system to include courseware and appropriate aids.

This training support system will be evaluated during the **Development Test/Operational Test (DT/OT)**, thereby ensuring that a totally validated training system is available prior to First **Unit Equipped (FUE)**. Many people feel this requirement cannot be fully met due to the dependency of training development on the aircraft design and performance characteristics.

Others, however, believe that through increased use of engineering simulators in aircraft design, especially in the area of man-machine interface, human performance parameters and constraints needed for developing the training system can be defined early and continously throughout the program.

Emphasis on **manpower and personnel integration (MANPRINT)** initiatives to define manpower and personnel constraints provides new opportunities for early determination of training system parameters which relate available personnel capabilities to manpower skill and knowledge requirements.

In addition, developing programs of instruction and unit training plans, obtaining classroom space, and the design, development, and delivery of training devices must all be integrated and harmonized to achieve concurrent fielding of the training system.

The **Project Manager for Training Devices (PM TRADE)**, under its recently expanded mission of providing training system concept formulation packages, and the current agreement to support PM LHX, is working closely with other members of the training community to provide the leadership and experience needed for successful achievement of the training objectives.

Current training strategy envisions the Airland Battle doctrine set forth in FM 100-5 and the emerging Army 21 concept, in combination with MACOM policies and agreements, as the operational umbrella for developing training doctrine and design. As the LHX matures, system-specific operational doctrine will be modified as necessary to incorporate the LHX's unique capabilities.

All new mission profiles and related tasks generated by the LHX will be incorporated into new and distinct soldiers' manuals, job books, soldiers' guides, skill qualification tests, aircrew training manuals, **Army Training Evaluation**

By COLONEL JAMES W. BALL
Project Manager for Training Devices, USAMC

Programs (ARTEP), the annual written examination for aviators, and standardization and evaluation flights.

The training support system will consist of all programs of instruction, courseware, technical documentation, and devices and training aids required at respective institutional and field training locations. The precise quantities and mix of the elements of the training support system will be developed commensurate with producing fully qualified personnel, while maintaining the highest standards of safety and mission readiness at an affordable system life cycle ownership cost.

Institutional training will be developed to produce personnel fully trained to journeyman skill levels for the MOS defined from MANPRINT analysis and the resulting **Qualitative and Quantitative Personnel Requirements Information (QQPRI).** Strategy for aircrew training has advanced quicker than that for maintenance and support training. During the first four to six years, aircrew training will be conducted in an **aircraft qualification course (AQC).**

"Early training may be conducted in a general purpose LHX aircraft."

Beginning in the fourth year after fielding, the LHX will be phased into the **Initial Entry Rotary Wing (IERW)** program to replace the currently used UH-1 and other light mission helicopters. The early phases of IERW training may be conducted in a general purpose LHX training aircraft, with the advanced combat skills phase being conducted in mission-specific aircraft. Students will be tracked into either the LHX-SCAT or LHX-U beginning with combat skills training and will thereafter be assigned and manned accordingly. AQC/IERW will incorporate team training and realistic scenario practice to produce combat mission-ready aviators.

Sustainment and continuation training will be conducted in operational units in accordance with training doctrine. Increased use of simulated environments and electronic job aids for training will be explored as a means of reducing the life cycle operating cost while improving the effectiveness of training. Concepts of ongoing, continuous evaluation and qualification of skill levels using simulated environments will be considered as a possible way of establishing criteria for eligibility for using operational flight hours. Special consideration will be given to ensure that Reserve and National Guard units can use the same training strategy as the Active Army component.

"The opportunity for continuous feedback of operator performance. ."

The LHX training system has several high interest topics under active consideration: embedded training, turn-key training, and a training aircraft. With the anticipated highly automated man-machine interface using high technology "glass cockpits", unparallelled opportunities will exist for activating these interfaces with simulated scenarios. Likewise, as these computer moderated interfaces become more interactive, the opportunities for continuous evaluation and corrective feedback of operator and maintenance performance increases.

A major trade-off lies with what extent such capability should be integrally built into the operational equipment versus connected on and off for training. Fully incorporating devices compatible with the **Multiple Integrated Laser Engagement System (MILES)** and eye-safe laser range finder/designator capabilities are examples of embedded training opportunities.

Turn-Key training systems have been used successfully for some time. With this approach, a supplier develops and provides a total training package, including training devices appropriate for training individuals to prescribed skill levels. To what extent such an approach can be applied in the LHX program is still being considered.

Clearly, meeting the objective of developing and having the training system become operational concurrent with the aircraft fielding presents a major challenge. This becomes especially true when requirements to minimize life cycle ownership costs are included.

With this in mind, PM TRADE, in coordination with TRADOC, the **Army Research Institute (ARI)**, and the **Human Engineering Laboratories,** is setting forth a baseline frame of reference to use in competitive procurement specifications, evaluations, and source selection which will ensure that the LHX training subsystem objects are met. IIIII

BELL Helicopter has a deeply rooted commitment to Army Aviation and the LHX program. This commitment to the LHX started well before Program Milestone 0 was reached and is manifested in many preparatory technology programs.

Two of these are most important: The **Advanced Composite Airframe Program (ACAP),** sponsored by the U.S. Army Applied Technology Laboratory, Ft. Eustis, Va.; and Bell's Independent Research and Development Program on 4-bladed bearingless rotors (Bell Model 680) with actual hardware now flying for over two years.

Bell: A deep commitment to the LHX Program

By WALTER G. SONNENBORN, Director of Advanced Technology Programs, Bell Helicopter Textron

Also, Bell formed a team with companies from the electronics industry in support of the integrated cockpit and mission equipment package. This article discusses these and other topics.

The ACAP (photo, next page) exceeds the Army's key goals for advanced composites airframe structures. It provides a:

- 17% reduction of fly-away cost using 1985 manufacturing technology.
- 22% reduction of an airframe weight when compared to a metal baseline designed to the same requirements.
- 20% reduction in an airframe related maintenance man-hours per flight hour primarily through the elimination of corrosion, fasteners, and many associated wear-out modes of metallic structures.

Bell chose a unique approach to composite airframe structure, using large components of up to 26 feet in length. The co-cured integrated structure avoided the need for costly splices in the major load paths thus combining structural efficiency with low manufacturing costs.

The low cost and ultra light fire containment structure in the engine area is also noteworthy. This structure is nonmetallic and has been successfully flame tested at 2,000º for 15 minutes without penetration. Ballistic testing of the Toolproofing Article has been completed at ATL and testing of the Static Test Article is in progress while the third article is in final preparation for flight test.

The results of the ACAP program have given Bell the confidence to commit to an all-composite airframe design for the V-22 Osprey and the LHX helicopter. The entire U.S. rotorcraft industry is benefitting through the distribution of technical reports and technology transfer seminars planned for the near future.

Bell's Model 680 all-composite bearingless rotor has been test flown on the Bell Model 222. The simple fail-safe design has reduced parts count by 60% of contemporary articulated rotors and portends a corresponding reduction in O&S costs. This virtually maintenance-free rotor has a minimum of 5,000 hours life on all components and provides a vibration environment believed to be unmatched by any other helicopter.

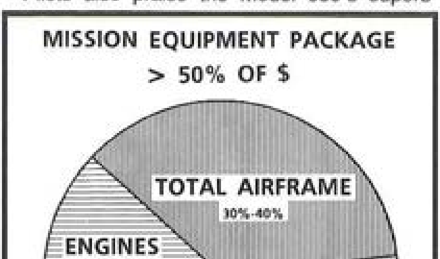
Vibrations at **all** pilot and cabin stations stay below .05 g's at all airspeeds and c.g. conditions with the exception of the very narrow transition region where never more than 0.1 g was measured. These unprecedented comfort levels are maintained in even the most severe maneuvers which include pushovers to below 0 g's and split S maneuvers in which pull-out speeds from a

FIGURE 1- THE BELL ACAP

vertical dive approaching 210 knots were measured.

This achievement is even more remarkable because no blade vibration suppression pendulums or active computer driven vibration control devices were employed. The rotor is mounted on a greatly simplified version of Bell's focused pylon/nodal beam suspension.

Pilots also praise the Model 680's superb



handling qualities and gust penetration cha acteristics. They are achieved through carefu tailoring of blade, hub, and mast stiffnesses an appropriate control couplings. Roll rates of ove 60°/second have been demonstrated with mini mal pilot effort. These combined comfort an handling qualities will be appreciated by th future combat pilot who is looking for unpre cedented agility at moderate workloads an minimum environmental fatigue.

The jet smooth vibration environment will als increase the reliability of the aircraft sub systems, particularly some of the more delicat electronics systems of the flight controls and th mission equipment package of LHX.

This brings us to perhaps the most importar subject in the development of future advance military aircraft, i.e. the **mission equipmen package (MEP)**. The value of the MEP will ou weigh the cost of the engine/airframe combin ation. (See **Figure 2**). Recognizing this earl Bell in 1983 conducted a competition an selected as its LHX MEP partners:

- **Texas Instruments** — Targeting, Naviga tion, Communication, ASE.
- **Honeywell** — Flight Controls.
- **Sperry** — Displays, Cockpit Managemen

In pursuit of a key goal for LHX — Single Pilo Combat Operations — this team has alread under the **Advanced Rotorcraft Technology Integration (ARTI)** Program, demonstrated a major workload reduction feature. On Feb. 26, 1985, under the full authority control of a Honeywell/Bell digital fly-by-wire control system, Bell Pilot **Tom Warren** flew numerous hands-off automatic maneuvers. These included precision hover in wind gusts of 25-30 knots, pop ups, slew to target, and remask. The aircraft was Bell's ARTI test vehicle, a 4-bladed Model 249 COBRA.

At this point, the single pilot effectiveness assessment is not finished as only the initial tasks under the ARTI program have been completed. A detailed mission segment by mission segment workload analysis has pinpointed the key areas that are in need of automation if a single pilot is to be successful on the future battlefield.

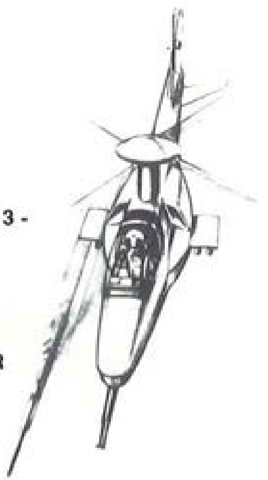
This study also concluded that a large degree of automation over current technology will be required. This is because projected threat systems are driving time lines well below what is available with today's sensors and information processors regardless of the number of pilots. For example, scanning of the target field will have to be accelerated by a significant factor if we are to identify targets before they have an opportunity to launch a weapon against us.

"Bell chose a unique approach to composite airframe structure using large components . . "

The Bell team is pursuing further programs aimed at LHX in virtually all fields of rotorcraft technology, including transmissions, advanced sensors, VHSIC computer, airfoils, aeroelasticity, electro-optical systems, fiber optics, displays, etc. While this high tech side is expected for a full capability rotorcraft team hoping to compete for the single most important future Army Aviation Program, Bell will not overlook logistics, training, and **manpower integration (MANPRINT)**, which are equally important.

Bell recognizes the need for simplified maintenance tasks in an inherently more complex and capable system. To reach this goal, we have abandoned the traditional black box approach and designed a truly integrated system that will be capable of extensive self-diagnosis and maintenance guidance.

FIGURE 3 - THE BELL LHX SCAT HELICOPTER



A rigorous modular approach solves the conflicting requirements of high capability — usually associated with complexity — and reliability/maintainability — usually associated with simplicity. Modularity is the reconciling concept that simply breaks a large task into easy bite-size chunks.

Our detail data, developed in a top-down systems engineering approach, predict that O&S costs can be reduced by 40% over current simpler but less reliable systems and that no increase in maintenance manpower skills will be required.

The recent decision by the Chief of Staff of the Army to eliminate all advanced rotorcraft, including tiltrotors, from consideration for LHX, resulted in a concentration of our design efforts on a single main rotor helicopter configuration that will meet the Army's goals within cost and weight constraints. (See **Figure 3**).

Bell's technology is ready for the most critical aspects of this advanced helicopter. Rotor, controls and airframe, have already been demonstrated in the right size class on ACAP, Model 680/222 and the fly-by-wire COBRA.

In summary, Bell's progress towards a winning proposal for the Army's new LHX is in step with the acquisition strategy time table IIIII.

Boeing Vertol Gets Ready to Produce the LHX

By WILLIAM W. WALLS
LHX Program Director, Boeing Vertol Company

SIX years ago, **Boeing Vertol Company** saw in the Army's LHX development program a significant opportunity to exploit the progress we were making in our research and product development. We identified the critical technologies for such an aircraft and, through our own and contracted research, focused our efforts to enter a full-scale development program with a configuration that would fulfill the Army's needs.

Our activities ranged from fundamental high speed aerodynamics and dynamics improvements to special military technologies and military systems analysis. To assist us in the systems analysis and military technologies, we tapped the special skills developed by other units of **The Boeing Company,** whose vast resources and full support underlie our efforts.

These organizations are **Boeing Aerospace Company (BAC),** Kent, WA, **Boeing Commercial Airplane Company (BCAC),** Renton, WA, **Boeing Military Airplane Company (BMAC),** Wichita, KS and **Boeing Computer Services Company (BCSC),** Bellevue, WA.

Additionally, we awarded key subcontracts to **Honeywell Aerospace and Defense,** Minneapolis, MN; **Westinghouse Defense and Electronic Center,** Baltimore, MD; and **Harris Corporation,** Melbourne, FL, to include their expertise in flight controls, processors, sensors, systems automation, and pilot displays.

We're now well prepared to establish a full-scale development team with the engineering, production, and field support required for an LHX family of helicopters.

By combining two "breakthrough" technologies, **very high speed integrated circuit (VHSIC)** electronics and composite materials, into totally integrated systems, we can develop an LHX that will be both affordable and clearly superior to the alternative of attempting to improve existing helicopters.

In avionics, for example, digital-data busses and central processors, at the heart of these installations, will permit a degree of interaction never before possible between subsystems. No longer will avionics need to be consigned to a collection of black boxes incapable of communicating effectively with each other.

When it comes to addressing the more helicopter-specific flight control area, we're including our work for the Army on the **Advanced Digital Optical Control System (ADOCS).** In this advanced flight control system, optical fibers carry digital control signals to rotor actuators faster, more precisely and reliably, and with reduced vulnerability than current flight control systems.

The ADOCS program is also establishing low pilot workload control laws for **nap-of-the-earth (NOE)** flying characteristics. These equations express the relationship between the pilot inputs to the controls and the subsequent responses of the control system and the aircraft.

Additional work centers on the use of sidearm controllers replacing conventional cyclic and collective-pitch controls. ADOCS goals are to enhance both controllability of the aircraft and flight safety, but the prime objective can be summed up in just three words: **low pilot workload.** The cockpit is the focus of design attention with the goal being to define a low workload, single-pilot concept.

We realized some years ago that we needed a more cost-effective means to conduct cockpit and flight-controls development work. We, therefore, developed a simulation facility that would provide a wide-field-of-view display in the cockpit that presents a realistic NOE environment. Providing realism required inventing a special terrain-board probe, a unique optical system that creates multiple, correlated images giving the pilot lateral and vertical views necessary for safe flight.

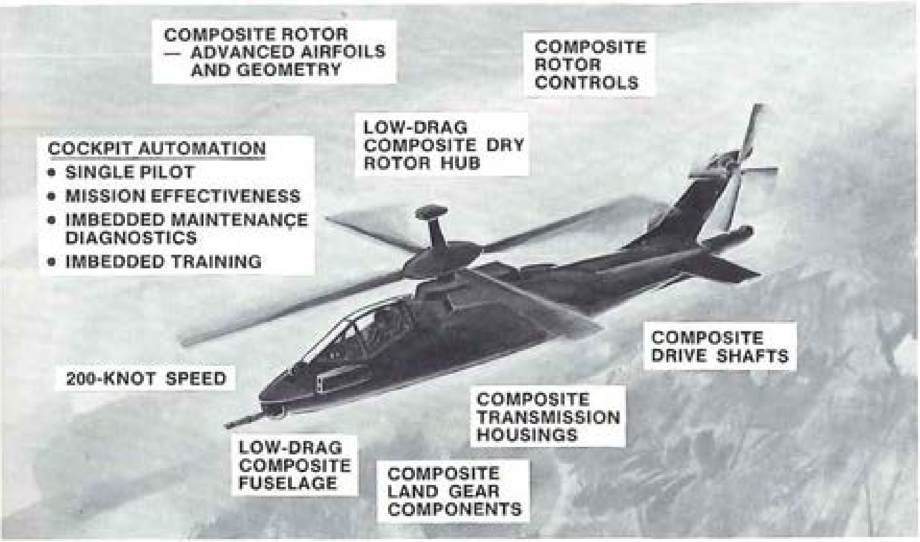
Boeing Vertol's simulation facility has explored a wide range of studies related to LHX control and display systems, which are complemented by avionics system designs. Complete LHX electronic systems and software are designed, developed, and built in a "hot-bench" installation. The hot-bench facility will permit efficient development, verification, and validation of the avionics mission equipment package, including software and cockpit controls/displays, prior to first flight.

The hot-bench consists of a set of core avionics equipment with associated operational software and a computer to model avionics functions, such as target acquisitions and navigation. The hot-bench is designed to allow replacement of the modeled functions with actual hardware to support a progressive hardware-in-the-loop development approach.

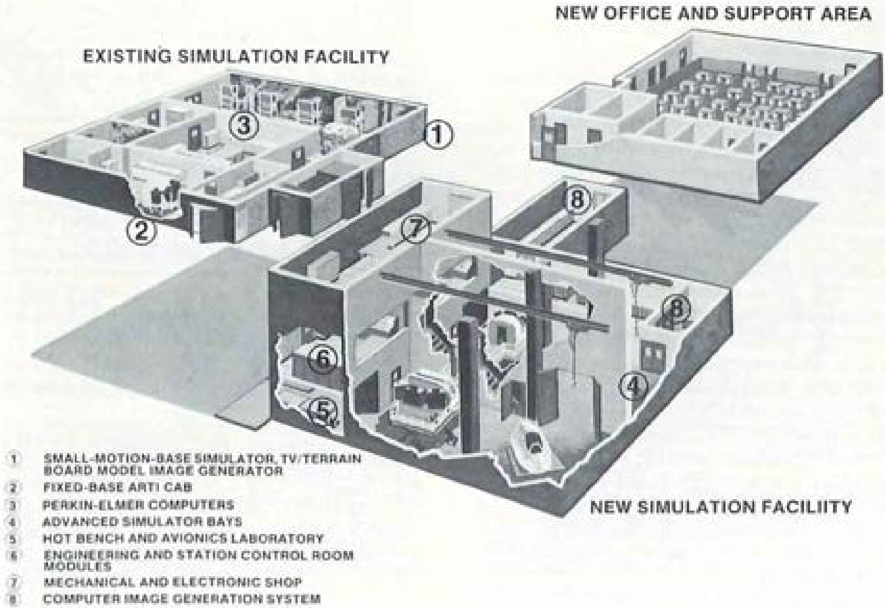
"Boeing developed a simulation facility that . . . presents a realistic NOE environment."

The hot-bench will be connected directly to our flight simulator creating a large-scale pilot-in-the-loop hybrid system which simultaneously assesses avionics functions, flight characteristics, pilot controls, and cockpit displays and workload.

This approach allows us to develop a combat mission trainer and to validate embedded training capability in the LHX configuration, thereby meeting the Army's objective of having full trainer support available along with initial deliveries. The "embedded" capability refers to designing the processor architecture, cockpit, and wiring so that each helicopter can become its own "ground trainer", by simply providing it with



ABOVE: Advanced technologies available for incorporation on a Boeing Scout/Attack LHX.



electrical power and the software necessary to drive the avionics and flight-control system with ample realism.

Built-in test and automated maintenance concepts will also be evaluated in the hot-bench facility. Boeing Vertol is tied into a company-wide artificial intelligence development network that will assist in this effort by creating the technology and software necessary for these manpower-saving maintenance techniques.

"Teaming will provide the synergism that will develop a superior product."

Composite technology and design work is rapidly progressing in programs, such as the **Bell-Boeing V-22** (formerly JVX) tilt-rotor aircraft, for which Boeing Vertol is developing an all-composite fuselage and BCAC is designing and tooling an all-composite wing.

We're doing more extensive work in the area of dynamic components, plus constructing an all-composite fuselage on the Boeing-sponsored Model 360 helicopter program. Composites are also being introduced on this aircraft in transmission covers, high-load shafting, and concentrated load fittings which are normally made of metal.

Boeing Vertol is a leader in low-cost manufacturing, factory automation, and low-cost composites tooling. Our engineering designers and manufacturing-technology experts are acting together to introduce labor and cost-saving automated machinery into the factory.

Our composite facility produces nearly a ton of these materials each day for use in rotor blades and other aircraft components. These technology advances are essential to the development of an LHX that can be produced to meet the Army's challenging cost targets.

Composites will also allow us to design and develop new airfoils offering unique benefits. These airfoils are optimized for high-speed flight and are more efficient in hover than those currently used, and will assure us of meeting LHX objectives by generous margins. Closed-die

(Boeing — Continued on Page 85)

HUGHES Helicopters, Inc. launched its LHX efforts in 1982 and has been building momentum steadily. Hughes recognized the emerging Army LHX activities, formed the nucleus of its team and began increasing its independent research and development activities to be commensurate with the technology requirements anticipated for the LHX.

It was in this time frame that the initial contract from AVSCOM's Directorate for Advanced Systems was issued to begin definition of potential

Hughes: An emphasis on a small, lightweight vehicle

LHX configurations. By 1983, as the Army began to define its **Advanced Rotorcraft Technology Integration (ARTI)** requirements, Hughes had identified two teammates to assist in developing a winning design. The teammates identified at that time were **Honeywell, Inc.** and **Hughes Aircraft Company.**

In early 1984, Hughes Helicopters became a subsidiary of the **McDonnell Douglas Corporation** family and recognized that **McDonnell Aircraft Company's** experience gained from their long history of fighter aircraft development would be a signifcant asset to the Hughes Helicopters LHX team activities and consequently were added to the team.

Therefore, the current Hughes Helicopters LHX team consists of **Honeywell, Hughes Aircraft Company,** and the **McDonnell Aircraft**

By DEAN C. BORGMAN, LHX Program Director, Hughes Helicopters, Inc.

Company. Other elements of the McDonnell Douglas Corporation also are providing support for the LHX effort on an as required basis.

From the outset, Hughes Helicopters has maintained an emphasis on keeping the LHX a small, lightweight vehicle, consistent with both the Hughes tradition of lightweight vehicles and, more importantly, the emerging requirements from the Army.

Hughes Helicopters received a second preliminary design contract in late 1983 to develop a **Best Technical Approach (BTA)** for LHX. The various designs that emerged from those studies are typified by the artist's conception shown in **Figure 1** (see next page).

Also, in this same time frame, Hughes Helicopters was awarded a contract for the ARTI program. The objective of this program is to determine the validity of the Army's stated goal for the LHX to be a single pilot vehicle. This has led to an emphasis on a highly integrated cockpit approach, built upon the APACHE experience at Hughes Helicopters and McAir's single seat fighter aircraft experience.

It has essentially dictated a design approch which is best described as 'inside out'. The Hughes approach focused on designing the aircraft and its mission equipment package around the pilot and his cockpit. To accomplish this 'inside out' design approach, the Hughes Helicopters team has been making extensive use of manned simulation. Part of the task simulation work is being addressed by all four team members; Hughes Helicopters, Honeywell, Hughes Aircraft and McDonnell Aircraft.

The results from these part task simulations are coming together in a fully capable combat mission simulator, which is now being developed for use at the McAir facilities. The Hughes simulation approach is based on that which has

An artist's conception of one of a number of LHX designs that is currently being considered by Hughes Helicopters.

been pioneered by McAir on fixed wing fighter aircraft development programs such as the F-15, F-18, and AV-8B.

The simulator becomes a key design tool in this development process. It uses an advanced visual display for the pilot using computer generated imagery, allowing realistic simulation of missions which may even include **Nap-of-the-Earth (NOE)** tactics as well as a complete array of both ground and air targets.

The Hughes Helicopters' team has completed its early phases of work in this simulator, and Army pilots have evaluated the aircraft cockpit design and its capabilities. The results are proving very encouraging in confirming the Army's goal of single crew operability.

"The simulator becomes a key design tool in (the LHX) development process."

As the simulator has become the key tool in the development process, Hughes Helicopters fully expects that this capability will continue to play a key role in the program throughout the life cycle of the aircraft. The simulator which evolves throughout the development program will continue its evolution into the training simulators to be used by the Army for the LHX aircraft.

The single pilot LHX will present many unique challenges to the training of both pilot and maintenance personnel and it is clear that the simulators must play a key role in a successful training concept to support the LHX.

The work on ARTI thus far has defined a baseline cockpit configuration which will continue to evolve throughout the LHX development program. The Hughes Helicopters' team has concurrently been pursuing the design of the remainder of the aircraft system as well. The LHX will exploit the technology that has been developed by the Army and the Hughes Helicopters' team over the past few years as necessary to meet the Army goals for LHX.

In particular, the LHX will encompass the technology developed under several recent technology programs. One example of this is the **Hughes Advanced Rotor Project (HARP)**, a new bearingless rotor concept that incorporates a flex beam made of composite materials and advanced airfoils in the all composite blades. This rotor design has been built on technology developed at Hughes in recent years and made a successful first flight on April 23, 1985.

"Simulators must play a key role in a successful training concept to support the LHX."

The HARP is expected to continue to contribute to the technology base upon which the rotor for the LHX can be built. The HARP rotor is shown during its first flight in **Figure 2**.

Another technology which will play a key role in the LHX program is the **Higher Harmonic Control (HHC)** concept. HHC is an active control system which reduces vibration levels throughout the speed envelope of the helicopter. Hughes was the first to successfully demonstrate in flight the feasability of Higher Harmonic Control.

Hughes first flew the Higher Harmonic Control concept in August of 1982. Development has continued on HHC since that time and it is clear that HHC can now be integrated with the advanced digital flight control systems which will be available for the LHX. In the case of the Advanced Digital Flight Control System, the Hughes team is demonstrating on an APACHE flight test vehicle the technology which will lead to an LHX application.

Another technology which is key to the Hughes team LHX concept is that of **NOTAR (No Tail Rotor).** NOTAR is a concept which has been pioneered by Hughes and was successfully demonstrated in flight in late 1981. It, too, has continued development since that time and will be a mature technology by the time the development program for LHX is initiated.

The NOTAR concept provides the aircraft designer and operator with their long awaited goal of eliminating the tail rotor and its associated maintenance and safety problems.

Finally, a technology which is fundamental to LHX meeting several of its design goals is that of composite materials. Hughes Helicopters has also been developing and demonstrating the benefits of composites design as applied to several key aspects of the helicopter. In addition to the use of composites in the rotor (HARP), Hughes has also been pursuing the application of composites in primary structural components of the fuselage.

"Utilization of composites will provide the Army pilot with new levels of crashworthy protection."

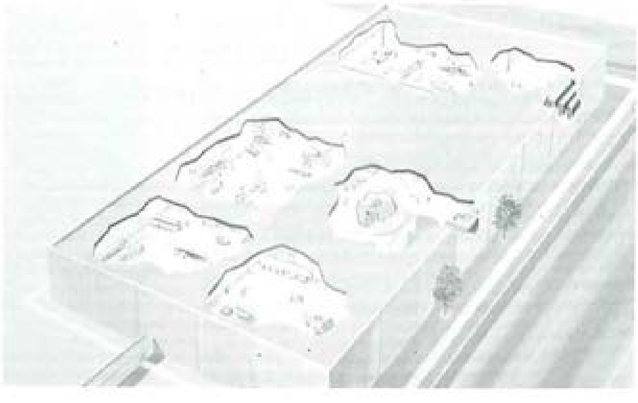
The crashworthy characteristics achievable through the proper design and utilization of composites to be incorporated on the LHX will provide the Army pilot with new levels of crashworthy protection.

In summary, the Hughes Helicopters team has laid extensive groundwork for the LHX in the form of technology development and design activities. Now Hughes Helicopters is launching a major expansion program at its Mesa, Ariz., location that will provide the facilities necessary for the LHX development and production programs.

The Hughes Advanced Rotor Project (HARP) is shown on its maiden flight on April 23, 1985. The HARP uses a modified Hughes 530F for the testing of all composite rotor blades.

On 6 March 1985, Hughes Helicopters broke ground for the new advanced development center and other facilities in Mesa, Ariz. An artist's concept of the development center is shown in **Figure 3.** The advanced development center is the centerpiece of the expansion program and will embody the latest in aircraft development laboratories. It will be completed in late 1986 in time for the initiation of the LHX development program.

The Hughes team is ready — and fully equipped — for the LHX program! IIIII



RIGHT: A conceptual view of the Hughes Helicopters Advanced Development Center to be built in Mesa, Arizona.

ARMY Aviation will have a different look in the 1990's and beyond. Demographic trends, especially toward smaller families, indicate a non-expanding pool of young men and women available for military careers. At the same time, the threat continues to grow.

Herein lies the dilemma: The capability of the fighting force must be increased to meet an expanding threat **without** increasing the overall force structure.

The LHX program offers unparalleled opportunities in this regard. **First,** a highly automated, single-pilot LHX capable of day/night, all-weather, nap-of-the-earth operation will substantially increase overall force capability and effectiveness without increasing the number of pilots required.

Sikorsky: Broad experience on which to base solutions

Second, the LHX will be designed from the outset for excellent **reliability, availability, and maintainability (RAM)**. Coupled with the implementation of a unit-level maintenance concept, improved RAM will permit a 50% reduction in maintenance manhours per flight hour, with 40% fewer personnel.

Third, commonality between the LHX scout/-attack and utility versions will reduce the demands on the logistics support system. Fifty percent fewer spare and repair parts will be required to support the LHX force, and fewer people to handle them, fill out the paperwork, and perform allied chores.

As developer and manufacturer of the Army's BLACK HAWK, and its Navy SEAHAWK and Air Force NIGHT HAWK derivatives, the Marine SUPER STALLION, and the commercial Sikorsky S-76, Sikorsky has the broad experience on which to base solutions to the crucial requirements for LHX supportability, maintainability, and mission performance.

In addition, Sikorsky Aircraft has, over the past several years, positioned itself for LHX through strong research and development programs. Underpinning this preparation have been investments in brick and mortar, in equipment, and especially in the people that will be required to develop LHX.

LHX will require major improvements in "housekeeping", navigation, flight controls, communications, and target acquisition aids. These systems will feature fault tolerance, self-diagnosis/self-healing, functional redundancy, ruggedness, and excellent RAM, all in an extremely compact and lightweight package. This has not been done in a helicopter — or any aircraft to the extent required by LHX.

On March 29, 1985 Sikorsky inaugurated a new research and engineering center. The purpose of the systems integration laboratories — the heart of the facility — is to integrate the sophisticated LHX electronics into a smoothly functioning, single entity with the LHX airframe.

By LOUIS S. COTTON, LHX Program Manager, Sikorsky Aircraft Division, UTC

Simulation is essential to developing a mission-capable aircraft and to determining the optimal man/machine interface. The Sikorsky integration laboratories currently house a fixed-base simulator supported by an extensive human factors lab, and avionics hot bench, flight controls, and software development facilities.

Next year, an advanced, 6°-of-freedom motion-base simulator will be installed with

ABOVE: The Sikorsky-ACAP helicopter with its all-composite airframe. BELOW: SHADOW, the Sikorsky-funded experimental research aircraft - a single-pilot cockpit attached to the nose of an S-76 helicopter.

computer-generated imagery of extremely high realism, rivalling that of the TV/terrain board, but with much greater variation possible.

But ground-based simulation can only go so far.

The Sikorsky-funded SHADOW aircraft will be used for airborne investigations of advanced

'The SHADOW . . is for airborne investigations of advanced cockpit concepts.'

cockpit concepts. The SHADOW features a single-pilot cockpit attached to the nose of a Sikorsky S-76 helicopter, outfitted with advanced avionics, voice control, CRT displays, and a digital fly-by-wire flight control system which uses multi-axis controllers in place of conventional helicopter controls.

To meet objectives such as those for the LHX, the development of an advanced helicopter must be accompanied by close attention to its producability. This emphasis starts on the drafting board — or more accurately at the **computer-aided design (CAD)** terminal — and must be carried through to the manufacturing floor.

To facilitate this, Sikorsky has co-located its design and manufacturing engineering people.

An artist's conception of an LHX design being considered by Sikorsky Aircraft.

Design approaches are predicated from the outset on their producability.

The spectrum of what is economically producible is constantly being expanded by the ongoing incorporation of advanced, highly automated manfacturing techniques. The emphasis at Sikorsky is on robotics and group technology, where similar parts are completely manufactured in a particular area of the shop floor.

'Sikorsky has developed composite expertise through manufacture of more than 530,000 parts'

A high percentage of composite material structures will be used in LHX. Sikorsky's new Tallassee, Alabama composites plant will include such features as automated materials handling, ply management, and water-jet trimming of composite components.

Over the years Sikorsky has developed its composites expertise through the manufacture of more than 530,000 composite parts for its current line of H-60, H-53, and S-76 helicopters. The true test of this capability, however, was in the U.S. Army/Sikorsky's **Advanced Composite Airframe Program (ACAP)** helicopter which first flew in July, 1984.

The ACAP, the world's first fully militarized, flightworthy composite aircraft, fixed or rotary wing, is a "sampler" of a number of different composite materials and manufacturing techniques.

Sikorsky is ready for LHX. Ready with up-to-the minute Army experience to know and understand the roles and missions; ready with facilities to develop the most sophisticated helicopter weapon system yet to be built; ready with the manufacturing experience and capabilities to built it rugged, reliable, maintainable, and at the lowest cost; and ready with experienced people to make it happen.

Sikorsky is ready for LHX; with the vision to see it, and the capability to see it through. ▮▮▮▮▮

AMC
(Continued from Page 19)

as he is for the end product. We cannot accept the aircraft if we are unable to train our troops on how to use and maintain it.

In summary, the LHX aircraft solicitation and systems specification will be a concise and simplified document that states what results are needed, rather than detailed 'how to' procedures and management systems for achieving those results. It will require a contractor to build economically producible, operationally suitable, and field supportable equipment, while providing equatable flexibility to optimize the design.

I believe that Army Materiel Command is well on the way to providing the soldier in the field the best weapons system that we have ever fielded. IIIII

BOEING
(Continued from Page 78)

molding of composite blades accurately reproduces the unique contours of these advanced airfoils at an economical cost, a technique denied by metal blades. Furthermore, we can instantly analyze results by testing scale-model airfoils in our on-site V/STOL wind tunnel.

The general introduction of composites into the LHX will provide a more rugged, damage-tolerant, and corrosion-free aircraft with significant reductions in maintenance requirements. Our efficient factory techniques will provide low-cost manufacturing.

The Army's LHX program objectives will require industry to provide a combination of advanced avionics and helicopter technologies. Industry must provide the best in management and engineering skills, research laboratories, and manufacturing capabilities. The Army plans to buy a large number of Scout, Attack, and Utility versions of the LHX and to procure them from two independent and competitive production sources.

Boeing believes the best way to meet the program's requirements is to team with another helicopter company that provides complementary strengths during full-scale development. Teaming will provide the synergism that will develop a superior product while also providing the Army with fully competitive and independent production sources. We plan to announce our LHX teaming arrangement in the near future.

The bottom line is to provide an LHX system which meets operational requirements without exceeding the affordability constraints on acquisition cost and cost of operation. We're working closely with the Army to achieve these objectives and I am confident we will succeed. IIIII

TRADOC
(Continued from Page 58)

which will include lightweight advanced flight controls, wide field of view displays, and reduced pilot workload tasks to single pilot levels; ballistic protection for the aircraft and pilot, and the LHX will be armed with HELLFIRE, air-to-air Stinger, 2.75'' rockets, and/or a turreted gun.

Most aviators will question the single pilot concept. The LHX program is structured to provide the single pilot answer before going into full scale development, and the issue will be further analyzed before entering production.

The aviator will be afforded the opportunity to verify industry's demonstrated feasibility of a one man operable helicopter at each milestone, to include developmental and operational tests. This will be done from the point of view of the single pilot's capability to perform the demanding missions required on the dirty battlefield of the 1990's and beyond.

I started this article with a brief statement of the Army Aviation Mission:

"To conduct prompt and sustained combat operations."

Within the limits of this article, I have tried to articulate the complexity of this mission, and the difficulty the aviation commander will face in accomplishing his numerous tasks with the existing aircraft.

The LHX will provide the aviation commander with the key ingredient he needs to accomplish his mission and win. The LHX will take a little longer to get in his hands; however, the wait will be well worth it.

In the meantime, the TRADOC System Manager's Office will continue to represent the user and will monitor the LHX program and will aggressively participate in it. IIIII

Registration Opens for the Third AAAA ASE Symposium

Registration for the 3rd Annual Aircraft Survivability Equipment (ASE) Symposium, to be sponsored by the Army Aviation Association of America, in cooperation with its industry member firms, is open now through Monday, 14 October 1985. The symposium will be hosted by Sanders Associates, Inc., in Nashua, New Hampshire, on 12-13 November 1985.

The 1985 ASE Symposium, which will explore "Modern ASE for Operations into Enemy Lines and against Hybrid Weapon Systems with Sensor Fusion", is open to all interested AAAA members who possess the appropriate level security clearance.

Please contact Lynn Coakley at the AAAA National Office, at (203) 226-8184 if you would like additional information.

MAY 1985

■■MAY 29. 'Follow Me' Chapter. Professional Luncheon Meeting. Ft. Benning Officers' Club. General Elections and Convention Report.

■■MAY 29. Lindbergh Chapter. Social Meeting. Executive International Inn.

■■MAY 29. Monmouth Chapter. General Membership Meeting. MG Charles F. Drenz, guest speaker. 'The AH-64A APACHE Helicopter'. Molly Pitcher Inn, Red Bank, NJ.

■■MAY 30. Schwaebisch Hall Chapter. General Membership Meeting. Election of new officers. Dolan Barracks Community Club.

JUNE 1985

■■June 1. North Texas Chapter. General Membership Meeting. H. Ross Perot, Jr., guest speaker. 'Around the World in 30 days — by Helicopter'. Amfac West Tower, D/FW Airport.

■■June 1. Morning Calm Chapter. Spring General Membership Meeting and Picnic. Hanger Area, Camp Humphreys.

■■June 3. Checkpoint Charlie Chapter. General Membership Meeting. Aviation Classroom TCA.

■■June 11. Army Aviation Center Chapter. Professional Luncheon Meeting. COL Bill Crouch, Ret., guest speaker. 'The AH-64A APACHE Helicopter'. Fort Rucker Officers' Open Mess.

■■June 20. Connecticut Chapter. Professional Dinner Meeting. Mr. Joseph Cribbins, Special Assistant to the Deputy Chief of Staff for Logistics, guest speaker. Three Doors Restaurant, Bridgeport.

■■June 21. Southern California Chapter. Space Shuttle Landing. Edwards AFB, California.

■■June 26. Jack H. Dibrell (Alamo) Chapter. Golf Tournament and General Membership Meeting. Fort Sam Houston Golf Course.

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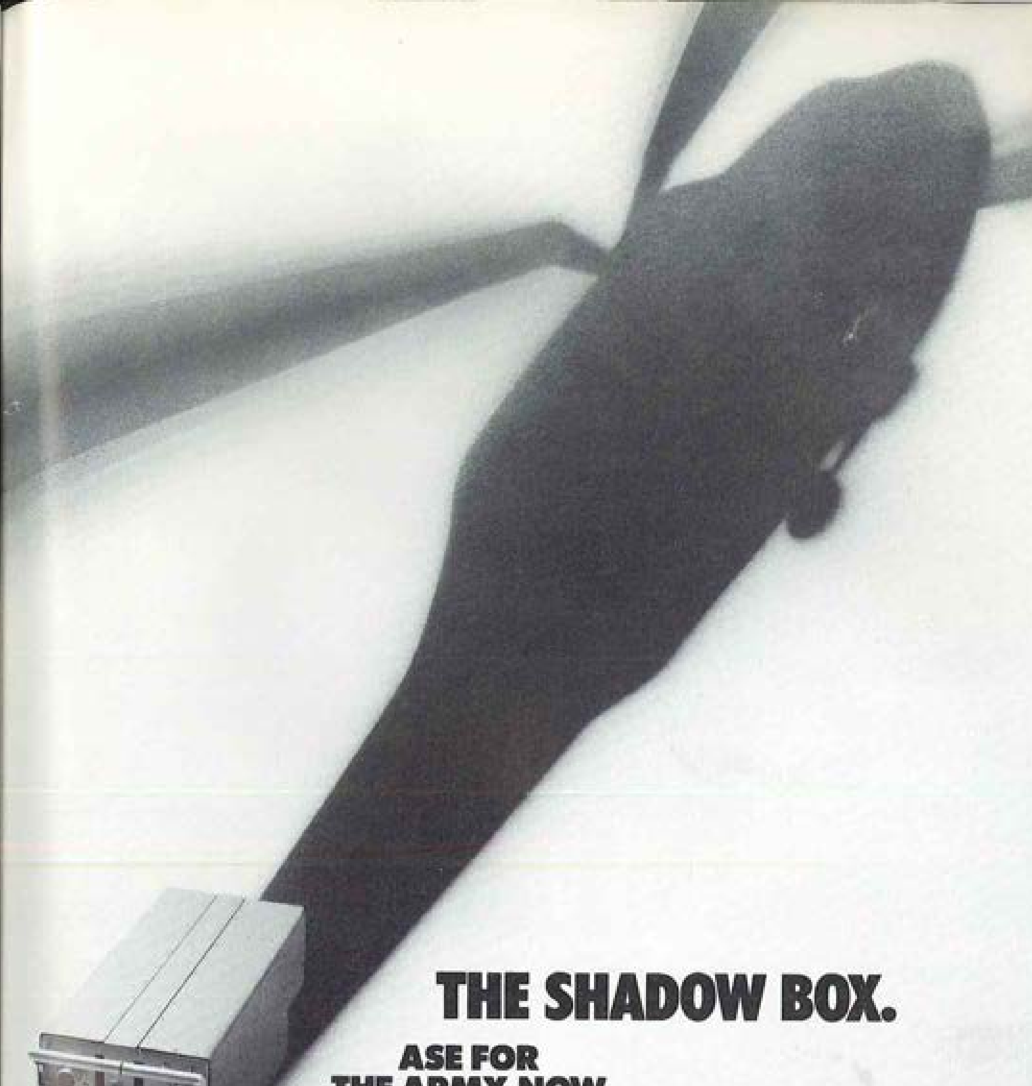

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